

STUDY

Requested by the PETI committee



Air Pollution in the European Union



Policy Department for Citizens, Equality and Culture
Directorate-General for Citizens' Rights, Justice and Institutional Affairs
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Air Pollution in the European Union

Abstract

This study, commissioned by the Policy Department for Citizens, Equality and Culture for the Committee on Petitions of the European Parliament, provides an analysis of the current legislative framework on ambient air quality, highlights the most relevant case law of the Court of Justice of the European Union concerning air quality, and examines selected infringement procedures and petitions. The study identifies best practices for air protection among Member States and offers policy recommendations.

This document was requested by the European Parliament's Committee on Petitions.

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CONTENTS

LIST OF ABBREVIATIONS	5
LIST OF FIGURES	7
LIST OF TABLES	7
EXECUTIVE SUMMARY	9
1. BACKGROUND INFORMATION	12
1.1. Introduction	12
1.2. Approach and methodology	14
1.3. Objectives and structure	15
2. CURRENT LEGAL SITUATION	17
2.1. Ambient Air Quality	20
2.1.1. AAQD 2008	21
2.1.2. Case law of the CJEU concerning AAQD 2008	23
2.1.3. New AAQD	25
2.2. NEC Directive	28
2.3. Sectoral legislation	31
3. IMPLEMENTATION OF AIR QUALITY LEGISLATION	33
3.1. EU Pilot dialogue	33
3.2. Infringement procedures	34
3.3. Environmental Implementation Review	35
3.4. 2030 targets based on the 8 th Environmental Action Programme	38
4. ROLE OF THE COMMITTEE ON PETITIONS	40
4.1. Case 1: Petition No. 465/2021 on keeping air quality below recognised health thresholds and Petition No. 180/2011 (Italy)	42
4.1.1. Summary of the petition	42
4.1.2. Status of the petition	42
4.1.3. Assessment of the case	42
4.2. Case 2: Petition No. 323/2011 on the alleged infringement of Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe by the Community of Madrid and Madrid City Council, Spain	43
4.2.1. Summary of the petition	43
4.2.2. Status of the petition	43
4.2.3. Assessment of the case	43

4.3.	Case 3: Petition No. 123/2011 on air pollution in the Polish town of Proszkow as a result of the burning of household waste	44
4.3.1.	Summary of the petition	44
4.3.2.	Status of the petition	44
4.3.3.	Assessment of the case	44
4.4.	Case 4: Petition No. 1484/2008 on the impact of noise and atmospheric pollution on the health of residents in the vicinity of Charles de Gaulle–Roissy airport	45
4.4.1.	Summary of the petition	45
4.4.2.	Status of the petition	45
4.4.3.	Assessment of the case	45
4.5.	Case 5: Petition No. 1337/2008 on the Maritza-Iztok power plant and pollution in the area around the Bulgarian town of Stara Zagora, together with Petitions No. 1865/2009 and No. 0257/2011	45
4.5.1.	Summary of the petitions	45
4.5.2.	Status of the petitions	46
4.5.3.	Assessment of the case	46
4.6.	Summary of recent petitions concerning air quality	47
5.	BEST PRACTICES AND POLICY RECOMMENDATIONS	48
5.1.	Best practices	48
5.1.1.	Energy and heat generation	49
5.1.2.	Traffic	50
5.1.3.	Agriculture	52
5.1.4.	Awareness raising and advisory support	53
5.1.5.	Integrated approaches	53
5.2.	Policy recommendations	54
5.2.1.	AAQD provisions	54
5.2.2.	Enforcement and implementation	55
5.2.3.	National level	56
	REFERENCES	58

LIST OF ABBREVIATIONS

AAQD or new AAQD	Directive (EU) 2024/2881 of the European Parliament and of the Council of 23 October 2024 on ambient air quality and cleaner air for Europe (recast)
AAQD 2008	Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe
AQP	Air Quality Plans
BaP	Benzo(a)pyrene
CJEU	Court of Justice of the European Union
CFREU	Charter of Fundamental Rights of the European Union
EAP	Environmental Action Programme
ECA	European Court of Auditors
EEA	European Environment Agency
EU	European Union
GDP	Gross domestic product
GHG	Greenhouse gases
IED	Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (recast)
LEZ	Low Emission Zone
LRTAP Convention	Convention on Long-Range Transboundary Air Pollution (1979)
MCPD	Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

NAPCP	National Air Pollution Control Programmes
NEC Directive	Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC
NERC	National emission reduction commitments under the NEC Directive
NH₃	Ammonia
NMVOC	Non-methane volatile organic compounds
NO₂	Nitrogen dioxide
NO_x	Nitrogen oxides, the sum of nitrogen monoxide and nitrogen dioxide expressed in units of mass concentration of nitrogen dioxide
O₃	Ozone
PETI	Committee on Petitions
PM	Particulate matter
PM₁₀	Particulate matter which passes through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter
PM_{2.5}	Particulate matter which passes through a size-selective inlet with a 50 % efficiency cut-off at 2.5 µm aerodynamic diameter
SO₂	Sulphur dioxide
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
WHO	World Health Organisation

LIST OF FIGURES

Figure 1:	Health impacts of air pollution	13
Figure 2:	Share of pollutant emissions from a given source, 2022	14
Figure 3:	Clean air policy framework in the EU	19
Figure 4:	Comparison of WHO Air Quality Guidelines (AQG)	20
Figure 5:	Comparison of air quality standards between EU and WHO	28
Figure 6:	Trend – Environmental Cases as a Percentage of New EU Pilot Cases	34
Figure 7:	List of Priority Actions, 2025 Environmental Implementation Review	38
Figure 8:	Premature deaths due to air pollution	39

LIST OF TABLES

Table 1	Current infringement procedures in the EU related to AAQD 2008	35
Table 2	Petitions considered in this study	41

EXECUTIVE SUMMARY

Background

Air pollution remains one of the most significant environmental and public health challenges facing the European Union (EU). Despite significant legislative efforts and gradual improvements in air quality since the 1970s, many Member States continue to exceed EU limit values for key pollutants, including particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide (NO₂), ozone (O₃) and sulphur dioxide (SO₂). This study examines the legal and policy framework of the EU on air quality, analyses enforcement mechanisms, evaluates best practices implemented by the Member States, and provides policy recommendations to strengthen compliance and reduce harmful emissions.

EU legal framework

The EU air quality framework is primarily governed by the Ambient Air Quality Directive (AAQD, Directive 2024/2881 to be transposed by 11 December 2026 and the previous Directive 2008/50/EC in force until 11 December 2026), which establishes binding limit values and requires Member States to develop air quality plans when exceedances occur. The new AAQD, adopted in 2024, aims to achieve closer alignment with World Health Organisation (WHO) guidelines, expand provisions on penalties and public information, and improve air quality monitoring and modelling. However, significant gaps remain. The new directive lacks penalties or coercive measures aimed at competent authorities, relies on national enforcement mechanisms, and provides lenient postponement provisions that can delay meaningful reductions in polluting substances.

The Court of Justice of the EU (CJEU) has delivered numerous judgements against Member States for failing to comply with air quality obligations. Analysis of the CJEU case law reveals that Member States have failed to adopt effective and timely air quality plans, particularly in urban agglomerations suffering from traffic-related pollution and industrial emissions. Key cases include proceedings against several Member States due to persistent exceedances of PM₁₀, PM_{2.5}, NO₂ and SO₂ limit values. These judgements clarify the Member States' obligations to adopt effective measures and demonstrate the Commission's role in ensuring compliance.

Role of Petitions and Public Participation

The European Parliament's Committee on Petitions plays a crucial role in combatting air pollution by providing a platform for citizens to raise concerns. This study analyses multiple petitions related to air quality infringement procedures, demonstrating how public participation influences Commission enforcement decisions. Petitions from several Member States highlighted persistent air quality violations, leading to or supporting ongoing infringement procedures.

However, the length of infringement procedures remains problematic. The cases analysed show durations ranging from 10 to 17 years before reaching the CJEU judgements, with some still ongoing. This delay undermines the effectiveness of enforcement and prolongs harmful exposure for populations living in affected zones.

Member State Non-Compliance and Barriers

Several Member States face persistent challenges in meeting EU air quality standards. Key barriers include inadequate political will to adopt stringent measures, socioeconomic constraints (particularly in regions with low GDP), insufficient regulation of domestic heating sources, heavy reliance on individual motor vehicle transport, and weak coordination between national and local authorities.

Infringement procedures reveal systemic issues. For example, a case concerning PM₁₀ exceedances was initiated in 2009, referred to the CJEU in 2015, and resulted in a judgement in 2018. Despite this, non-

compliance continued, leading to additional formal notices under Article 260 of the Treaty on the Functioning of the EU (TFEU) in 2023. However, not all cases necessarily lead to the court's acknowledgement of the infringement. For example, another case (C-174/21) was dismissed as inadmissible because the Commission failed to clearly establish that previous judgement obligations remained unfulfilled, demonstrating procedural challenges in enforcement.

Best Practices and Effective Measures

The study identifies proven measures across several categories:

Energy and heat generation: The most effective measures and practices include the transition from fossil fuels to renewable energy, phase-out of coal and lignite power plants, replacement of obsolete domestic boilers with cleaner alternatives, and awareness campaigns on proper boiler operation. Examples include Hungary's LIFE-IP-HUNGAIKY project to decarbonise the Mátra power plant and Czechia's boiler replacement scheme, which replaced 100,000 boilers and saved 2.7 kilotons of PM_{2.5} emissions.

Traffic management: Low-emission zones, ultra-low-emission zones, zero-emission zones, congestion charges, and vehicle access restrictions have proven effective. Berlin's low-emission zone significantly reduced transport emissions, avoiding an estimated 10 days of exceedance of PM₁₀ daily limit values in 2010 and reducing NO₂ pollution by approximately 5%. Studies confirm that low-emission zones boost local economies rather than harm them.

Public transportation and active mobility: Cities like Antwerp and Vilnius demonstrate integrated approaches that combine improved public transport, cycling infrastructure, and spatial planning. Copenhagen's cycling policies and Berlin's pop-up bicycle lanes exemplify successful active mobility promotion.

Agriculture: Precision farming, integrated manure management, closed manure storage and improved livestock feeding strategies effectively lower ammonia emissions. Up to 75 % of ammonia emissions come from manure and 20 % come from inorganic fertilisers.

Integrated approaches: Sustainable Urban Mobility Plans and spatial planning instruments that integrate congestion, air pollution, climate change, road safety, and parking considerations prove most effective. LIFE projects like PREPAIR in Italy's Po Valley demonstrate successful multi-sector coordination.

Policy Recommendations

The study offers recommendations at both the EU and national levels:

EU level:

- Strengthen the interconnection between the AAQD and legislation concerning individual polluting sources, particularly vehicles.
- Harmonise provisions on low-emission zones and traffic restrictions across Member States.
- Establish institutionalised forums for cooperation amongst competent authorities, similar to the Forum for Air Quality Modeling (FAIRMODE¹).
- Improve transparency and establish clear timelines for EU Pilot dialogue.

¹ The Forum for Air Quality Modeling (FAIRMODE) was launched in 2007 as a joint response initiative of the European Environment Agency (EEA) and the European Commission Joint Research Centre (JRC). FAIRMODE brings together air quality modelers and users in order to exchange experience and results from air quality modeling in the context of the European Air Quality Directives (AQD). Besides that it promotes and supports the harmonised use of models by EU Member States, with emphasis on model application under the European Air Quality Directives. https://knowledge4policy.ec.europa.eu/fairmode_en.

- Develop a more effective enforcement approach within infringement procedures.
- Consider establishing a substantive right to clean air within the EU legal framework, building on Advocate General Kokott's Opinion in C-723/17 linking air quality to the fundamental right to life.
- Align the limit values for NO₂, PM_{2.5}, PM₁₀, SO₂ and O₃ with the WHO air quality guidelines.
- Cooperation amongst Member States and between Member States and the Commission has demonstrated effectiveness and should be expanded.
- Clean Air Dialogues, TAIEX-EIR workshops, and LIFE projects provide valuable platforms for exchanging best practices and technical support.

National level:

- Ban or restrict the use of coal, lignite and wood for domestic heating in densely populated areas.
- Provide financial mechanisms to support the modernisation of heating appliances.
- Establish low-emission zones with gradual phase-out of polluting vehicles.
- Promote public transportation and active mobility through campaigns and spatial planning.
- Adopt integrated approaches through Sustainable Urban Mobility Plans.
- Ensure effective air quality plans that address specific local polluting issues and strict adherence by competent authorities.

Conclusion

The EU legislative framework on ambient air quality contains sufficient regulatory provisions. The primary deficiency lies in implementation, enforcement, and compliance. Specifically, key barriers include lack of political will to adopt strict measures, inadequate financial resources in regions with low GDP, weak enforcement mechanisms at both EU and national levels, absence of comprehensive connections between air quality legislation and sector-specific legislation governing polluting sources, and limited cooperation frameworks among competent authorities.

The new AAQD addresses some technical issues but lacks penalties or coercive measures aimed at competent authorities and maintains overly lenient limit value deadlines. With stricter limit values, the number of infringement cases will likely increase. Better enforcement instruments are needed to oversee air quality in Member States, as prolonged cases directly impact the health of people living in affected zones. Public participation through petitions demonstrates citizen engagement but also highlights the urgent need for faster and more effective enforcement mechanisms.

1. BACKGROUND INFORMATION

KEY FINDINGS

Air pollution causes approximately 357,000 deaths annually in the European Union (2022), with economic costs ranging from €268 billion to €428 billion per year, despite significant legislative efforts.

The new Ambient Air Quality Directive (AAQD) adopted in 2024 strengthens air quality standards to align with World Health Organisation (WHO) recommendations and establishes a zero-pollution target for 2050, while providing citizens with legal remedies for health damage resulting from air pollution.

The study employs a comprehensive methodology combining legal analysis, policy evaluation, and case law review to identify implementation gaps and best practices across Member States, with particular focus on the European Parliament's Committee on Petitions and its role in addressing persistent violations.

1.1. Introduction

Air pollution is a phenomenon connected to industrialised societies and their economic growth. It occurs in various regions of our planet and in different concentrations, but its impact on human health, fauna, and flora is undeniable. The effect on human health and well-being has been the focus of many scientific studies (Li *et al.*, 2020; Chua *et al.*, 2021; Vohra *et al.*, 2021; Chen *et al.*, 2024).

From an economy perspective, air is classified as a kind of public goods. This classification, in the context of protecting air quality, does it disservice, since public goods tend to be overused and/or overconsumed (Huck *et al.*, 2021).

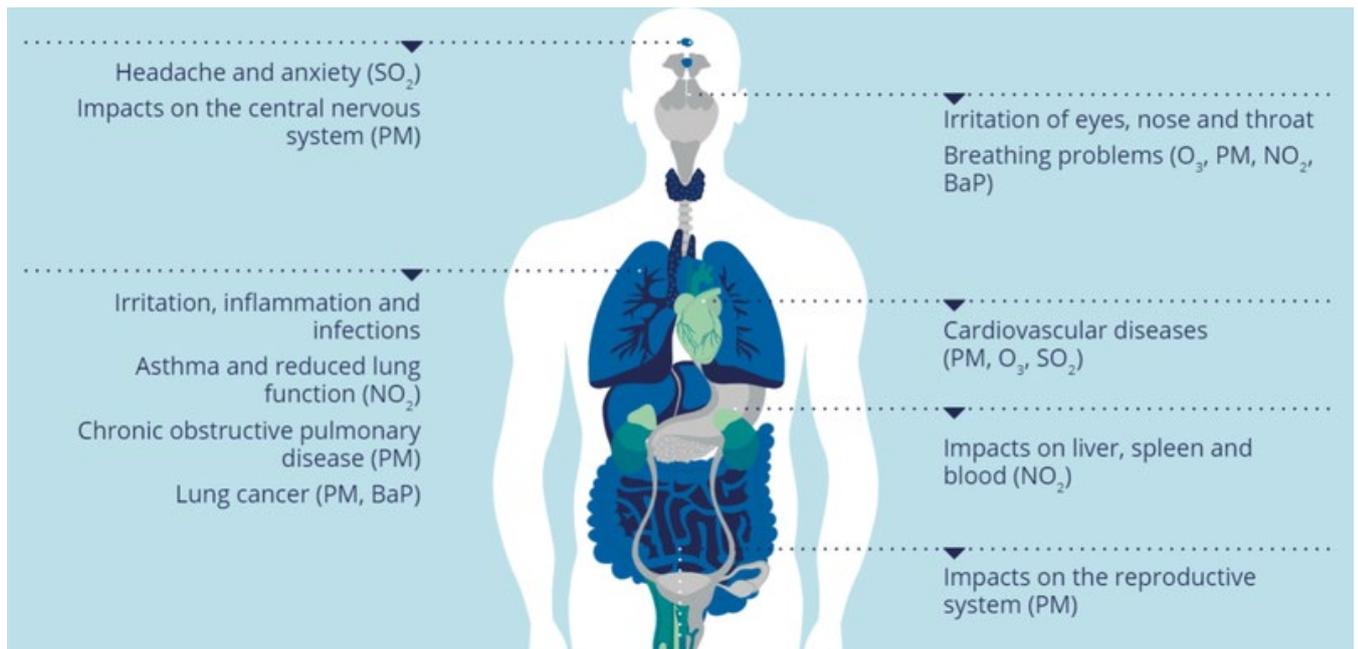
Even though the European Union has strengthened its laws and policies in recent years, air pollution is still a major environmental and public health concern. Data from the European Environment Agency (EEA, 2024) show that air pollution was responsible for 357,000 deaths in the EU-27 in 2022, of which almost 239,000 deaths because of fine particulate matter² (PM_{2.5}); 70,000 from exposure to ozone (O₃) and 48,000 from exposure to nitrogen dioxide (NO₂). This ongoing health crisis, along with the substantial economic damage it causes (between €268 billion and €428 billion a year from Europe's largest industrial plants) according to EEA (EEA, 2023a), underscores the importance of carefully reviewing the success of current strategies and identifying remaining problems.

The effects on human health of polluted air are well documented. Exposure to high levels of air pollutants contributes to a wide range of negative health issues, such as stroke, chronic obstructive pulmonary disease, trachea, bronchus and lung cancers, aggravated asthma, and lower respiratory infections (EEA, 2025b). Furthermore, there is evidence linking air pollution exposure and type 2 diabetes, obesity, systemic inflammation, Alzheimer's disease, and dementia (EEA, 2025b). Additionally, data show that poor air quality can cause low birth weight (Giovannini *et al.*, 2017) and premature births (Malley *et al.*, 2017). Moreover, research highlights that women are more vulnerable to cardiovascular diseases caused by air pollution than men (Liu *et al.*, 2020).

² Particulate matter which passes through a size-selective inlet with a 50 % efficiency cut-off at 10 µm or 2.5 µm aerodynamic diameter (PM₁₀ and PM_{2.5} respectively).

The picture below describes possible effects of polluted air on human body.

Figure 1: Health impacts of air pollution



Source: EEA, 2025b

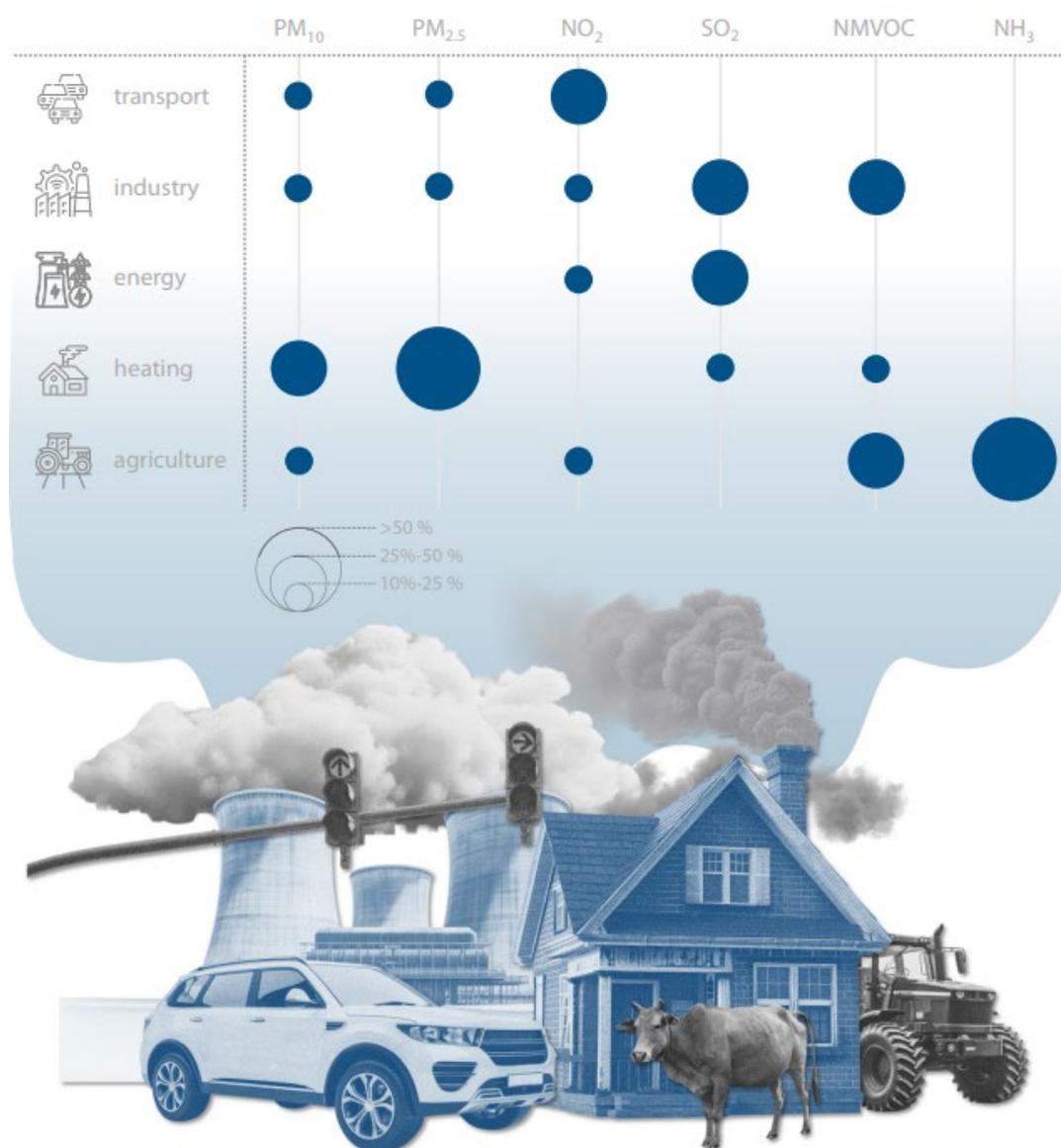
Air pollution also exacerbates rising inequalities within society (Simkovich *et al.*, 2019). Some vulnerable groups (older people, children, and other sensitive individuals) are affected more than others (EEA, 2018). At the same time, low-income households and families tend to suffer more, as their locations are often closer to industrial areas and busy roads (EEA, 2025b).³

Similarly, regions in Eastern and South-Eastern Europe with lower GDP per capita tend to have higher levels of $\text{PM}_{2.5}$ (EEA, 2025a). This is attributable to the use of low-quality solid fuels in low-efficiency domestic heating ovens (EEA, 2025b). Furthermore, in some cases, improvements in air quality are not necessarily linked to legislation or regulatory measures. For example, due to mild winters in Poland (caused by climate change), air quality has improved because residents used individual heating less frequently (Radecka, 2025a).

In addition to the different levels of $\text{PM}_{2.5}$, its sources also differ greatly among Member States (Thunis *et al.*, 2023). Beyond the consequences of air pollution, it is therefore important to examine the sources of air pollutants. Proper identification of these sources can facilitate the adoption of legislation to regulate and control them, thereby fulfilling fundamental environmental law principles: the prevention principle, the rectification at source principle, and the polluter-pays principle.

³ However, this is not a strict rule and may vary from city to city across the EU.

Figure 2: Share of pollutant emissions from a given source, 2022



Source: ECA, 2025

1.2. Approach and methodology

The adoption of the new Ambient Air Quality Directive (AAQD; Directive (EU) 2024/2881) – in force from 10 December 2024 and to be transposed by 11 December 2026– represents a substantial leap in the regulatory framework that governs air quality within the EU. This directive introduces more stringent air quality standards, closely aligned with (but still less strict than) the recommendations set forth by the World Health Organization (WHO), establishes the objective of achieving zero pollution by 2050, and importantly, incorporates provisions that ensure citizens' access to legal remedies and compensation for health damage resulting from air pollution. Such progress demands a thorough examination of the current legal and policy framework, the challenges related to implementation, and the evolving responsibilities of EU institutions in addressing ongoing air quality infringements.

To fully examine the issue of air pollution and its governance in the EU, this study adopts a multifaceted research approach that combines legal analysis, policy evaluation, and case study review.

The following elements make up the methodology:

Doctrinal legal analysis: The study includes a comprehensive examination of both primary and secondary EU legislation, along with their developmental trajectory, which collectively constitute the existing legal framework of the European Union on air quality. The analysis focuses on the scope of, and provisions contained in the Ambient Air Quality Directives and related legislation, notably the National Emissions Ceilings (NEC) Directive [Directive (EU) 2016/2284], in addition to other relevant secondary legislation.

Policy implementation analysis: The evaluation of implementation practices and compliance across EU Member States is an essential component of this approach. This involves the examination of data concerning air quality trends and compliance levels, including the identification of countries or regions that have consistently exceeded the EU limit values for pollutants. Reports issued by the European Commission and the European Environment Agency (EEA) are the main source for this assessment.

Infringement and case law review: This part examines case law and enforcement actions pertaining to Member States' obligations under the air quality framework. The study catalogues and analyses infringement proceedings initiated by the European Commission against Member States for violations of air quality legislation, predominantly under the previous AAQD (2008). It also reviews the key Court of Justice of the EU (CJEU) case law related to air pollution, with a particular emphasis on landmark rulings that clarify the rights of citizens and the responsibilities of Member States under the air quality legislation.

Comparative review of recent studies and best practices: The study conducts a comprehensive review of literature and data from authoritative sources on air pollution in the European Union, thereby situating the analysis within the framework of the existing scholarship as well as the most recent publications released by the EEA.

1.3. Objectives and structure

The general objective of the study is to present the most up-to-date findings on the harmful impacts of air pollution in the EU, to analyse the current legislative and policy framework, including an analysis of policy gaps and needed improvements, and to assess the role of the European Parliament and the Committee on Petitions (PETI).

This general objective is complemented by specific objectives which are addressed throughout the study:

1. To provide an overview of the health, environmental, and economic impacts of air pollution in the EU;
2. To analyse the relevant EU legal and policy framework, including the key CJEU judgements concerning air quality and the fight against air pollution;
3. To identify which air pollution policies implemented by EU Member States have proven most effective in reducing pollutant levels, and which EU policies remain insufficient and require further improvement;
4. To examine EU Member States – particularly those subject to infringement procedures – that are currently failing to meet the EU air quality targets for key pollutants, such as PM_{2.5}, nitrogen dioxide (NO₂), and ozone (O₃), to identify the main barriers preventing EU Member States from meeting the EU air quality standards, and to propose specific measures for improvement;

5. To assess the role of the European Parliament and the Committee on Petitions in combatting air pollution in the EU, and to evaluate the situation regarding infringements procedures under the EU air pollution directives, with a focus on cases linked to petitions submitted to the PETI Committee;
6. To provide a set of policy recommendations for EU policymakers, first and foremost for Members of the European Parliament, on what actions could be taken at the EU level (especially concerning any issues which may fall within the remit of the PETI committee), offering concrete policy options for EU institutions and Member States to mitigate the harmful effects of air pollution.

The study interprets the legislative obligations placed on Member States and EU institutions, explains how key terms and standards are defined, and outlines how the directives have evolved (or been recast) to reflect emerging scientific evidence. The doctrinal analysis establishes a solid legal foundation for understanding the requirements that the EU imposes concerning air quality objectives, monitoring mechanisms, and public rights. The effectiveness of EU air quality measures is evaluated through this policy analysis, which also highlights any major gaps between legislation in theory and results in practice.

The second chapter analyses both current and previous air quality legislation, with special attention to environmental policies that provide the legal backbone of this framework. The description of the AAQD 2008 legal framework draws on the book *EU Environmental Law and Policy* (Langlet & Mahmoudi, 2016). The chapter focuses particularly on provisions in primary law – Treaty on the Functioning of the European Union (TFEU), Treaty on European Union (TEU), and Charter of Fundamental Rights of the European Union (CFREU) and secondary law (AAQDs and NEC Directive). However, air quality issues are also addressed in other legislative acts discussed in this chapter.

A section of the chapter is devoted to relevant CJEU case law. Since the database contains a vast number of cases on air quality, only landmark decisions (as often mentioned in jurisprudence) are discussed.

The third chapter focuses on the implementation of the AAQDs in the Member States and identifies recurring problems in this area. This analysis is based on publicly available Environmental Implementation Reviews, infringement proceedings, and EU Pilot dialogues. Through this research, problematic areas and positive practices are identified.

The fourth chapter addresses PETI's role, with a particular focus on petitions concerning air quality.

The fifth and final chapter concludes the study by examining best practices among EU Member States aimed at improving air quality. It also provides policy recommendations concerning both the AAQD and the enforcement and implementation of air quality standards.

2. CURRENT LEGAL SITUATION

KEY FINDINGS

EU air quality legislation has evolved from pollutant-specific directives in the 1980s–1990s into comprehensive frameworks, with Directive 2008/50/EC (AAQD 2008) successfully reducing premature deaths from 420,000 in 2010 to approximately 357,000 in 2022.

The 2019 fitness check revealed persistent implementation problems across Member States, including inadequate air quality plans, strategic placement of sampling points to circumvent detection of exceedances, and insufficient coordination between air quality standards and sectoral legislation regulating pollution sources.

Academic literature confirmed that the AAQD 2008 contained sufficient regulatory rules but lacked robust implementation and compliance mechanisms.

The new AAQD of 2024 (to be transposed by December 2026) represents a fundamental shift by aligning EU standards more closely with WHO guidelines, establishing a zero-pollution target for 2050. It codifies CJEU case law granting citizens access to justice to challenge state decisions, acts, or omissions concerning sampling points, air quality plans, and short-term action plans.

The directive introduces a groundbreaking right to compensation for health damage caused by violations of air quality plans and roadmaps, preventing Member States from creating barriers that would render the exercise of this right impossible or excessively difficult.

The NEC Directive complements ambient air quality legislation by establishing binding national emission reduction commitments for five key pollutants, with targets for 2020–2029 and stricter ones from 2030 onwards.

A critical interplay exists between AAQD and sectoral legislation, particularly the Industrial Emissions Directive (IED) and vehicle emissions standards (Euro 7), though insufficient coordination remains a documented problem.

From a primary law perspective, Articles 191–193 TFEU govern environmental policies, with Article 192 being the main legal basis for air quality legislation in the EU. The TFEU contains principles (leading ideas and interpretational guidelines) concerning environmental policies. These are set out in Article 11 TFEU and Article 191(2) TFEU.

Article 11 TFEU

Environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, in particular with a view to promoting sustainable development.

Article 191(2) TFEU

*Union policy on the environment shall aim at **a high level of protection** taking into account the diversity of situations in the various regions of the Union. It shall be based on the **precautionary principle** and on the **principles that preventive action should be taken**, that environmental damage should as a priority be **rectified at source** and that the **polluter should pay**.*

In this context, harmonisation measures answering environmental protection requirements shall include, where appropriate, a safeguard clause allowing Member States to take provisional measures, for non-economic environmental reasons, subject to a procedure of inspection by the Union

Furthermore, the protection of the environment is one of the core values of the EU, as enshrined in the Article 3(3) TEU.

Article 3(3) TEU

*The Union shall establish an internal market. It shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and **a high level of protection and improvement of the quality of the environment**. It shall promote scientific and technological advance.*

Finally, the founding documents are complemented by the CFREU. The Charter establishes environmental protection in Article 37, which must be integrated into EU policies.

Article 37 of CFREU

A high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in accordance with the principle of sustainable development.

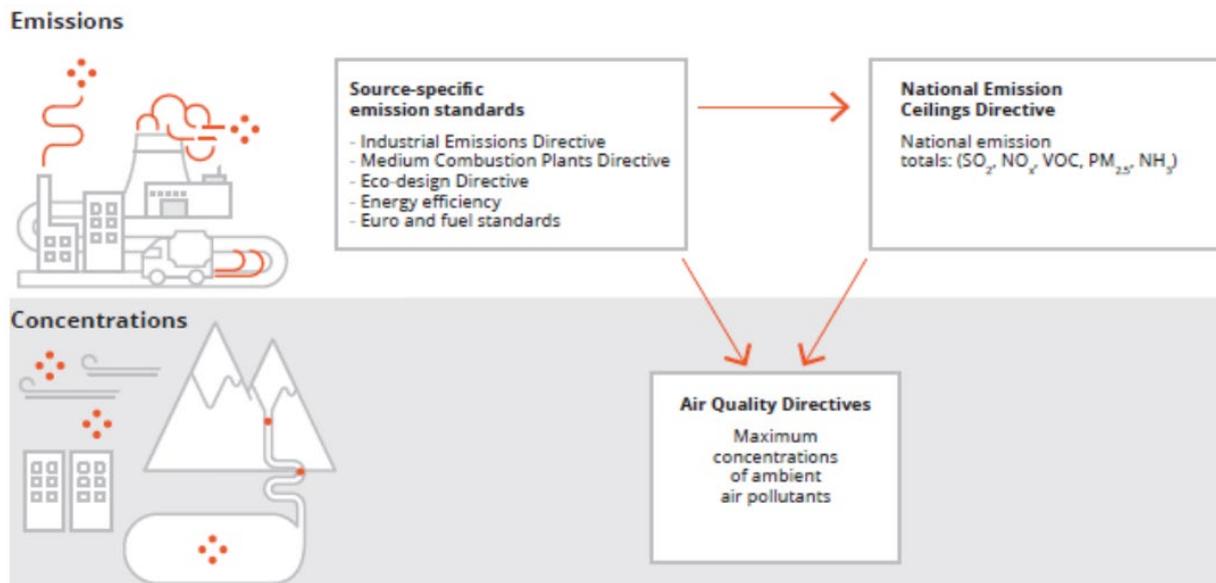
From a secondary law perspective, the EU's ambient air policy stands on three pillars: the Ambient Air Quality Directives, the National Emissions Ceilings Directive, and source-specific emission standards. Together, these pillars aim to ensure that ambient air quality within the EU remains within limits that are not detrimental to human health and environment. In theory, the interplay among these legislative instruments should create synergy. However, as will be shown further, this is not always the case, particularly concerning the relationship between the AAQD and sector-specific legislation.

It is important to note that the legal framework does not regulate all air-polluting substances, but only a selected group that significantly impacts human health and the environment. According to AAQD 2008, the pollutants identified as the most harmful to human health, fauna, and flora include ozone (O₃) and related NO and NO₂, sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and oxides of nitrogen, benzene, carbon monoxide (CO), lead (Pb), PM_{2.5}, PM₁₀, and volatile organic compounds (VOC).

In addition, the NEC Directive targets the following pollutants: sulphur dioxide (SO₂), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH₃), and fine particulate matter (PM_{2.5}).

For a better visual understanding of the three pillars of EU ambient air quality legislation, see Figure 3 below.

Figure 3: Clean air policy framework in the EU



Source: European Commission, 2020

The overarching aim of regulatory instruments on ambient air quality is to achieve an environment that is non-toxic to human health, fauna, and flora. The definition of a non-toxic environment – specifically, the permissible concentrations of certain pollutants and their corresponding limit values in the atmosphere – is provided by the WHO⁴. This organisation has issued non-binding air quality guidelines (WHO, 2021) based on scientific and medical evidence, which serve as a reference point for EU ambient air quality legislation. Although these guidelines are non-binding, Member States are expected to strive to meet them; failure to do so means that inhabitants may not live in an environment conducive to their health, development, and well-being.

The guidelines have been revised over time, becoming increasingly stringent. Consequently, Member States that were previously close to meeting these standards may now struggle to comply, even if they remain in conformity with the EU's air quality standards, which are more lenient than the WHO guidelines.

⁴ Further information on the guidelines can be found on the website of the WHO, available at <https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines>.

Figure 4: Comparison of WHO Air Quality Guidelines (AQG)

Recommended 2021 AQG levels compared to 2005 air quality guidelines

Pollutant	Averaging Time	2005 AQGs	2021 AQGs
PM _{2.5} , µg/m ³	Annual	10	5
	24-hour ^a	25	15
PM ₁₀ , µg/m ³	Annual	20	15
	24-hour ^a	50	45
O ₃ , µg/m ³	Peak season ^b	-	60
	8-hour ^a	100	100
NO ₂ , µg/m ³	Annual	40	10
	24-hour ^a	-	25
SO ₂ , µg/m ³	24-hour ^a	20	40
CO, mg/m ³	24-hour ^a	-	4

µg = microgram

^a 99th percentile (i.e. 3–4 exceedance days per year).

^b Average of daily maximum 8-hour mean O₃ concentration in the six consecutive months with the highest six-month running- average O₃ concentration.

Note: Annual and peak season is long-term exposure, while 24 hour and 8 hour is short-term exposure.

Source: WHO, 2021

Greenhouse gases are not covered by the EU ambient air quality legal framework, as they are addressed under separate regulatory acts and fall within a different policy domain—climate policy (managed by the Directorate-General for Climate Action of the European Commission). Ambient air quality, by contrast, falls under environmental policy (managed by the Directorate General for Environment of the European Commission).

From an applicability standpoint, air pollutants primarily affect local air quality and daily life within specific zones, whereas greenhouse gases have a global impact on the planet's climate.

2.1. Ambient Air Quality

Protection of air quality has been continuously developing in the EU since the 1970s. Through the 1980s and 1990s, several legislative acts were introduced to combat the rise in air pollution predominantly caused by industrial processes and installations.

This push towards a better environment and air quality was driven by the gradual rise of people's living standards across Europe and by an increasing focus on protecting human health in relation to the environment. In 1980, the Directive on air quality limit values and guide values for sulphur dioxide and suspended particulates (80/779/EEC) was introduced, thus limiting specific pollutants in the air.

Following this first directive, other related directives were introduced, thereby expanding the scope of regulated air pollutants. Namely: the Directive on a limit value for lead in the air (82/884/EEC), the Directive on air quality standards for nitrogen dioxide (85/203/EEC), and the Directive on air pollution by ozone (92/72/EEC).

However, a long-term solution aimed at achieving long-term air quality objectives was needed. Therefore, under the Fifth European Community environment programme (1992-2000), the first framework directive on ambient air quality was adopted. The Directive on ambient air quality assessment and management (96/62/EC) contained provisions on:

- unified measurement system (covering both technology and location),
- results regularly transmitted to the Commission,
- air quality information made available to the public, and
- plans and programmes for zones or agglomerations where limit values were exceeded.

However, it is important to note that the directive itself did not contain any limit values. These were included in the daughter directives, namely: the Directive relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air (1999/30/EC), the Directive relating to limit values for benzene and carbon monoxide in ambient air (2000/69/EC), the Directive relating to ozone in ambient air (2002/3/EC), and the Directive relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (2004/107/EC).

These directives were subsequently merged into the second framework directive on ambient air quality (except for Directive 2004/107/EC, which remains in force). This merger resulted in Directive 2008/50/EC on ambient air quality and cleaner air for Europe (AAQD 2008).

2.1.1. AAQD 2008

The following section presents the AAQD 2008 based on the chapter 'Ambient Air Quality and Cleaner Air for Europe' (Langlet & Mahmoudi, 2016).

The AAQD 2008 (in force until 11 December 2026) was established to define and articulate objectives concerning ambient air quality that aim to prevent, pre-empt, or mitigate adverse effects on human health and the environment as a whole. Additional objectives include the assessment of ambient air quality within Member States using standardised methodologies and criteria; the monitoring of long-term trends and improvements resulting from national and EU interventions; the dissemination of public information regarding ambient air quality, the preservation of air quality in areas characterised by good quality; the enhancement of air quality in other areas; and the promotion of increased cooperation among Member States in their efforts to reduce air pollution (Article 1).

Member States are required to designate zones across their jurisdiction for the purpose of air quality assessment and management. This constitutes their fundamental responsibility. An 'agglomeration' is defined as a zone that included an urban area with a population exceeding 250,000 inhabitants, or with a specific population density as determined by the Member States. The assessment and management of air quality have to be carried out in all designated zones and agglomerations (Articles 2 and 4).

Chapter II of the AAQD 2008 (Articles 5–11) sets out regulations pertaining to the assessment of ambient air quality in relation to SO₂, NO₂, NO_x, PM, lead, benzene, and CO. The classification of each zone and agglomeration is governed by the specific assessment thresholds set out in Annex II and is to be reviewed at least every five years. The ambient air quality across all zones and agglomerations is to be assessed in relation to the aforementioned pollutants. The methodology for conducting this assessment in a specific zone or agglomeration depends on whether pollutant levels exceed or remain below the prescribed assessment thresholds. Moreover, the chapter includes ozone-specific assessment criteria.

Chapter III of the Directive (Articles 12–22) pertains to the management of ambient air quality. Annexes XI to XIV of the Directive stipulate a range of thresholds, target values, and limit values related to this

chapter. Specifically, these provisions include limit values aimed at safeguarding human health, information and alert thresholds, critical levels for the protection of vegetation, national exposure reduction targets, and target and limit values for PM_{2.5}.

In zones and agglomerations where the concentrations of SO₂, NO₂, PM₁₀, PM_{2.5}, lead, benzene, and CO in ambient air are below the respective limit values, Member States are obliged to maintain pollutant levels below those limits and to endeavour to uphold the best possible ambient air quality consistent with sustainable development (Article 12).

Regarding limit values, the concentrations of SO₂, PM₁₀, lead, and CO present in ambient air are not to exceed the established limit values within any designated zone or agglomeration. To fulfil the national exposure reduction target set out in Section B of Annex XIV, all necessary measures that did not entail disproportionate costs are to be implemented to reduce exposure to PM_{2.5} (Articles 13–16).

An 'alert threshold' refers to a level beyond which the population as a whole faces a risk of adverse effects from short-term exposure, thereby necessitating immediate intervention by Member States. In contrast, an 'information threshold' denotes a level beyond which the health of particularly vulnerable groups is at risk due to short-term exposure, thereby requiring immediate and appropriate dissemination of information. In the event that any alert threshold or information threshold are exceeded, the relevant Member State is required to inform the public through various media, including radio, television, newspapers, or the internet (Articles 12 and 19).

If a Member State presents evidence to the Commission demonstrating that an exceedance is attributable to natural sources, the exceedance of a limit value for a given pollutant is not considered an exceedance under the Directive (Article 20).

To ensure the attainment of the target values and long-term objectives for ozone (O₃), all necessary measures are to be undertaken without incurring disproportionate costs. Member States are obliged to maintain O₃ concentrations below the long-term objectives in zones and agglomerations where O₃ levels have complied with these objectives, to the extent permitted by the transboundary nature of O₃ pollution and prevailing meteorological conditions. The best possible ambient air quality consistent with sustainable development and ensuring a high level of protection for the environment and human health is to be preserved through proportionate actions (Articles 17 and 18).

The Directive permits the postponement of attainment deadlines and exemptions from the obligation to apply specific limit values under certain circumstances. Nonetheless, such provisions were primarily relevant during the initial years following the enactment of the Directive (Article 22).

In instances where pollutant concentrations in ambient air within specific zones or agglomerations exceed any limit value or target value, along with any applicable margin of tolerance, Member States are required to formulate air quality plans (AQP) for those zones and agglomerations in order to achieve the corresponding limit or target values. The Commission has to be promptly notified of those plans (Article 23).

In circumstances where the concentrations of pollutants within a designated zone or agglomeration are likely to exceed one or more of the alert thresholds specified in Annex XII, Member States are required to develop action plans setting out the immediate actions necessary to reduce the risk or duration of such exceedances. Short-term action plans can be established in cases where there is a risk that pollutant levels would exceed one or more alert thresholds. Depending on the specific context, these short-term action plans can include effective measures to control and, if necessary, suspend activities that contribute to the risk of exceeding the relevant limit, target, or alert thresholds (Article 24).

In accordance with Article 26, the general public and relevant organisations, including environmental bodies, have to be promptly and adequately informed of the ambient concentrations of the pollutants listed in the AAQD 2008, as well as of the related air quality plans and programmes.

In instances where any alert threshold, limit value, or target value, along with any relevant margin of tolerance or long-term objective, are exceeded due to significant transboundary transport of air pollutants or their precursors, the Member States concerned are required to cooperate and, where necessary, to establish joint activities, which can include the formulation of joint or coordinated AQP (Article 25).

Arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air remain subject to regulation under Directive 2004/107/EC, which continues to exist as a separate directive. Among other provisions, it includes target values and rules for the assessment of ambient air concentrations and deposition rates⁵ for these substances.

Ambient air protection has come a long way since its inception. According to the Report by the EEA (2016), in 2013 the EU was experiencing approximately 520,000 premature deaths due to air pollution. Based on data from the EEA (2024), this number has gradually decreased, thanks to measures implemented within the AAQD framework, to approximately 239,000 deaths attributable to PM_{2.5} pollution, 48,000 deaths due to NO₂ exposure, and 70,000 deaths resulting from O₃ exposure in 2022.

As Yamineva and Romppanen (2017) note, the EU legislative framework on ambient air quality (AAQD 2008) contains sufficient regulatory provisions; however, it lacks stronger implementation and compliance mechanisms. Additionally, even when Member States fully implement all relevant provisions, they may still fail to achieve the desired outcomes, which could lead to potential infringement procedures. This may result from policy choices and legislative gaps in other sectoral areas (Čavoški, 2017).

2.1.2. Case law of the CJEU concerning AAQD 2008

The Court of Justice has been interpreting air quality legislation for several decades. The official database (Curia) contains dozens of cases pertaining to the interpretation of relevant provisions and infringement proceedings related to air quality.

However, the following section describes only the most significant cases that are also discussed in the legal literature. On a positive note, many of these rulings – and their implications – have been incorporated into the new AAQD.

The case law in this area can be divided into several categories: the first concerns the interpretation of provisions (usually as part of preliminary rulings), the second concerns infringement procedures, and the third concerns the interplay between the AAQD and other legislative acts.

Most of the relevant case law revolves around several key provisions: Article 13 (limit values), Article 22 (postponement of attainment deadlines and exemptions), Article 23 (air quality plans), and Article 24 (short-term action plans).

The first case (C-237/07) concerns Directive 96/62/EC; as this directive was merged into the AAQDs, the conclusions remain applicable under both AAQD 2008 and the new AAQD. The case addresses the possibility of demanding the preparation of a short-term action plan (Article 24 AAQD 2008).

⁵ The total mass of pollutants which is transferred from the atmosphere to surfaces (e.g. soil, vegetation, water, buildings, etc.) in a given area within a given time. Deposition rates should generally be given as µg/m² per day.

This case established the right of individuals directly affected by the risk of exceeding air quality limit values (PM₁₀) to require the competent national authorities to draw up an action plan. It confirmed that provisions of the AAQD 2008 imposing unconditional and precise obligations (such as the duty to prepare an action plan) can be relied upon by individuals against public bodies before national courts to ensure the effective protection of public health.

The second case (C-404/13) addressed persistent exceedances of NO₂ limit values. The CJEU ruled that a Member State, if it is objectively apparent that compliance cannot be achieved by the deadline (1 January 2010), is obliged to apply for a postponement (maximum of five years) under Article 22(1). It also clarified the role of national courts, mandating that they must take 'any necessary measure' (such as issuing an order) to compel authorities to establish an air quality plan [Article 23(1)] ensuring that the exceedance period is kept 'as short as possible'. This empowered national courts to decisively rule on EU law matters, even though they might have been hesitant to do so in the past (Ryall, 2015).

Furthermore, the Court clarified that while Member States enjoy a certain degree of discretion in deciding which measures to adopt, those measures must, in any event, ensure that the period of exceedance is as short as possible. In other words, air quality plans must be effective, and their mere adoption is not sufficient (Ryall, 2015).

The third case (C-723/17) concerns the drawing up of another strategic document: the air quality plan (Article 23 AAQD 2008). This judgement clarified the methodology for assessing compliance with air quality standards. It confirmed that national courts have jurisdiction to verify whether sampling points are located in accordance with the criteria set out in Annex III, specifically to ensure that data reflect areas with the highest pollutant concentrations. Crucially, the Court held that a limit value is exceeded if the higher level is measured at a single sampling point within a zone or agglomeration. Averaging results across all stations is prohibited, as this would undermine the Directive's public health objective. Furthermore, exceedance at a single sampling point is sufficient to trigger the obligation to draw up an air quality plan. The case is also significant for acknowledging that the purpose of AAQD 2008 is to protect human health, thereby linking it to fundamental rights (Huck *et al.*, 2021).

The fourth case (C-752/18) concerned enforcement mechanisms when a public authority persistently refused to implement traffic bans mandated by a final court order (Article 23). The question was whether the court could impose coercive detention on officials, given that financial penalties had proven ineffective. The CJEU affirmed that the principle of effective judicial protection (Article 47 of the CFREU) requires national courts to have effective coercive means to enforce final judgements. However, ordering coercive detention – a restriction on the right to liberty (Article 6 of the CFREU) – is permissible only if based on a national legal provision that is 'sufficiently accessible, precise and foreseeable', and complies with the principle of proportionality [Article 52(1) of the CFREU]. The case highlighted and confirmed that EU law largely depends on national enforcement mechanisms (Misonne, 2020a).

The final case (C-61/21) concerns state liability. The applicant sought compensation from the French state for health damage allegedly caused by long-term exceedances of NO₂ and PM₁₀ limit values. The Court ruled that while the air quality directives impose clear and precise obligations on Member States (e.g., meeting limit values, drawing up plans), they pursue a general objective of protecting public health and do not confer individual rights capable of triggering state liability for compensation (damages) under the Francovich doctrine⁶. This distinction separates the right to compel action

⁶ Based on landmark case Francovich v Italy, C-6/90. The European Court of Justice ruled that damages may be awarded against an EU Member State for breaches of EU law where three conditions are met:

1. the provision of EU law that has been infringed must have been intended to confer rights on individuals;

(injunctive relief) from the right to monetary compensation. However, the Court did not exclude the right to compensation under national law, which may nonetheless pose challenges within individual national legal systems, particularly regarding causation (Lutman & Strojan, 2023).

This decision was surprising to a large group of scholars, since it was widely believed that AAQD 2008 contains specific and clear provisions conferring rights on individuals (as stated in C-237/07), and that previous case law supported the notion that individuals could seek compensation for damage resulting from a breach of Articles 13 and 23 of AAQD 2008 (Calzolari, 2024). However, the Court adopted a restrictive approach, leaving the question of liability to be addressed through a normative interpretation (Wegener & Wilkens, 2023).

2.1.3. New AAQD

In 2020, the European Commission (2020) issued the results of a fitness check of the AAQD 2008. The results were unsatisfactory. Although ambient air quality had gradually improved over the years, most people in the EU still did not live in environments favourable to their health. Many inhabitants remained exposed to exceedances of PM, NO₂, O₃, and benzo(a)pyrene. The overall clean air policy framework was found to be only partially effective. This conclusion aligns with the academic literature, which recognised that there was room for improvement in several legal instruments (Richelle, 2025; Krämer, 2015, and Squintani & Rijswick 2016).

The fitness check identified several weaknesses that contributed to the Directive's limited effectiveness. First, there was a lack of flexibility in adjusting air quality standards to the latest technical and scientific progress. Second, Member States often submitted poor or insufficient air quality plans, characterised by a lack of appropriate measures and delays in their adoption. The establishment of the monitoring network was considered a success. However, the AAQD 2008 provided excessive discretion and unclear requirements regarding the location of sampling points. In some instances, Member States circumvented their obligations by setting up sampling points in places that did not represent areas with the highest concentrations of air pollutants.

While air quality reporting has significantly improved, the Commission emphasised that further harmonisation was still required. Moreover, the Commission acknowledged that Member States continued to report exceedances above EU limit values for one or more pollutants. The fitness check stressed that improvements in air quality depended critically on actions taken by Member States to address the sources of air pollution that lead to the exceedances. These sources of pollution were often regulated by different legislative frameworks (e.g., mobile sources such as vehicles or stationary installations such as industrial plants) that are not sufficiently interconnected (Vodička, 2024a).

Based on the fitness check and the Zero Pollution Action Plan introduced by the Commission in 2021⁷, the new AAQD was adopted in 2024 aiming to achieve zero pollution of water, soil, and air by 2050. In addition to reducing harmful effects on human health and the environment, the new directive also focuses on the protection of ecosystems and biodiversity.

The new AAQD is a recast of the previous AAQD 2008. It builds on the foundations of AAQD 2008 while enhancing and streamlining its provisions. Consequently, only the differences between the two directives will be discussed below.

2. the breach must be 'sufficiently serious'; and,

3. there must be a direct causal link between the breach and the damage suffered.

⁷ Further information on the plan can be found on the website of the Commission, available at https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en.

One of the main reasons for introducing the new directive was to bring the EU's air quality standards closer to the WHO's recommendations (Bertaux, 2024). The directive explicitly emphasises the connection with the WHO's guidelines by requiring regular reviews by the Commission every five years, or more frequently if the WHO issues new air quality guidelines (Article 3).

In general terms, the new AAQD introduces new definitions and expands several existing ones previously contained in the AAQD 2008. For example, it introduces the umbrella term 'air quality standards', as well as new concepts such as 'sensitive population and vulnerable groups', 'the public concerned', 'air pollution hotspots', and 'monitoring supersite'. These new definitions were included based on the experience gained from the implementation of the AAQD 2008. Although some of them are technical in nature, they are expected to eliminate ambiguities that previously affected the directive's application by Member States. The concept of air quality plans remains in place; however, a specific form of such plans—the air quality roadmap—has been newly introduced. In addition, some definitions reflect the case law of the CJEU, which clarified both the legal standing of persons and the obligations of Member States under the AAQD 2008.

The new AAQD also merges with and repeals Directive 2004/107, thereby broadening the scope of pollutants and setting limit values⁸ for the following specific pollutants: PM_{2.5}, PM₁₀, nitrogen dioxide (NO₂), sulphur dioxide (SO₂), benzene, carbon monoxide (CO), lead (Pb), arsenic (As), cadmium (Cd), nickel (Ni), and benzo(a)pyrene (BaP). Additionally, target values⁹ are specified for ozone (O₃) and for As, Cd, Ni, and BaP.

The air quality standards are tightened compared to those under AAQD 2008, and explicit reference is made to the WHO's guidelines (Annex I). Nevertheless, it must be noted that even the new limit values still do not align with the limit values recommended by the WHO. For visual comparison of the limit values of the new AAQD and the WHO, see Figure 5. The new AAQD also promotes the maintenance of ambient air quality in zones where pollutant levels are already below the established limit values (Article 12). For Member States that have not yet achieved compliance, Annex I sets a deadline of 2030 for meeting the limit values.

At the same time, the directive provides a degree of flexibility for zones (and Member States) where compliance with the limit values for specific pollutants – PM₁₀, PM_{2.5}, NO₂, benzene or benzo(a)pyrene – cannot be achieved by the 2030 deadline. In such cases, Member States may postpone the deadline stated in Annex I, provided that specific conditions are met and an air quality roadmap is drawn up. The deadline may then be extended to 2035 or 2040, with a possibility of a further postponement of up to two years (Article 18).

As mentioned above, particulate matter remains one of the biggest threats to public health. The new AAQD continues the existing regulatory trend by introducing obligations to monitor ultrafine particles¹⁰ but without setting any limit values.

The new AAQD further expands the provisions on the disclosure of public information. Its aim is to ensure the timely provision of air quality information to stakeholders, enabling them to inform their patients, customers, clients, members, and the general public about, air quality conditions, potential health risks associated with deteriorated air quality, and existing air quality plans. Information

⁸ 'Limit value' means a level which is fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health or the environment, and which is to be attained within a given period and not to be exceeded once attained.

⁹ 'Target value' means a level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health or the environment, to be attained where possible over a given period.

¹⁰ 'Ultrafine particles' or 'UFP' means particles with a diameter less than or equal to 100 nm, where UFP are measured as the particle number concentrations per cubic centimetre for a size range with a lower limit of 10 nm and for a size range with no restriction on the upper limit.

concerning air quality must be easily accessible and free of charge when made available to the public (Article 22).

As explained above, air quality plans, as a core planning instrument, remain in place but are now enhanced by the introduction of air quality roadmaps (Article 19).

The possibility of establishing short-term action plans is also retained (Jančářová & Vodička, 2018). Such plans must be drawn up when there is a risk that pollutant levels will exceed one or more of the alert thresholds specified in Section 4 of Annex I. However, an exception applies to O₃, where no significant potential exists to reduce the risk or severity of the exceedance (Article 20).

The new AAQD also codifies two major rights in Articles 27 and 28. The first concerns access to justice for the public concerned, allowing them to challenge the substantive or procedural legality of any decisions, acts, or omissions by Member States relating to the location and number of sampling points, as well as air quality plans, air quality roadmaps, and short-term action plans. While this possibility had already been recognised by the CJEU case law, the implementation across Member States has been uneven, with certain jurisdictions showing limited adherence to these rulings (Radecka, 2025b).

Therefore, this article primarily codifies existing case law, while at the same time defines the conditions that the public concerned must meet to obtain legal standing and sets minimum procedural criteria for proceedings in Member States.

The second right introduced is the right to compensation for damage to human health caused by a violation of national rules transposing air quality plans, roadmaps, or short-term action plans. A key part of the provision aims at preventing Member States from establishing barriers or limitations that would render the exercise of the right to compensation impossible or excessively difficult. Lastly, it must be mentioned that Member States are granted a two-year period to adopt the laws, regulations, and administrative provisions necessary to transpose the revised directive.

Figure 5: Comparison of air quality standards between EU and WHO

to be attained by 2030   new limit  increase in ambition  limit remains the same

	Current EU limit values		New EU limit values	WHO's 2021 Air quality guidelines	Averaging period	
NO ₂	200 Max. 18x		200 Max. 3x	N/A	one hour (µg/m ³)	Exceedances permitted per year
	N/A		50 Max. 18x	25 Max. 4x*	one day (µg/m ³)	Exceedances permitted per year
	40		20	10	In a calendar year (µg/m ³)	
PM ₁₀	50 Max. 35x		45 Max. 18x	45 Max. 4x*	one day (µg/m ³)	Exceedances permitted per year
	40		20	15	In a calendar year (µg/m ³)	
PM _{2.5}	N/A		25 Max. 18x	15 Max. 4x*	one day (µg/m ³)	Exceedances permitted per year
	25		10	5	In a calendar year (µg/m ³)	
SO ₂	350 Max. 24x		350 Max. 3x	N/A	one hour (µg/m ³)	Exceedances permitted per year
	125 Max. 3x		50 Max. 18x	40 Max. 4x*	one day (µg/m ³)	Exceedances permitted per year
	N/A		20	N/A	In a calendar year (µg/m ³)	
O ₃	120 Max. 25 days		120 Max. 18 days	N/A	target value	daily max. eight-hour mean (µg/m ³) Exceedances permitted per year averaged over 3 years
	120**		100***	100 Max. 4x*	long-term objective	daily max. eight-hour mean (µg/m ³) within a calendar year
	N/A		N/A	60	peak season	average of daily max. eight-hour mean concentration (µg/m ³) in the six consecutive months with the highest six-month running-average concentration

- * 3 to 4 days in a year correspond to the 99th percentile of daily measurements in 1 year.
- ** Long-term objective with no fixed deadline.
- *** To be attained by 2050.

Source: ECA, 2025

2.2. NEC Directive

The NEC Directive is the transposition of international commitments, namely the 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP Convention) and its Gothenburg Protocol (as revised in 2012). The international legal framework obliges signatories to introduce emission reduction commitments, which are made operational under EU law through the NEC Directive by requiring

Member States to establish binding national emission reduction commitments (NERC). By doing so, the EU seeks to reduce health risks and mitigate the environmental impact of air pollution.

The NERC cover five key pollutants: sulphur dioxide (SO₂), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH₃), and fine particulate matter (PM_{2.5}).

The commitments are defined per pollutant and per Member State, with reduction targets to be attained by 2020 and 2030. This means that each Member State must meet reduction targets for the 2020–2029 period and achieve stricter commitments from 2030 onwards. The exact percentages for each pollutant are provided in Annex II of the Directive, and the commitments mirror those set out in the revised Gothenburg Protocol.

The Directive also introduced intermediate emission levels for 2025, calculated on the basis of a linear reduction trajectory – that is, by reducing emissions by a constant percentage each year towards the 2030 targets. However, Member States may follow a non-linear trajectory if it proves more effective or cost-efficient. If a Member State deviates from its trajectory planned, it must justify the deviation and outline corrective actions to return to compliance.

Certain exemptions apply to emission sources not covered by the NERC. These include aviation beyond take-off and landing cycles, maritime traffic, and specific agricultural sources of NO_x and NMVOCs.

The Directive also provides a degree of flexibility in compliance under specific circumstances. Member States may adjust emission inventories to reflect advances in scientific knowledge or, in the event of exceptionally cold winters or exceptionally dry summers, may average annual emissions with those of the preceding and subsequent years to determine compliance.

The National Air Pollution Control Programmes (NAPCPs) play a central role in achieving the commitments set under the Directive. Member States must adopt and update these programmes every four years, detailing policies and measures designed to meet their emission reduction obligations. The programmes must also assess transboundary impacts, prioritise the reduction of black carbon when addressing PM_{2.5}, and ensure consistency with other policy areas. Moreover, public participation and cross-border consultations are mandatory components of the NAPCP process.

Furthermore, the programmes must consider measures across all relevant sectors to limit emissions, including:

- agriculture,
- energy,
- industry,
- road transport,
- inland shipping,
- domestic heating,
- use of non-road mobile machinery, and
- solvents.

Monitoring and reporting are central elements of air quality legislation. The NEC Directive requires Member States to submit annual national emission inventories, biennial emission projections, and reports on ecosystem impacts (including freshwater, forests, and sensitive habitats). All data must comply with the methodological requirements of the LRTAP Convention to ensure consistency and comparability.

As mentioned above, the specific national emission reduction commitments for each Member State are set out in Annex II and are divided into two categories. The first one obliges Member States to reduce the specific pollutant by a specific percentage between 2020 and 2029. The second (subsequent)

category obliges Member States to further reduce the pollutant from 2030 onwards. It is important to state that both reduction numbers are compared to the concentration of pollutants in 2005, which serves as the baseline year. Specific examples of average reduction commitments and Member States's specific commitments follow.¹¹

The average reduction commitment for SO₂ from 2020 to 2029 is 49 %, with the highest reductions for Cyprus (83 %) and the lowest reductions for Latvia (8 %). From the year 2030 onwards, the average reduction commitment is 70 % with the highest increase of a commitment of additional 37 % for Germany and the lowest increase of commitment of 0 % for Sweden.

The average reduction commitment for NO_x from 2020 to 2029 is 39 %, with the highest reductions for Denmark (56 %) and the lowest reductions for Estonia (18 %). From the year 2030 onwards the average reduction commitment is 60 % with the highest increase of a commitment of additional 40 % for Luxembourg and the lowest increase of 2 % for Latvia.

The average reduction commitment for NMVOC from 2020 to 2029 is 26 %, with the highest reductions for Greece (54 %) and the lowest reductions for Netherlands (8 %). From the year 2030 onwards the average reduction commitment is 40 % with the highest increase of a commitment of additional 32 % for Czechia and the lowest increase of 1 % for Poland.

The average reduction commitment for NH₃ from 2020 to 2029 is 7 %, with the highest reductions for Denmark (24 %) and the lowest reductions for Estonia, Croatia, Ireland, Latvia, Luxembourg, Austria, Poland and Slovenia (1 %). From the year 2030 onwards the average reduction commitment is 17 % with the highest increase of a commitment of additional 24 % for Germany and Croatia and the lowest increase of 0 % for Denmark, Estonia, Latvia, Lithuania and Finland.

The average reduction commitment for PM_{2.5} from 2020 to 2029 is 23 %, with the highest reductions for Cyprus (46 %) and the lowest reductions for Italy (10 %). For the year 2030 onwards the average reduction commitment is 48 % with the highest increase of a commitment of additional 43 % for Czechia and the lowest increase of 0 % for Sweden.

Across all pollutants, average reduction commitments increase substantially after 2030, indicating a clear tightening trajectory. Polluting substances such as SO₂ and NO_x show the strongest overall ambition (averages moving from 49 % to 70 % and from 39 % to 60 %), with notable post-2030 step-ups in Germany (+37 % for SO₂) and Luxembourg (+40 % for NO_x). The reduction commitments for NMVOC and PM_{2.5} also increase markedly, with Czechia positioned for large additional commitments (+32 % NMVOC; +43% PM_{2.5}). Reduction commitments for NH₃ remain limited (from 7 % to 17 % on average).

¹¹ Data exclude United Kingdom.

2.3. Sectoral legislation

This subchapter provides a concise presentation of the most relevant sectoral legislation.

Large polluting installations, industrial activities, and intensive livestock production are regulated by the Industrial Emissions Directive (IED, Directive 2010/75/EU). The directive aims to ensure a high level of protection of human health and the environment, achieved by preventing waste generation, improving resource, water, and energy efficiency, and promoting the circular economy and decarbonisation. In contrast to the AAQD, which regulates ambient concentrations of pollutants, the IED targets specific sources of pollution.

All installations covered by the IED must prevent and reduce pollution through the application of Best Available Techniques (BATs). Operators must also address efficient energy, water, and resource use, as well as waste prevention and management.

With regard to air protection, the IED focuses on preventative measures, aiming to reduce pollution at source. For certain sectors and types of installations, the directive introduces emission limit values, operational conditions, and rules for monitoring and demonstrating compliance.

The relationship between the AAQD 2008 and the IED was examined by the CJEU in case C-375/21. The Court emphasised that the AAQD 2008 protects ambient air quality in its entirety, reflecting the environmental principle of a high level of protection. Consequently, when assessing a possible derogation under the IED, competent authorities must consider the cumulative effects of the installation in question (together with other comparable installations) along with the measures included in relevant air quality plans. If the proposed installation could contribute to an exceedance of AAQD 2008 limit values, a derogation must not be granted. This approach restricts the authorities' margin of discretion regarding exceptions (Bruno, 2024).

Furthermore, Directive 2015/2193 sets obligations for medium combustion plants (with a rated thermal input between 1 MW and 50 MW) to control emissions of SO₂, NO_x, and dust.

Mobile sources of pollution are regulated through several distinct legislative instruments. The degree of harmonisation varies across categories: a fully harmonised or unified framework governs non-road mobile machinery (Regulation 2016/1628) and vehicles, while a harmonised – though less comprehensive – approach applies to aircraft (for example Commission Regulation no. 748/2012) and ships (for example Directive 2005/35/EC).

The most significant interaction between sectoral legislation and the AAQD 2008 concerns vehicle emissions. The core of this framework is Regulation 2018/858, which establishes the rules and procedures for the type-approval of vehicles of categories M and N and their trailers (category O) within the Internal Market. Once type-approved, these vehicles benefit from free circulation. Given that the majority of vehicles on the road continue to rely on combustion engines, the impact on local air quality remains considerable.

Within this legal context, Regulation 2024/1257 (commonly referred to as the Euro 7 emission standards) is intended to reduce pollutant emissions from vehicles. It introduces specific limit values for pollutants emitted by vehicles in categories M, N, and their trailers. This legislative framework is also addressed extensively in academic literature (Vodička, 2024b). As for case law, the interaction between AAQD 2008 and vehicle emission legislation has so far been considered only in Case C-177/19, though without a substantive conclusion, as the CJEU ultimately quashed the case. Nonetheless, the issue of inconsistencies between AAQD 2008 requirements and vehicle emission rules has long been recognised in scholarly work (Nagl, Schneider & Thielen, 2016).

Finally, it is important to note the role of eco-design requirements (regulation 2024/1781 and directive 2009/125/EC) which significantly influence household appliances such as boilers and contribute to the reduction of air pollutant emissions.

3. IMPLEMENTATION OF AIR QUALITY LEGISLATION

KEY FINDINGS

The EU Pilot dialogue, an effective soft-enforcement mechanism between 2008–2023, has markedly declined in use and become secondary to formal infringement procedures. As of September 2025, 27 active infringement cases concerning the AAQD 2008 (including 7 linked to petitions) remain open, but the number of cases has largely stagnated since 2018. Notably, no financial sanctions have been imposed so far, demonstrating limited escalation despite persistent non-compliance.

Four Environmental Implementation Review cycles (2017–2025) consistently identified improper monitoring site placement failing to capture the highest pollution concentrations, inadequate air quality plans, and insufficient coordination between air quality standards and sectoral legislation. There are currently 12 active infringement cases concerning PM₁₀ exceedances, and over 70% of Member States remain at high risk of non-compliance with ammonia-emission reduction commitments.

Several measures have demonstrated effectiveness, including low-emission zones (Berlin's LEZ was estimated to avoid 10 PM₁₀ exceedance days in 2010), Czechia's boiler-replacement scheme (100,000 units replaced, reducing PM_{2.5} emissions by 2.7 kT), LIFE integrated projects like PREPAIR in Italy's Po Valley or the LIFE-IP-HUNGAIKY project that aimed at the decarbonization of the Mátra power plant.

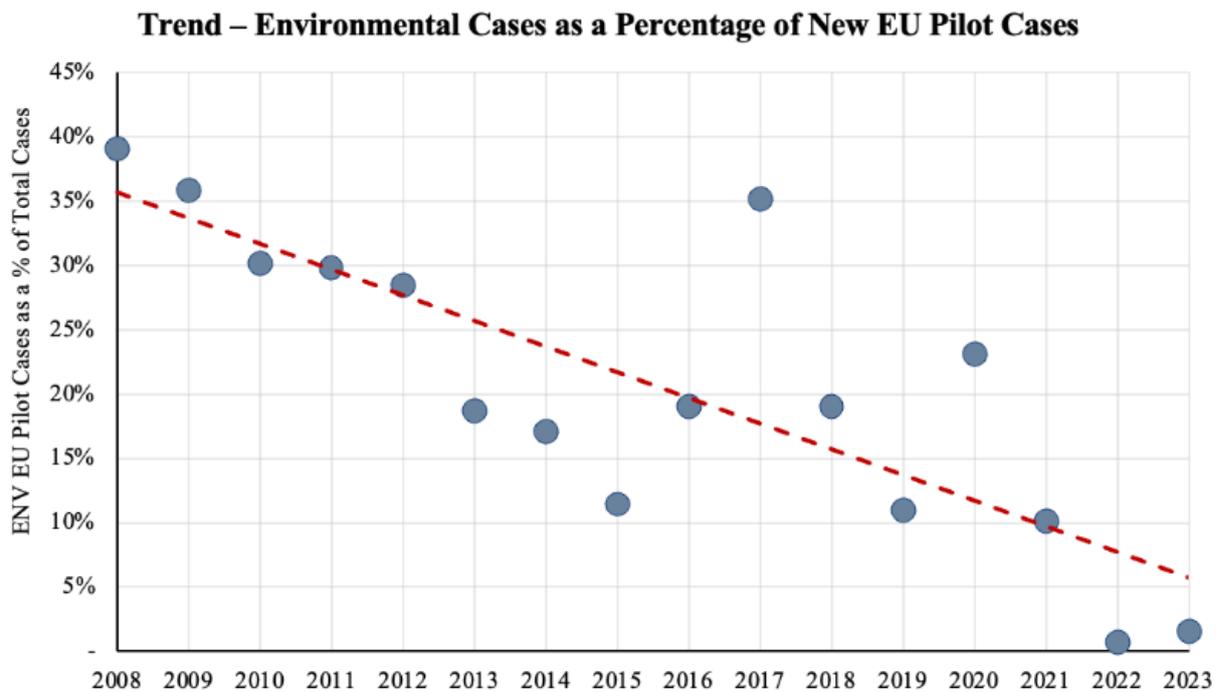
Current trends indicate potential achievement of a 68% reduction in PM_{2.5}-related premature deaths by 2030 compared to 2005 (exceeding the 55% target), making this the only zero pollution goal likely to be achieved. However, new infringement waves related to PM₁₀ and PM_{2.5} are anticipated after 2030 due to stricter limit values in the new AAQD.

3.1. EU Pilot dialogue

One of the soft enforcement tools of EU legislation is the EU Pilot dialogue. This instrument serves as an informal mechanism between the Commission and the Member States for addressing potential non-compliance with EU law. Successful dialogue can prevent the launching of a formal infringement procedure (Article 258 TFEU).

This mechanism has worked in the past. Between 2008 and 2021, environmental cases formed one of the largest subsections of this mechanism (Stagstrup, 2024). However, from 2022 the number of environmental cases has been experiencing a declining trend.

Figure 6: Trend – Environmental Cases as a Percentage of New EU Pilot Cases



Source: Stagstrup, 2024

This negative trend has been criticised (Stagstrup, 2024; Smith, 2018), particularly with regard to its impact on environmental law cases. Naturally, the EU Pilot dialogue has had negative aspects, such as opaque and non-transparent interactions between the Commission and the Member States. Nevertheless, it has proven to be an effective tool due to its flexibility.

Unfortunately, in environmental matters the EU Pilot dialogue now appears to have become a secondary instrument compared to infringement procedures.

3.2. Infringement procedures

Under the AAQD 2008, the infringement database currently (November 2025) contains 27 active cases¹², of which seven are linked to petitions (see Chapter 4). There is no positive trend in the overall number of cases, as this figure has been stagnating for several years (in 2018, there were 29 cases according to Nagl *et al.*, 2018).

As of October 2025, no financial sanctions have been imposed on infringing Member States.

Since the new AAQD sets 2030 as the target year for compliance with the revised limit values, a new wave of infringement procedures can be expected after this year and the years immediately following.

The most problematic polluting substance – both currently and looking ahead – is PM₁₀. There is a high likelihood that the number of non-complying states will rise due to the new and stricter limit values under the revised AAQD. A similar development can also be expected for PM_{2.5}. Although less frequent, issues relating to NO_x and SO₂ emissions will likely remain present in the future.

¹² This number also includes Commission Directive (EU) 2015/1480.

Table 1 Current infringement procedures in the EU related to AAQD 2008

Category	Number of cases	Countries
PM ₁₀ Limit Value Exceedances	12	Bulgaria, Croatia, Czechia, France, Greece, Hungary, Italy, Poland, Romania, Slovakia, Spain, Sweden
NO ₂ Limit Value Exceedances	9	Italy, Poland, Greece, Germany, Romania, Spain, France, Portugal, Belgium
Non-Conforming Transposition/Bad Implementation or Application	4	Finland, Bulgaria, Poland, , Romania
PM _{2.5} Limit Value Exceedances	2	Italy, Croatia
SO ₂ Exceedances	1	Bulgaria

Source: European Commission

The total number of cases is 27. However, the table contains 28 cases because Infringement case INFR(2020)2298 (Croatia) contains exceedances of PM₁₀ and PM_{2.5} limit values (falls within two categories).

Similarly to the above, there are plenty of infringement cases concerning the NEC Directive. The database contains 26 active cases, almost all of which relate to inadequate implementation of the reduction commitments under the Directive. Specifically, they concern the failure to meet the reduction commitments for certain pollutants for the year 2020.

3.3. Environmental Implementation Review

This subchapter is based on environmental implementation reviews conducted by the Commission. A total of four reviews were carried out in 2017, 2019, 2022 and 2025.

An analysis of these reports reveals a shift from merely identifying initial compliance gaps to a phase of intensified enforcement and widening sectoral scrutiny. While early reviews focused heavily on urban transport and domestic heating, later reports increasingly highlighted systemic failures in agricultural emissions and air quality monitoring networks.

A recurring theme across all four reviews is the persistent difficulty Member States face in meeting limit values for PM₁₀, PM_{2.5} and NO₂. In 2017, the Commission noted that while general air quality had improved, 16 Member States faced legal action for PM₁₀ exceedances and 12 Member States for NO₂ exceedances. By 2019 and 2022, these warnings had evolved into active infringement proceedings and rulings by the CJEU. The 2025 review confirms that despite some progress, air pollution remains a major health concern, with the Commission consistently initiating infringement proceedings where limits are exceeded.

The scope of sectoral challenges has broadened over the years:

- **Transport and Heating:** The 2017 review primarily targeted solid fuel burning and diesel vehicles, recommending low-emission zones (LEZs) and stricter permits for industrial sources.

By 2019, the focus on transport sharpened, calling for 'proportionate and targeted restrictions' on vehicle access.

- **Agriculture:** A significant shift occurred in later reviews regarding NH₃ emissions. While the 2019 review noted that 6 Member States needed to reduce ammonia emissions, the situation deteriorated in subsequent years. The 2022 review identified that more than 70% of Member States were at high risk of non-compliance with their ammonia reduction commitments under the National Emission Reduction Commitments (NEC Directive). By 2025, 8 Member States had failed to meet their 2022 commitments for NH₃, highlighting agriculture as a bottleneck for compliance.

The reliability of data has emerged as a critical structural issue. The 2019 review raised the concern that air pollution was likely being underestimated due to poorly located sampling points—they must be placed where the highest concentrations occur. This issue has persisted; both the 2022 and 2025 reviews stressed that Member States must fulfil monitoring requirements in a 'systematic and consistent way' to inform policy correctly, with infringement cases launched specifically against countries with inadequate monitoring networks.

To address these gaps, the Commission has promoted various support mechanisms and shared best practices:

The European Commission (2017) report identified that many European cities have introduced low-emission zones that restrict the circulation of certain vehicle categories depending on their emission potential. In many cases, these zones have proven successful. For example, the 'Air Quality Plan for Berlin 2011-2017' estimated that, following the introduction of a low-emission zone in 2008, transport emissions were significantly reduced, resulting in 10 fewer exceedance days of the daily PM₁₀ limit value in 2010. The estimates also indicated that NO₂ pollution in that year declined by about 5% and pollution from traffic-related soot particles along roads was reduced by more than half.

The second report of the European Commission (2019) recognised that since 2017, Member States and the Commission have engaged in a series of dialogues focused on air quality. By the end of 2018, six 'Clean Air Dialogues' had been organised to address specific challenges in the Czech Republic, Hungary, Ireland, Luxembourg, Slovakia, and Spain. These efforts have been complemented by thematic workshops supported by the European Commission's TAIEX-EIR Peer2Peer mechanism¹⁵.

In addition, in Poland, the LIFE project 'Małopolska Region' provides support and advisory services to implement measures tackling severe air pollution in the region

The third European Commission (2022) report identified several projects. The LIFE integrated project PREPAIR (Po Regions Engaged to Policies of AIR) in Italy covers the Po Valley, targeting regions and cities with the greatest impact on air quality in the basin, extending into Slovenia. The project spans 7 years (2017-2024) and includes measures addressing biomass burning, energy efficiency, transport, and agriculture – in line with the 2017 Po Basin Agreement and the air quality plans. One specific goal is to create a network of bike stations in the main cities of the Po Basin and to develop the necessary supporting infrastructure.

The LIFE integrated project LIFE-IP-HUNGAIRY aims to decarbonise the Mátra power plant in Hungary by 2030, which currently relies on lignite. The project leverages support from the Just Transition Fund through cohesion policy, as well as the Connecting Europe Facility and the Modernisation Fund. The

¹⁵ The "TAIEX-EIRPEER 2 PEER" is an EU technical assistance and policy support instrument. It provides tailored support to national, regional and local EU Member states authorities implementing environmental policy and legislation. Further information on the mechanism can be found on the website of the Commission, available at https://environment.ec.europa.eu/law-and-governance/environmental-implementation-review/peer-2-peer_en.

decarbonising of the Mátra power plant is also part of the 2020 Hungarian Climate and Environment Protection Action Plan.

Czechia has implemented a scheme to replace obsolete and inadequate household heating sources (Kotlíková dotace), supported by EU funds. Up until 2020, the scheme enabled the replacement of 100,000 boilers, resulting in a reduction of 2.7 kiloton (kT) of PM_{2.5} emissions and energy savings. These efforts can be complemented with additional national grants to further improve building energy efficiency (Nová zelená úsporám). Poland also has a similar programme (Czyste Powietrze¹⁴).

The last report of the European Commission (2025) found that Ireland has made use of the TAIEX-EIR tool to organise a multi-country workshop on measures to reduce air pollution from transport and residential energy, enabling the exchange of good practices, including on communication.

The reviews also contain suggested actions on better environmental implementation, together with concrete states that would benefit the most. For a better visualisation see figure 7 which includes only priority actions for air quality and industrial emissions.

¹⁴ Further information on the programme can be found on the website of the programme, available at <https://czystepowietrze.gov.pl/>.

Figure 8: Premature deaths due to air pollution



Premature deaths due to air pollution (exposure to fine particulate matter):

Will they be reduced by 55% from 2005 levels by 2030?



Very likely. The target will be overreached and reach 68% if the trend of the past 10 years continues to 2030.

Figure 4.1 Premature deaths attributable to exposure to fine particulate matter, EU



Source: EEA, 2023b

4. ROLE OF THE COMMITTEE ON PETITIONS

KEY FINDINGS

Since 2013, the European Parliament's Committee on Petitions (PETI) has received over 1,650 environmental petitions, of which 432 concern pollution issues. Citizen petitions serve as a vital public watchdog mechanism, directly influencing Commission enforcement decisions and the initiation of infringement procedures.

Analysis of several landmark petitions (Italy, Spain, Poland, France, Bulgaria) reveals persistent patterns of Member State non-compliance, including Italy's ongoing PM₁₀ exceedances since 2014 culminating in the CJEU judgments C-644/18 (2020) and C-573/19 (2022), Spain's NO₂ violations taking 8 years from petition to the CJEU referral (C-125/20), and Poland's PM₁₀ exceedances linked to household waste burning, highlighting the interconnection between air quality and waste framework directives.

Infringement procedures exhibit alarming durations. For instance, France's Charles de Gaulle Airport cases spanned 17 years for PM₁₀ [INFR(2008)2190] and 10 years for NO₂ [INFR(2015)2074] as of 2025, raising concerns about the protection of populations living in exceedance zones during prolonged enforcement processes.

The Bulgarian Maritsa Iztok power plant cases (C-488/15, C-174/21, C-730/19) illustrate that the Commission retains discretion in initiating infringement procedures regardless of petitioner requests. However, it must establish facts and clear evidence clearly when pursuing Article 260 TFEU penalties, as procedural errors can lead to CJEU dismissals with direct consequences for affected populations.

Regarding environmental protection, PETI has received numerous petitions from concerned citizens. Since 2013, it has registered over 1,650 petitions concerning various environmental issues. Of these, 432 petitions address pollution-related problems (a broad category covering noise, air pollution, and water pollution).¹⁵

Several of these petitions are considered in this study due to their particular success and impact.

¹⁵ Further information on the programme can be found on the website of the programme, available at https://www.europarl.europa.eu/cmsdata/282096/PETI%202019_2024%20Activity%20Report_FINAL.pdf

Table 2 Petitions considered in this study

Petition number	reference	Title of the petition	Member State
1337/2008		on the Maritza-Iztok power plant and pollution of the area around the Bulgarian town of Stara Zagora	Bulgaria
1484/2008		on the impact of noise and atmospheric pollution on the health of residents in the vicinity of Charles de Gaulle-Roissy airport	France
1865/2009		on air pollution in the town of Stara Zagora in central Bulgaria	Bulgaria
0123/2011		on air pollution in the Polish town of Proszkow as a result of the burning of household waste	Poland
0180/2011		on the protection of the Valli Mirandolesi Natura 2000 site and other sites in Emilia Romagna in danger of being damaged by the CisPadana Motorway	Italy
0257/2011		on behalf of the citizens' initiative 'Clean air over Stara Zagora', bearing approximately 30 000 signatures, on air pollution in the town of Stara Zagora in central Bulgaria	Bulgaria
0323/2011		on the alleged infringement of Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe by the Community of Madrid and Madrid City Council, Spain	Spain
465/2021		on keeping air quality below recognised health thresholds	Italy

Source: Author's own elaboration

4.1. Case 1: Petition No. 465/2021 on keeping air quality below recognised health thresholds and Petition No. 180/2011 (Italy)

4.1.1. Summary of the petition

Petition no. 465/2021 points out that the daily limit value for PM₁₀ in Italy is set at 50 µg/m³, which may not be exceeded on more than 35 days per year. However, even during the Covid-19 lockdowns, exceedances were not reduced in 2020. The petitioner stresses that Europe is making major investment efforts focused on the process of decarbonisation by implementing Next Generation EU, and that the Italian Government has presented its National Recovery and Resilience Plan (NRRP). He therefore argues that local and regional authorities (regions and municipalities) should step up their efforts and take action through Sustainable Urban Mobility Plans. Achieving the target of 'zero exceedances (of PM₁₀ and PM_{2.5})' should, in his view, be a matter of priority, supported by continuous monitoring by regional and municipal policymakers. Lastly, he emphasises the growing importance of protecting public health and the environment.

4.1.2. Status of the petition

The petition was declared admissible on 29 October 2021. The European Parliament requested information from the Commission, which replied on 30 March 2022 and again on 15 November 2022.

The central issue of the petition concerned exceedances of PM₁₀ limit values in Italy. In its reply, the Commission referred to an infringement procedure that has been ongoing since 2014 and concerned the same issue [INFR(2014)2147].

In short, Italy had failed to keep exceedances 'as short as possible', and the procedure culminated in the Commission referring the case to the CJEU. In 2020, the Court delivered its judgement in C-644/18, finding that Italy had breached the Air Quality Directive due to systematic exceedances of the limit values for particulate matter and because it had failed to adopt appropriate measures to ensure that the exceedance periods were kept as short as possible.

The petition was submitted after the Court's decision, and the Commission subsequently followed up with Italian authorities regarding the measures adopted in response.

However, air quality in Italy still does not comply with EU limit values, and exceedances continue. Therefore, in 2024, the Commission sent a formal notice to Italy within the same infringement procedure.

4.1.3. Assessment of the case

This case is notable because it demonstrates Italy's long-standing systemic problems with air quality. In addition, the infringement procedure launched in 2014 and referred to by the Commission is linked to another petition—no. 0180/2011.¹⁶

The petition from 2011 was originally aimed at environmental impact assessment and a possible breach of Natura 2000 sites but in 2017 the petitioners also raised possible breaches of the AAQD 2008 (PM₁₀ and NO₂). The Commission responded that Italy had already received a reasoned opinion concerning PM₁₀, which ultimately led to C-644/18 judgment. In 2024, the Commission sent a further formal notice

¹⁶ The petition was merged with Petition no. 1468/2016.

letter pursuant to Article 260 TFEU¹⁷. If non-compliance persists, the CJEU may order Italy to pay a fine.

Similarly, in 2022 the CJEU delivered judgement C-573/19, confirming that Italy had breached the AAQD 2008 with respect to the annual limit value for NO₂.

Overall, petition no. 465/2021 was another piece of the mosaic that helps the Commission monitor and assess whether Member States comply with air quality standard.

4.2. Case 2: Petition No. 323/2011 on the alleged infringement of Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe by the Community of Madrid and Madrid City Council, Spain

4.2.1. Summary of the petition

In the petition no. 323/2011, the petitioner claims that the Community of Madrid and Madrid City Council have, for several years, been infringing the AAQD 2008. According to the petitioner, concentrations of several harmful substances have exceeded the limit values established by the Directive and by the WHO. These substances include suspended particulates (PM₁₀ and PM_{2.5}), nitrogen dioxide (NO₂), and ozone (O₃). The petitioner reports that the Community of Madrid operates a monitoring network consisting of 23 stations, while the city of Madrid maintains its own network managed by the City Council. He alleges that the City Council relocated some monitoring stations to new sites and removed others located in areas with higher pollution levels, contrary to the requirements of the Directive. Finally, the petitioner notes that the 2007–2011 road plan foresees additional road construction, which in his view contributes to even higher air pollution levels.

4.2.2. Status of the petition

The petition was declared admissible on 17 June 2011. The European Parliament requested information from the Commission, which provided seven replies over a period of seven years, the last one in 2018.

The core issue concerns exceedances of PM, NO₂ and O₃ limit values in Spain. In its first reply, the Commission referred to the already ongoing infringement procedure concerning exceedances of PM₁₀ limit values [INFR(2008)2203].

In 2013, the Commission followed up on Spain's failure to comply with the NO₂ limit values, which led to a formal notice in 2015 [INFR(2015)2053]. A Reasoned Opinion was sent in 2017, and finally in 2019 the Commission referred the case to the CJEU (C-125/20). The Court held that Spain had failed to ensure that the AQP provided for appropriate measures to ensure that the period of exceedance of NO₂ limit values was as short as possible.

4.2.3. Assessment of the case

This case illustrates how petitions can operate as an important public accountability instrument. At the same time, the length of the infringement process raises concerns: although the petition was lodged in 2011, the CJEU referral occurred in 2019, and the judgement C-125/20 was delivered in 2022 – eleven years after the initial petition.

¹⁷ According to Article 260 TFEU, if the Court finds that the Member State concerned has not complied with its judgment it may impose a lump sum or penalty payment on it.

Even though the effects of adopted measures may take time to materialise, the prolonged enforcement process must be considered in the light of the health implications for residents living for years in zones with persistent exceedances.

4.3. Case 3: Petition No. 123/2011 on air pollution in the Polish town of Proszkow as a result of the burning of household waste

4.3.1. Summary of the petition

The petitioner in the petition no. 123/2011, a resident of Proszków in Poland, claims that a large proportion of the local population burns household waste as fuel, partly due to the absence of an effective municipal waste-collection system. According to the petitioner, this practice results in severe air pollution harmful to human health. Since the Polish authorities have not intervened, he calls on the European Parliament to examine the situation.

4.3.2. Status of the petition

The petition was declared admissible on 10 May 2011. Information from the Commission was requested, and several replies were received (in 2011 and 2014).

The petition was linked to an already existing infringement procedure concerning PM₁₀ limit value exceedances [INFR(2008)2199]. This infringement procedure was initiated in 2009 and culminated in 2015 with a referral to the Court. The CJEU delivered its judgement in February 2018 (C-336/16), ruling that Poland infringed its obligations under the AAQD 2008. Specifically, the Court held that exceedances of PM₁₀ limit values and no (missing) appropriate measures in AQP that would ensure exceedances of PM₁₀ limit values as short as possible meant breach of AAQD 2008. Subsequently, an additional formal notice pursuant to Article 260 TFEU was sent to Poland in 2023.

4.3.3. Assessment of the case

The petition highlighted several core issues.

First, the excessive length of the infringement procedure itself. Although it was launched in 2009, the public saw no tangible results for years, prompting the submission of the petition.

Second, the case clearly illustrates how legislation operates across interconnected legal regimes [in this case, the AAQD 2008 and the Waste Framework Directive (Directive 2008/98/EC)]. These regimes converge at national levels.

Third, it demonstrates the crucial importance of specific measures adopted by Member States to combat air pollution. These measures unavoidably have a political dimension, as they must take into account the social and economic conditions of the affected population. This can be particularly challenging in regions with low GDP, where the adoption of cleaner household equipment, such as modern boilers, may be difficult.

4.4. Case 4: Petition No. 1484/2008 on the impact of noise and atmospheric pollution on the health of residents in the vicinity of Charles de Gaulle–Roissy airport

4.4.1. Summary of the petition

In the petition no. 1484/2008, the petitioner criticises the failure of the French authorities to reduce noise and atmospheric pollution arising from the excessive number of aircraft using Charles de Gaulle–Roissy Airport. She maintains that the constant noise and air pollution levels have adverse effects on the health of local residents. According to her, during the day one aircraft passes every 30 seconds, and during the night one aircraft passes every three minutes over the district in which she lives. She therefore seeks the assistance of the European Parliament, stating that her representations to the French authorities have been ignored.

4.4.2. Status of the petition

The petition was declared admissible on 12 March 2009. The Commission has been continuously updating its replies since 2009. In total, 12 replies have been submitted (with the latest received in May 2025). The Commission linked the petition to two infringement cases: INFR(2008)2190 and INFR(2015)2074.

The petition was among the factors considered in initiating INFR(2008)2190, which concerns PM₁₀ limit-value exceedances. The Commission referred the case to the CJEU, which delivered its judgment in 2022 (C-286/21). The Court agreed with the Commission and ruled that France had failed to ensure that the daily limit value applicable to concentrations of particulate matter (PM₁₀) was not exceeded, systematically and persistently. Furthermore, France had failed to ensure that the AQP provided for appropriate measures to ensure that the period of exceedance of that limit value was as short as possible. The Commission continues to monitor the situation.

The petition was also an impulse for the initiation of an infringement procedure concerning NO₂ limit-value exceedances—INFR(2015)2074. This case was also referred to the CJEU, which delivered its judgment in 2019 (C-636/18). The Court declared that France was in breach of NO₂ annual limit values in several zones in France therefore infringed AAQD 2008. The procedure is ongoing, and the Commission has sent an additional formal notice pursuant to Article 260 TFEU.

4.4.3. Assessment of the case

The petition clearly demonstrates how public participation can influence the Commission's handling of environmental enforcement matters. However, as noted above, the overall duration of the infringement procedures is significant – 17 years for PM₁₀ and 10 years for NO₂ as of 2025.

4.5. Case 5: Petition No. 1337/2008 on the Maritza–Iztok power plant and pollution in the area around the Bulgarian town of Stara Zagora, together with Petitions No. 1865/2009 and No. 0257/2011

4.5.1. Summary of the petitions

Petition no. 1337/2008 highlights the power plant's non-compliance with EU environmental legislation, including the Integrated Pollution Prevention and Control Directive (Council Directive 96/61/EC) and the Large Combustion Plants Directive (Directive 2001/80/EC). The petitioner requests the European

Parliament to ensure that the plant's operations meet EU emission standards, noting that only two of its eight units are equipped with sulphur-cleaning systems.

Petition no. 1865/2009 raises concerns regarding emissions of pollutants such as hydrochloric acid, hydrogen sulphide, and nitrogen dioxide, as well as the presence of heavy metals in soil, plants, and food. The petitioner claims that these pose serious health risks and accuses the Bulgarian authorities of inaction, urging the Parliament to intervene in what is described as an almost 'genocidal' situation.

Petition no. 0257/2011 reiterates similar concerns about air pollution in Stara Zagora, again linked to harmful emissions and contamination of the environment and food chain. The petitioner argues that Bulgarian authorities have failed to act effectively and calls for EU-level intervention.

4.5.2. Status of the petitions

All three petitions were declared admissible, in 2009, 2010 and 2011 respectively. Following its first reply, the Commission provided numerous updates jointly related to the three petitions.

The petitions originally focused on issues slightly different from ambient air quality. Specifically, they concerned emission standards for industrial installations (power plants), i.e., specific emission sources.

However, in its subsequent replies, the Commission notified PETI that the zone in which the emission source was located suffered from limit value exceedances under AAQD 2008. Therefore, two infringement procedures were initiated: one concerning PM₁₀ limit-value exceedances [INFR(2010)2109] and another concerning SO₂ limit-value exceedances [INFR(2009)2135].

The infringement case INFR(2010)2109 was initiated in 2010, being subsequently referred to the CJEU. The Court delivered its judgement in 2017 (C-488/15), declaring that Bulgaria failed to keep the PM₁₀ annual and daily exceedances period of limit values as short as possible. However, as the situation in Bulgaria did not improve, the Commission sent a formal notice pursuant to Article 260 TFEU in 2018, followed by a second referral to the Court in 2020 (C-174/21) under the same article.

In the case C-174/21, the CJEU dismissed the action as inadmissible. It held that the Commission had failed to allege and establish, at first sight, and with the requisite clarity, the essential prerequisite that the judgment C-488/15 still required compliance in the zones and agglomerations referred to in the formal notice. As a result, the Court found that the Commission had not legitimately demonstrated that the Republic of Bulgaria failed to fulfil its obligation to take the necessary measures to comply with that judgment.

The second infringement procedure, INFR(2009)2135, concerning exceedances of SO₂ limit values, was initiated in 2009. The case was referred to the CJEU in 2019, and the Court delivered its judgement in 2022 (C-730/19) in which it declared that Bulgaria had failed to fulfil its obligations under the AAQD 2008 (breach of hourly and daily limit values for SO₂ and no adoption of appropriate measure for keeping exceedances as short as possible).

4.5.3. Assessment of the case

The petitions show that, although the Commission provides replies related to the petitions, it retains discretion to initiate an infringement procedure irrespective of the petitioners' requests.

Furthermore, it is vital that the Commission ascertains all relevant facts and clearly demonstrates that a Member State has not complied with previous case law, if it intends to refer an infringement case to the CJEU pursuant to Article 260 TFEU. Procedural shortcomings of this kind can have a direct effect on air quality and on the local population living in the affected areas.

4.6. Summary of recent petitions concerning air quality

During the period 2020–2025, PETI received several hundred petitions concerning environmental problems. Of these, only a small number relate specifically to air quality issues.

Petitions¹⁸ concerning air quality often referred to:

- Traffic-related problems in cities and urban areas (for example, missing or insufficient LEZ, the lack of harmonisation of emission stickers across Member States, or low/inadequate vehicle technical standards)¹⁹,
- specific air quality issues, such as exceedances of limit values in certain zones or agglomerations²⁰,
- general air quality protection (usually linked to broader concerns, such as the lack of green spaces, tree felling, or public health protection)²¹.

¹⁸ Regardless their status in PETI database.

¹⁹ Petition no. 173/2020, petition no. 1358/2020, petition no. 0808/2021, petition no. 465/2021, petition no. 1001/2021, petition no. 0307/2022, 0383/2023.

²⁰ Petition no. 409/2020, petition no. 951/2020, petition no. 0154/2021, petition no. 1253/2021, petition no. 1378/2021, petition no. 0130/2022, petition no. 0594/2022, 0927/2022, petition no. 1182/2022, petition no. 0923/2025, petition no. 1161/2025.

²¹ Petition no. 0939/2021, petition no. 0018/2023, petition no. 0353/2023 petition no. 0439/2023, petition no. 0003/2024, petition no. 0183/2024, petition no. 0410/2024, petition no. 0807/2024, petition no. 0005/2025, petition no. 0537/2025, petition no. 0589/2025, petition no. 1063/2025.

5. BEST PRACTICES AND POLICY RECOMMENDATIONS

KEY FINDINGS

Energy and heat generation measures demonstrate significant impact, including Czechia's boiler replacement scheme (Kotlíková dotace), which replaced 100,000 obsolete heating units by 2020, saving 2.7 kT of PM_{2.5} emissions, and Hungary's LIFE-IP-HUNGAIKY project aimed at decarbonising the Mátra lignite power plant by 2030. Traffic interventions also show measurable results, particularly Berlin's low emission zone implementation in 2008, which reduced transport emissions and prevented 10 PM₁₀ exceedance days in 2010. Moreover, studies demonstrate that, contrary to political concerns, LEZs tend to boost local economies rather than harm them.

Successful cities such as Antwerp with its 'Smart Ways to Antwerp' programme and Vilnius (European Green Capital 2025) combine sustainable transport improvements with digital solutions, spatial planning, and public transport promotion. Antwerp now has 764 kilometres of 'slow roads', where motorised transport is prohibited, with bicycles surpassing cars in commuting trips by 2022. The LIFE project PREPAIR, covering Italy's Po Valley, exemplifies comprehensive regional cooperation, addressing biomass burning, energy efficiency, transport, and agriculture simultaneously over a seven-year period (2017–2024).

Despite adequate regulatory frameworks, the new AAQD still lacks effective enforcement mechanisms, with infringement procedures lasting more than ten years and no financial sanctions imposed on Member States as of 2025. The Directive also omits a substantive 'right to clean air' within EU law, although legal scholarship points to its gradual emergence through CJEU case law, particularly AG Kokott's Opinion in C-723/17, which links air quality to the fundamental right to life.

Key recommendations include:

- establishing mandatory low emission zones with a gradual phase-out of polluting vehicles;
- banning or restricting coal, lignite, and wood burning for domestic heating in densely populated areas;
- creating institutionalised cooperation forums among Member States and the Commission;
- harmonising vehicle-restriction provisions across the EU to facilitate enforcement;
- strengthening connections between AAQD and sectoral legislation governing pollution sources.

5.1. Best practices

The best practices to reduce air pollution remain largely the same throughout recent years. This is due to the fact that air-polluting substances also remain the same (PM and NO_x). Therefore, the following text is based on the best practices introduced in studies by the ECA (2025), Nagl *et al.* (2018), Nagl, Schneider & Thielen (2016), and the Commission's Environmental Implementation Reviews presented in section 3.3 of this study.

The best practices can be divided into several categories:

- energy and heat generation,

- traffic,
- agriculture,
- awareness-raising and advisory support,
- integrated approaches.

5.1.1. Energy and heat generation

This broad category includes the transition from using fossil fuels to renewable energy in both the electricity generation sector and the domestic heating sector. The shift from fossil fuels to renewable energy sources will limit not only greenhouse gas emissions but also significantly help to reduce polluting substances affecting local air quality. In particular, power plants that generate heat and electricity from fossil fuels—especially coal and lignite—emit air pollutants such as PM₁₀, PM_{2.5}, SO₂, and certain heavy metals, all of which can contribute to poor ambient air quality.

The LIFE integrated project LIFE-IP-HUNGAIKY provides an example for this phase-out. It has the objective of decarbonising the Mátra power plant in Hungary by 2030, which currently uses lignite, leveraging support from the Just Transition Fund through cohesion policy, the Connecting Europe Facility, and the Modernisation Fund. The decarbonisation of the Mátra power plant is also an action under the 2020 Hungarian Climate and Environment Protection Action Plan.²²

One of the most prominent sources of local air pollution is domestic boilers. Czechia has implemented a scheme for the replacement of obsolete and inadequate local heating sources in households (Kotlíková dotace), supported by EU funds. The scheme supported the replacement of 100,000 boilers by 2020, resulting in savings of 2.7 kT of PM_{2.5} emissions and reduced energy consumption. These could be combined with additional national grants to increase energy efficiency in buildings (Nová zelená úsporám)²³. Similar incentives can be found in Austria²⁴ or Poland²⁵.

Furthermore, as stated in the study by Nagl *et al.* (2018), there are many best practices throughout Europe linked to heat generation. Some examples include:

- Awareness campaigns on how to properly use and operate domestic boilers (Austria²⁶, Switzerland²⁷, Germany,²⁸ and Czechia²⁹). These are often connected with public education (Czechia and Germany);

²² Further information on the Hungarian protection plan can be found on the websites of the Hungarian Government, available at <https://2015-2019.kormany.hu/en/ministry-for-innovation-and-technology/news/climate-and-nature-protection-action-plan-consists-of-eight-points>.

²³ Further information on the Czech incentive can be found on the websites of the Státní fond životního prostředí ČR, available at <https://novazelenausporam.cz/>.

²⁴ Further information on the Austrian program can be found on the websites of the Sanierungsoffensive, available at <https://www.sanierungsoffensive.gv.at/>.

²⁵ Further information on the Polish program can be found on the websites of the Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej, available at <https://czystepowietrze.gov.pl/>.

²⁶ Further information on how to correctly operate boilers in Austria can be found on the websites of the Umweltbundesamt, available at <https://www.richtigheizen.at/>.

²⁷ Further information on how to correctly burn wood in Switzerland can be found on the websites of the Amt für Umwelt und Energie des Kantons St.Gallen, available at <http://www.fairfeuern.ch/>.

²⁸ Further information on Air pollution can be found on the websites of the Deutsche Umwelthilfe, available at <https://www.duh.de/informieren/saubere-luft/holzfeuerung/>.

²⁹ Further information on local heating can be found on the websites of the Ministerstvo životního prostředí, available at <https://mzp.gov.cz/cz/agenda/ochrana-ovzduchi/zdroje-zneucistovani-ovzduchi/lokalni-topeniste>.

- Bans on the use of solid fuels (Dublin, Krakow,³⁰ Czechia³¹);
- Regulatory provisions on maintenance—for example, chimney sweeps (Germany, Czechia) – and possible inspection of fuels and usage of the combustion source (Czechia);
- District heating and cooling (Vienna³² and Sweden³³).

5.1.2. Traffic

The transport sector plays a vital role in Europe. It has helped shape the economies of many Member States and has granted people a sense of freedom and prosperity. However, the rapid development of this sector has also highlighted its negative impacts. One of these impacts is air pollution.

Current issues with traffic pertain predominantly to road traffic. Large (and busy) agglomerations have problems with curbing NO_x and PM emitted by vehicles. This was also the case in T-339/16 (later quashed by C-177/19 P).³⁴ There are several initiatives aiming to help cities with urban transportation issues.³⁵

Urban traffic is a very specific topic because it bridges several other standalone policy areas. One of the policy areas concerns spatial planning and other urban planning tools that address the urban transport sector. Another different policy area connected to the traffic, is the limitation of vehicles, which directly restricts their usage within urban areas. Another policy area concerns accessibility and affordability of public transportation and so on. All these areas must be addressed in order to achieve the desired effects in air quality.

As traffic is such complex problem, it requires an integrated approach. An example of this approach was the LIFE project PREPAIR³⁶ (Po Regions Engaged to Policies of AIR) in Italy, which covered the Po Valley with the regions and cities that had the greatest impact on air quality in the basin, extending into Slovenia. It lasted seven years (2017–2024) and included measures for biomass burning, energy efficiency, transport, and agriculture—in line with the 2017 Po Basin Agreement and the air quality plans. One specific goal was to create a network of bicycle stations in the main cities of the Po Basin and to develop the accompanying infrastructure.

a. Vehicle limitations

Vehicle limitations are one of the most effective ways to reduce vehicle emissions in specific zones. There are various forms of these instruments: low-emission zones (LEZ), ultra-low-emission zones (ultra-LEZ), zero-emission zones, congestion charges, road tolls, and restrictions on vehicle access.

LEZ, ultra-LEZ, and zero emission zones

³⁰ Further information on the best practices in Krakow can be found on the websites of the European Commission, available at https://environment.ec.europa.eu/topics/urban-environment/european-green-capital-award/inspiration/krakow-air-protection_en.

³¹ Specific low-quality fossil fuels according to Act No. 201/2012 Coll., on Air Protection.

³² Further information on district heating in Vienna can be found on the websites of the World Economic Forum, available at <https://www.weforum.org/videos/vienna-decarbonize-homes/>.

³³ Further information on district heating and cooling in Sweden can be found on the websites of the Smart City Sweden, available at <https://smartcitysweden.com/focus-areas/energy/district-heating-cooling/>.

³⁴ European cities—Paris, Brussels, and Madrid—challenged Commission Regulation (EU) 2016/646, arguing that it effectively legalised certain type-approved vehicles even though the underlying type-approval data had been falsified. These vehicles emitted more NO_x than Regulation No 715/2007 had permitted. One of the cities' arguments was that they had been unable to effectively combat NO_x pollution in their zones and agglomerations because those vehicles remained legally in circulation and use, and that they consequently experienced exceedances of the applicable NO_x limit values (Vodička, 2024a).

³⁵ Further information on the LEZ in Europe can be found on the websites of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/index_en.

³⁶ Further information on the project can be found on the websites of the Lifeprepare, available at <https://www.lifeprepare.eu/index.php/project/?lang=en>.

Many European cities have introduced low-emission zones which limit the circulation of certain vehicle categories depending on their respective emission potential. On the one hand, the introduction of these zones can speed up the renewal of vehicles, but on the other hand, the core issue remains the same— heavy reliance on individual vehicle transport.

In many cases, these have proved to be successful. For example, the 'Air Quality Plan for Berlin 2011–2017' estimated that by implementing a low-emission zone in 2008, transport emissions would be reduced significantly, and as a result, 10 exceedance days of the daily limit value of PM₁₀ were avoided in 2010.³⁷ The estimates also indicated that NO₂ pollution for that year would be reduced by approximately 5%, and pollution from traffic-related soot particles along roads would be reduced by more than half.

As of October 2025, there are dozens of low-emission zones and even stricter zero-emission zones throughout Europe.³⁸ Besides these instruments, some Member States use pollution-emergency instruments (sometimes called emergency smog schemes), which can temporarily limit or restrict vehicles in cities or parts of cities (northern Italy, France, or Czechia)³⁹.

At the same time, there is considerable misinformation suggesting that the introduction of low-emission zones will harm the local economy and drive people away from affected urban areas. However, this has been disproved by several studies (Wu *et al.*, 2025; Yoshimura *et al.*, 2021), which show the opposite effect—that LEZs actually boost local economies.⁴⁰

Congestion charges

Congestion charges are fees imposed on drivers entering a specific part of a zone (usually a city centre). This instrument is very flexible and can be modified during the day depending on traffic and its density. Furthermore, their variability makes them one of the most universal tools available to regulate traffic. Since this tool can be specifically tailored to certain vehicles, times of day, and even particular sub-zones, its use offers a wide range of applications.

The best examples in Europe can be found in London⁴¹, Oxford⁴², Stockholm⁴³, Gothenburg⁴⁴, and Milan⁴⁵.

b. Alternative urban mobility and public mobility

The issue of vehicle congestion and air pollution may be addressed by promoting other means of transportation (other than individual transport by car).

³⁷ Further information on the air quality plan can be found on the web archive of the City of Berlin, available at <https://www.berlin.de/sen/uvk/umwelt/luft/luftreinhaltung/archiv/>.

³⁸ Further information on the LEZ in Europe can be found on the websites of the Urban Access Regulations in Europe or EU Urban Mobility Observatory, available at <https://urbanaccessregulations.eu/userhome/map> or <https://urban-mobility-observatory.transport>.

³⁹ Further information on the LEZ in Europe can be found on the website of the Urban Access Regulations in Europe, available at <https://urbanaccessregulations.eu/low-emission-zones-main> and Section 10 of Act No. 201/2012 Coll., on Air Protection.

⁴⁰ Further information on the benefits of fewer cars in cities can be found on the website of the CleanCities, available at <https://cleancitiescampaign.org/research-list/why-fewer-polluting-cars-in-cities-are-good-news-for-local-shops/>.

⁴¹ Further information on the congestion charge can be found on the website of the Transport for London, available at <https://tfl.gov.uk/modes/driving/congestion-charge>.

⁴² Further information on the congestion charge can be found on the website of the Oxfordshire County Council, available at <https://www.oxfordshire.gov.uk/transport-and-travel/oxfords-temporary-congestion-charge-cars>.

⁴³ Further information on the congestion charge can be found on the website of the Transportstyrelsen, available at <https://www.transportstyrelsen.se/sv/vagtrafik/fordon/skatter-och-avgifter/trangselkatt/>.

⁴⁴ Ibid.

⁴⁵ Further information on the Area C can be found on the website of the Comune di Milano, available at <https://www.comune.milano.it/aree-tematiche/mobilita/area-c>.

Public transportation is sometimes a neglected aspect of urban mobility, yet it plays a vital role in the urban mobility ecosystem. Improving public transportation strengthens other policies and ancillary measures within cities. Prime examples of such projects are the Smart Ways to Antwerp⁴⁶ strategy and Vilnius' approach to enhancing public transportation⁴⁷. What these examples have in common is a strong focus on making public transport affordable, convenient, and accessible. At the same time, municipalities employ additional measures that encourage, or in some cases require, people to use public transport for example, by restricting car usage.

Alternative urban mobility is often associated with micromobility⁴⁸ and the general use of bicycles. Micromobility vehicles are designed for a short-distance travel (often in combination with public transportation systems). Effectively combining micromobility with public transport can reduce the need for privately owned cars, thereby alleviating traffic congestion.⁴⁹ One of the most popular vehicles that can be used for city-wide travel is the bicycle. Many European cities now have positive experience with the widespread promotion of cycling and bicycle-friendly policies.

Key success factors include safe cycling infrastructure, separated cycle tracks, secure and numerous parking facilities, integration of cycling with all modes of transport (especially public transport), bicycle-sharing schemes, and long-term political commitment (Nagl *et al.* 2018). A flagship example of this approach is Copenhagen and its extensive support for cyclists and cycling policies.⁵⁰ Other examples include the pop-up bicycle lane on a major street in Berlin⁵¹ or the cargo bike depot supported in Prague⁵².

Furthermore, there are additional benefits to shifting from cars to active mobility (cycling and walking), such as improved health outcomes, reduced greenhouse gas emissions, and increased road safety—fewer accidents and fatal incidents (Pisoni *et al.*, 2021).

5.1.3. Agriculture

The agriculture sector is a major contributor of ammonia (NH₃). Most emissions originate from manure (75 %) and inorganic fertiliser (20 %).⁵³

Here, one of the best practices is the use of closed manure storage and more precise application of manure and fertiliser and improved livestock feeding strategies.

⁴⁶ Further information on the Antwerp initiative can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/resources/case-studies/smart-ways-antwerp-mobility-management-long-term-strategy-tackle-mobility-challenges-and-improve_en.

⁴⁷ Further information on the Vilnius smart transport system can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/building-greener-smarter-transport-system-vilnius_en.

⁴⁸ A form of transportation in small vehicles designed for short, lightweight travel and usually powered by human or low-power electric motors (for example bicycles, velomobiles, e-bikes, cargo bikes, electric scooters, electric skateboards, shared bicycle fleets). Further information on micromobility can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/resources/case-studies/rise-micromobility_en.

⁴⁹ Further information on the micromobility can be found on the website of the McKinsey & Company, available at <https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-micromobility>.

⁵⁰ Further information on the Copenhagen's cycling solutions can be found on the website of the Bæredygtig byudvikling, available at <https://byudvikling.kk.dk/mobilitet/verdens-bedste-cykelby>.

⁵¹ Further information on the POP-up cycling roads can be found on the website of the Deutsche Umwelthilfe, available at https://www.duh.de/fileadmin/user_upload/download/Projektinformation/Verkehr/Untersuchungsbericht_Pop-up_Radweg_Kantstraße_DUH.pdf.

⁵² Further information on the bike depots in Prague can be found on the website of the Městem na kole, available at <https://mestemnakole.cz/2023/11/prague-will-get-its-third-bike-depot-it-will-be-located-in-zahradni-mesto/>.

⁵³ Further information on the specific air pollution sectors can be found on the website of the European Commission, available at https://environment.ec.europa.eu/topics/air/air-pollution-key-sectors_en.

Similarly, according to Nagl *et al.* (2018), precision farming and integrated manure management have the highest potential to curb ammonia emissions.

5.1.4. Awareness raising and advisory support

Since 2017, Member States and the Commission have engaged in a series of dialogues focused on air quality. By the end of 2018, six 'Clean Air Dialogues' had been organised to address specific challenges in the Czech Republic, Hungary, Ireland, Luxembourg, Slovakia, and Spain. These efforts have been complemented by the organisation of thematic workshops supported by the European Commission's TAIEX-EIR Peer2Peer mechanism⁵⁴.

In Poland, the LIFE project 'Małopolska Region' provides support and advisory services to implement measures tackling severe air pollution in the region.⁵⁵

Ireland has made use of the TAIEX-EIR tool to organise a multi-country workshop on measures to reduce air pollution from transport and residential energy. This initiative enabled the exchange of good practices, including communication strategies.

5.1.5. Integrated approaches

One of the best approaches is an integrated one. Two levels of integration can be distinguished. The first is large-scale integration through spatial planning and other specific instruments that take a broad perspective. Spatial planning plays a key role in urban development, determining land use and spatial layout. It focuses on protecting and developing natural, cultural, and historical heritage while ensuring urban, architectural, and technical continuity.

It is therefore essential that air protection objectives are incorporated into spatial planning and into the future development of urban areas. Spatial planning can guide decisions regarding the placement and regulation of major emission sources (such as large industrial facilities or high-traffic corridors).

The second level involves narrower integrated instruments, such as Sustainable Urban Mobility Plans⁵⁶ (SUMP). These instruments address specific issues such as congestion, air and noise pollution, climate change, road safety, and parking, while identifying potential measures and solutions.

This holistic approach has been adopted by several European cities. A prime example is the city of Antwerp and its Smart Ways to Antwerp initiative. Originally aimed at promoting sustainable urban mobility, it has since 2016 become a platform for cooperation between public and private stakeholders in developing new mobility solutions. Nowadays, the city has approximately 764 kilometres of 'slow roads' where motorised transport is not allowed, and in 2022 bicycles surpassed cars in the commuting modal share among Antwerp's residents.⁵⁷

Another example is the city of Vilnius.⁵⁸ The Lithuanian capital combines sustainable transport improvements with smart digital solutions. From redesigning streets to support public transport, cycling, and walking, to using real-time data to optimise services, the city is working towards a more

⁵⁴ Op, cit. 13.

⁵⁵ Further information on the LIFE integrated project can be found on the website of the Małopolska region, available at <https://powietrze.malopolska.pl/en/life-project/>.

⁵⁶ Further information on the mobility plans can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/sustainable-urban-mobility-plans_en.

⁵⁷ Further information on the Antwerp initiative can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/resources/case-studies/smart-ways-antwerp-mobility-management-long-term-strategy-tackle-mobility-challenges-and-improve_en.

⁵⁸ Further information on the Vilnius smart transport system can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/building-greener-smarter-transport-system-vilnius_en.

accessible and user-friendly mobility system. This integrated approach has earned Vilnius notable international recognition: it was selected as European Green Capital 2025 for its strong commitment to sustainability and its clear vision of becoming a greener city.

5.2. Policy recommendations

Recommendations are provided in three sections below. The first section contains recommendations concerning the provisions of the AAQD. The second section includes recommendations on enforcement and implementation, and the third section focuses on national levels.

5.2.1. AAQD provisions

On the one hand, the new directive adopted provisions that had already proven effective (for example specific limit values and strategy documents). On the other hand, some problematic provisions – especially those concerning rules on sampling points⁵⁹, data collection amongst Member States, and additional specific pollutants such as ultrafine particles and black carbon – were reworked and further specified.

The new AAQD aims to achieve closer alignment with WHO guidelines (although full alignment has not yet been reached), to expand provisions on penalties and public information, and to enhance air quality monitoring, modelling, and planning.

The progress in ambient air quality is evident from sections 3.3 and 3.4, which show that the concentration of polluting substances has been gradually decreasing since 2005 and is likely to reach the 2030 pollution target for air quality of the Zero Pollution Action Plan. However, when viewed in the context of the entire history of EU air quality legislation (dating back to the late 1970s), the results remain insufficient (Krämer, 2018).

Recommendations

- Consider establishing a new substantive right to clean air within the EU law framework**

One element omitted by the new directive – and which may be considered for future development – is the establishment of a new substantive right to clean air within the EU law framework. Some scholars have already suggested that such right is emerging (Misonne, 2020b; or Pouikli & Tsoukala, 2023). Although neither the AAQD 2008 nor the new AAQD contains an explicit provision, Advocate General Kokott, in her Opinion in C-723/17, linked air quality, EU primary law, and the fundamental right to life (Misonne, 2020b). The situation remains fragmented at the level of Member States: some include a right to clean and healthy environment or a right to favourable environment in their constitutions (for example, Czechia or Slovakia), whereas others provide only for the protection of health (for example, Poland) and continue to debate whether a subjective right to a healthy environment exists as an autonomous right or as part of other rights (Radecka, 2022).

Introducing such a substantive right would strengthen the legal standing of claimants in future air-quality-related litigation. Therefore, it can be expected that the Commission may seek to address this issue in the future.
- Consider aligning the limit values for NO₂, PM_{2.5}, PM₁₀, SO₂ and O₃ with the WHO air quality guidelines**

⁵⁹ This long-standing issue of flexible (and vague) criteria concerning location of sampling points was often pointed out in literature and special reports (e.g. ECA, 2018).

The limit values for these pollutants are still set at higher levels in the new AAQD than those recommended in the 2021 WHO Air Quality Guidelines (see Figure 5 in section 2.1.3). As the WHO establishes its guideline values on the basis of the best available scientific evidence and research, these values can be regarded as protective of human health and long-term wellbeing.

5.2.2. Enforcement and implementation

Overall, the EU legislative framework on ambient air quality (AAQD 2008) **provided sufficiently detailed regulatory rules. What it lacked was stronger implementation and compliance** (Yamineva & Romppanen, 2017; or Pouikli & Tsoukala, 2023).

Recommendations

- **Consider including penalties or coercive measures targeted at competent authorities into the new AAQD**

One shortcoming entails that, the new AAQD does not contain any penalties or coercive measures targeted at competent authorities. If a competent authority or official fails to adopt the required air quality measures, the Member State must rely on its own national mechanisms to ensure compliance.

- **Consider reducing the deadlines for the attainment of limit values, together with a significant reduction or the complete annulment of the postponement provision in the new AAQD**

The process of adopting new legislation is heavily influenced by political will; therefore, strict rules, regimes, or deadlines may not always be politically viable. Nevertheless, another shortcoming of the new AAQD is that the limit value deadlines and postponements are too lenient. This suggests that further reductions in polluting substances will progress slowly.

- **Develop a more effective enforcement approach within infringement procedures**

Non-compliance by Member States continues to be a problem, as shown in section 3.2 (infringement procedure). The number of infringement cases is stagnating. With stricter limit values, it can be reasonably assumed that this number will increase in the future.

This shows that the Commission does not have any effective tools to compel Member States to comply. Additionally, infringement procedures take too long to function as a truly effective enforcement instrument. As shown in section 4 of this study, several petitions related to air quality and infringement cases concern proceedings that have been ongoing for 10 years or even longer.

- **Improve transparency and establish clear timelines for EU Pilot dialogue**

The non-compliance issues could be mitigated using the EU Pilot dialogue. However, this process needs to be made more transparent, with clearly defined rules and a fixed timeline.

Therefore, better – meaning more effective – instruments are needed to oversee air quality in Member States. The longer these cases continue, the greater the impact on the health of people living in the affected zones.

- **Strengthen the interconnection between the AAQD and legislation on individual polluting sources**

The new AAQD (and the air quality policy framework in general) still lacks a comprehensive connection to other pieces of legislation. Specifically, it lacks links to legislation concerning individual polluting sources such as vehicles.

- **Make the restriction of vehicles easier, more comprehensive, and harmonised across the EU (for example, harmonisation of low-emission zones, traffic restrictions or emission stickers⁶⁰)**

At the same time, Member States have rather broad discretionary powers in selecting specific tools to improve air quality (the air quality legal framework requires results, not specific tools).

- **Expand cooperation amongst Member States and between Member States and the Commission**

What has been shown to work (section 5.1.4 of this study) is cooperation amongst Member States and between Member States and the Commission. However, enhanced cooperation between competent authorities and the Commission, or even institutionalised cooperation amongst competent authorities themselves, would be beneficial.⁶¹

- **Establish institutionalised forums for cooperation amongst competent authorities**, similar to Forum for Air Quality Modeling (Fairmode)
- **Strengthen and make use of Clean Air Dialogues, TAIEX-EIR workshops and LIFE projects** as valuable platforms for exchanging best practices and technical support

5.2.3. National level

At national level, there are many possible policies that could help achieve lower concentrations of polluting substances in the atmosphere in cities and regions.

Recommendations

- **Ensure effective air quality plans addressing specific local polluting issues and strict adherence by competent authorities**

It is vital (as it is also evident from CJEU case law in section 2.1.2) to have an effective air quality plan in place that addresses and includes specific air-polluting issues connected to the individual agglomeration. Furthermore, the competent authority needs to strictly adhere to the air quality plan.

One of the biggest sources of PM and other harmful substances such as BaP is domestic heating. Therefore, measures targeting this issue include:

- **Ban or restrict the use of coal, lignite and wood for domestic heating in densely populated areas**
Good practices show the positive impact of this measure. In Krakow for instance, a ban on the use of solid fuels introduced on 1 September 2019 turned out to be a key element in improving the air quality⁶².
- **Provide financial mechanisms to support modernisation of appliances used for domestic heating, targeting less effective solid fuel boilers**, similarly to Commission Regulation 2015/1189, or adopting a more decisive approach to domestic heating than Directive 2024/1275.

⁶⁰ There are even petitions calling for harmonisation of basic rules, for example, petitions no. 0647/2022 or 0553/2025.

⁶¹ This cooperation could be similar to Forum for Air Quality Modelling (FAIRMODE). <https://fairmode.jrc.ec.europa.eu/home/index>

⁶² Further information on the best practices in Krakow can be found on the websites of the European Commission, available at https://environment.ec.europa.eu/topics/urban-environment/european-green-capital-award/inspiration/krakow-air-protection_en.

Road transport is the main source of PM and NO_x polluting substances. Therefore, national recommendations include:

- **Establish low emission zones with a gradual phase-out of the most polluting vehicles** (Reveal, 2022)

Studies confirm that low-emission zones boost local economies rather than harm them. Berlin's low-emission zone significantly reduced transport emissions, avoiding an estimated 10 days of exceedance of PM₁₀ daily limit values in 2010 and reducing NO₂ pollution by approximately 5%⁶³.

- **Promote public transportation and active mobility, such as walking and cycling both through public campaigns and spatial planning**

Public transportation plays a vital role in the urban mobility ecosystem. Good practices in this field include the Smart Ways to Antwerp⁶⁴ strategy and Vilnius' approach to enhancing public transportation⁶⁵. In addition, many European cities now have positive experience with the widespread promotion of cycling and bicycle-friendly policies. A flagship example of this approach is Copenhagen and its extensive support for cyclists and cycling policies.⁶⁶

- **Ensure that all policies follow an integrated approach through Sustainable Urban Mobility Plans⁶⁷**

As shown in chapter 5.1.5, this holistic approach has been adopted by several European cities. A prime example is the city of Antwerp and its Smart Ways to Antwerp initiative. LIFE projects like PREPAIR in Italy's Po Valley⁶⁸ also demonstrate successful multi-sector coordination.

⁶³ Further information on the air quality plan can be found on the web archive of the City of Berlin, available at <https://www.berlin.de/sen/uvk/umwelt/luft/luftreinhaltung/archiv/>.

⁶⁴ Further information on the Antwerp initiative can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/resources/case-studies/smart-ways-antwerp-mobility-management-long-term-strategy-tackle-mobility-challenges-and-improve_en.

⁶⁵ Further information on the Vilnius smart transport system can be found on the website of the EU Urban Mobility Observatory, available at https://urban-mobility-observatory.transport.ec.europa.eu/building-greener-smarter-transport-system-vilnius_en.

⁶⁶ Further information on the Copenhagen's cycling solutions can be found on the website of the Bæredygtig byudvikling, available at <https://byudvikling.kk.dk/mobilitet/verdens-bedste-cykelby>.

⁶⁷ These measures are not a novel approach. Similar or identical instruments and measures have been suggested in previous studies and papers (Pisoni *et al.*, 2022 or Nagl *et al.*, 2018 or Nagl, Schneider & Thielen, 2016).

⁶⁸ Further information on the project can be found on the websites of the Lifeprepare, available at <https://www.lifeprepare.eu/index.php/project/?lang=en>.

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This study, commissioned by the Policy Department for Citizens' Rights and Constitutional Affairs for the Committee on Petitions (PETI) of the European Parliament, provides an analysis of the current legislative framework on ambient air quality, highlights the most relevant case law of the Court of Justice of the European Union (CJEU) concerning air quality, and examines selected infringement procedures and petitions. The study identifies best practices for air protection among Member States and offers policy recommendations.

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