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COVER NOTE

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PART 1/3

COMMISSION STAFF WORKING DOCUMENT

EVALUATION

Evaluation of the National Emission Reduction Commitments Directive

{SWD(2025) 395 final}

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In a separate document:

Glossary

Term/acronym	Meaning/definition	Term/ acronym	Meaning/definition
AAQD	Ambient Air Quality Directive(s)	NAPCP	National air pollution control programme
Air Convention	UNECE Convention for Long-Range Transboundary Air Pollution (also referred to as CLRTAP)	NECD	National Emission reduction Commitments Directive
BAT	Best available techniques	NECD IA	The 2013 impact assessment underpinning the NEC Directive
BCR	Benefit-cost ratio	NH_3	Ammonia
CAO	Clean air outlook	NMVOC	Non-methane volatile organic compounds
CAP	Common agricultural policy	NO_x	Nitrogen oxides
CLRTAP	UNECE Convention for Long-range Transboundary Air Pollution	PaMs	Policies and measures
ERC	Emission reduction commitment	PM	Particulate matter
FTE	Full-time equivalent	$PM_{2.5}$	Fine particulate matter
GP	Gothenburg Protocol (UNECE Air Convention)	SO_2	Sulphur dioxide
IED	Industrial Emissions Directive	Source legislation	EU legislation regulating emissions from specific sources (e.g. industrial sources, vehicles, etc.)
IIR	Informative inventory report	WAM	Projection of compliance 'with additional measures'
LPS (inventory)	Large point sources	WM	Projection of compliance with current measures ('with measures' scenario)
MRV	Monitoring, reporting and verification	ZPAP	Zero pollution action plan
MTFR	Maximum technically feasible reductions		

EU Member States

AT	Austria	EL	Greece	LV	Latvia
BE	Belgium	FI	Finland	MT	Malta
BG	Bulgaria	FR	France	NL	Netherlands
CY	Cyprus	HR	Croatia	PL	Poland
CZ	Czechia	HU	Hungary	PT	Portugal
DE	Germany	IE	Ireland	RO	Romania
DK	Denmark	IT	Italy	SE	Sweden
EE	Estonia	LT	Lithuania	SI	Slovenia
ES	Spain	LU	Luxembourg	SK	Slovakia

1 INTRODUCTION

1.1 Context of this evaluation

Air pollution damages human health and the environment. Several pollutants are emitted into the air from different sources. The effects may be felt locally or even hundreds of kilometres away due to the pollutant being transformed and transported in the atmosphere. Air pollution policy addresses this complex reality. It comprises legislation covering environmental quality standards and the abatement of specific emissions sources (nationally and at EU level), as well as strategic legislation to tackle long-range pollution that crosses national borders, including an international agreement under the auspices of the United Nations Economic Commission for Europe (see Box 1 below). There are strong inter-connections between the various policies influencing air pollution. This reflects the reality that similar economic activities often affect both air pollution and climate change, as well having an impact on water pollution and ecosystems. This makes evaluating the specific role of the National Emissions reduction Commitments Directive (NECD)[1] particularly challenging.

The NECD sets out mandatory commitments per Member State to reduce emissions of five key air pollutants that have a distinct transboundary effect and a harmful impact on human health and the environment. There are emission reduction commitments (ERCs) to be achieved by 2020 and another set of commitments to be achieved by 2030. Inventories of emissions are reported annually by the Member States to monitor the effectiveness of national policy programmes and measures to abate emissions. The purpose of the current evaluation therefore is to take stock of progress made so far and to assess whether additional effort or policies may be needed to ensure delivery of ERCs by 2030. Moreover, the evaluation will specifically address opportunities for cost reduction and simplification, in line with the Commission's reinvigorated simplification agenda and its commitment to improving the EU's economic competitiveness[2].

The evaluation will inform the Commission's agenda on clean, competitive and socially fair prosperity by providing insights for implementing key political initiatives, such as the Clean Industrial Deal, the Vision for Agriculture, the Water Resilience Strategy and the upcoming Bioeconomy Strategy. It will also show the extent to which the Directive is contributing to implementing the related targets and objectives set so far, notably as part of the European Green Deal. More specifically, the analysis will take into account links with other policy areas that either directly or indirectly influence air pollutant emissions, such as climate, energy, mobility, industrial and agricultural policies.

BOX 1. The Gothenburg Protocol under the UNECE Air Convention and the EU's role

The Gothenburg Protocol (GP), officially known as the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, is a key international agreement under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention). The Convention was

[1] 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.

[2] Europe's Choice – Political Guidelines for the next European Commission 2024-2029.

adopted in 1979 and provides a platform for clean air policy discussions, supported by a well-established science network (EMEP).

The GP was established to reduce air pollution and its harmful effects on human health and the environment across Europe and North America. It sets ERCs for major air pollutants and their precursors. Along with the individual EU Member States, the EU is a signatory to the Protocol. The amended GP was ratified by Council Decision (EU) 2017/1757. The protocol is currently under revision following a decision taken at the 43rd session of the Executive Body of the Convention in Geneva in December 2023, with the aim of finalising the process by its 46th session in 2026. The revision is a follow-up to a review of the Protocol, which found that countries in the UNECE region are set to suffer long-term damage to human health, ecosystems, crop yields and the climate from air pollution, and that current efforts would not be sufficient to avoid these harmful effects.

1.2 EU clean air policy and the NECD

The NECD is part of a comprehensive clean air policy framework that relies on three main pillars:

- the Ambient Air Quality Directive(s) (AAQD)[3], which sets air quality standards for concentration levels of 12 pollutants in ambient air;
- the NECD, which sets out mandatory commitments per Member State to reduce the emissions of five key air pollutants contributing to transboundary pollution;
- EU source legislation, which tackles air pollutant emissions from key sources, such as road vehicles, domestic heating installations and industrial installations.

While the AAQD regulates the exposure of the public to pollutant concentrations at local level, the NECD addresses pollutant emissions at national level. It aims to reduce background concentrations, i.e. the air pollutant concentrations to which individuals are exposed over the longer term, independently of the influence of individual sources (e.g. industrial locations, major roads)[4]. Reductions of emissions from key sources are complemented by the global approach of the NECD, as source legislation does not limit the number of sources (e.g. industrial installations or products).

Since the NECD was adopted in 2016, the policy context in which it is embedded has evolved. In December 2019, the European Commission committed, in the European Green Deal, to further improving air quality and to aligning EU air quality standards more closely with the recommendations of the World Health Organisation (WHO). The WHO Global Air Quality Guidelines were most recently updated in September 2021[5] and are subject to periodic scientific review. The objective of closer alignment with the latest scientific findings was confirmed in the zero pollution action plan (ZPAP) and underpinned the revision of the AAQD adopted in October 2024.

The ZPAP outlines a vision for 2050 where air (and water and soil) pollution is reduced to levels that are no longer considered harmful to human health and natural ecosystems,

[3] 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 (OJ L 152, 11.6.2008, p. 1) and Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (OJ L 23, 26.1.2005, p. 3) recast in Directive (EU) 2024/2881 on ambient air quality and cleaner air for Europe (OJ L, 20.11.2024, p. 1).

[4] See also Ambient Air Quality Directive ((EU)2024/2881): 'urban background locations' means places in urban and suburban areas where levels are representative of the exposure of the general urban population and 'rural background locations' means places in rural areas with low population density where levels are representative of the exposure of the general rural population, vegetation and natural ecosystem.

[5] WHO (2021) WHO Global Air Quality Guidelines.

and that respect planetary boundaries. In addition, the ZPAP introduced two targets for 2030 (relative to 2005):

- reduce by over 55% the health impacts of air pollution (premature deaths); and
- reduce by 25% the share of EU ecosystems where air pollution threatens biodiversity.

The evaluation takes into account this updated clean air policy framework to assess not just whether the legislation has met the initial objectives, but also whether it continues to be relevant in view of the targets and standards adopted since.

The interplay between the relevant EU legislation listed in the intervention logic and the NECD is analysed using the effectiveness and coherence criteria. The effect of developments at international level and other external factors are also considered. See a short description of the NECD in Section 2.1 and a detailed one in Annex VI.

1.3 Purpose and scope of the evaluation

1.3.1 Purpose of this evaluation

This evaluation fulfils the commitment laid down in Article 13 of the NECD. It comes midway between 2020, when ERCs were first applied, and 2030, the year by which Member States must meet more ambitious ERCs. It is thus an opportune moment to take stock as to whether Member States have implemented sufficient measures to meet the 2020-2029 ERCs and are on track towards achieving their 2030 objectives.

In line with the requirements of Article 13, as regards ammonia, this evaluation also assesses the latest scientific evidence, updates to UNECE guidance on the matter, updates to Best Available Techniques (BAT) under the old and revised Industrial Emissions Directive (IED) and relevant measures in the common agricultural policy (CAP).

Furthermore, Article 13 includes a specific point on mercury, as it refers to the need to consider measures for reducing mercury emissions and, if appropriate, to submit a legislative proposal. In 2017, a Regulation on mercury was adopted, which was last revised in 2024. The IED also covers mercury emissions into the air. As these policy developments are in line with the requirements on mercury laid down in Article 13 of the NECD, this evaluation does not cover this point.

1.3.2 Scope of this evaluation

This evaluation includes the NECD and other acts related to its implementation, namely Commission Implementing Decision (EU) 2018/1522 laying down a common format for national air pollution control programmes under Directive (EU) 2016/2284; Commission Guidance for the development of National Air Pollution Control Programmes under Directive (EU) 2016/2284 and the Commission Notice 2019/C 92/01 on ecosystem monitoring under Article 9 and Annex V of Directive (EU) 2016/2284.

In line with the Commission's Better Regulation Guidelines, this report assesses the NECD against all five of the standard evaluation criteria: effectiveness, efficiency, coherence, relevance and EU added value.

This evaluation covers the period from adopting the NECD on 14 December 2016 until 31 October 2025, and looks at how it has been implemented across all current EU

Member States (with some consideration given to transboundary pollution from outside the EU).

1.3.3 Methodology, robustness and limitations[6]

The evaluation relies on **reported data** for levels of emissions (air pollutant emission inventories), ecosystem monitoring (measured data on sites), data on administrative burden (reported data) and data on funding related to clean air (tracking of clean air funding). The latest air pollutant emissions data refer to 2023 (reported in 2025). To cover the full 2016-2025 evaluation period, we had to base 2024 and 2025 data on Member State **emission projections and the (greenhouse gas and air pollution interactions and synergies (GAINS) model**. Evidence regarding adjustment costs was also very limited. This gap was also covered via the GAINS model.

Annex II to this staff working document describes the GAINS model in detail. It is important to note that the model is validated against reported data (e.g. national statistics) and monitoring data (e.g. atmospheric concentrations of $PM_{2.5}$). Assumptions on national policies, activity data and cost parameters are checked with Member State and industry experts. The GAINS modelling framework shows the aggregate effects (and costs) in future years of the emissions abatement measures already taken by the Member States (and of the measures that are likely to be applied). However, the framework integrates all relevant measures, including those taken due to non-air pollution policies (such as climate or energy policies, or source legislation). **It is therefore not possible to disentangle the modelled impacts of air pollution policies from impacts linked to other policies**. Thus, it is not possible to estimate the share of emission reductions that are due to the NECD: policies act in synergy and individual effects are impossible to determine. This ripples through to assessing adjustment costs and benefits. These limitations are highlighted throughout this document as well as in Annex III.

In addition to the above, the evaluation has also used desk research and a range of consultation activities to supply further evidence on the evaluation criteria. The response to the open public consultation (OPC) (53 replies) and targeted stakeholder consultation (TSC) (42 replies) was limited. Thus, the results are not representative and must be interpreted with caution. It is not possible to draw general conclusions.

2 WHAT WAS THE EXPECTED OUTCOME OF THE DIRECTIVE?

2.1 Description of the intervention and its objectives

The main **objective** of the NECD is to **contribute to achieving levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment**. The main tools for addressing this objective are the ERCs for Member States' emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3) and fine particulate matter ($PM_{2.5}$). These are in place for the 2020-2029 period, with more stringent ERCs applicable from 2030 onwards. The ERCs were defined considering what was both technically feasible and cost effective, while contributing to the main objective of the NECD.

[6] See the detailed assessment in Annex II.

Significant progress in reducing air pollution had already been made under the predecessor legislation, but, as stated in the 2013 Commission Communication 'A Clean Air Programme for Europe', significant negative impacts on and risks to human health and the environment remained. The NECD was adopted to support compliance with obligations under the EU's air quality legislation, to harmonise with international requirements under the amended Gothenburg Protocol to the Air Convention[7] (GP), and to achieve the EU's long-term objectives on air quality. These objectives are supported by the WHO Global Air Quality Guidelines, and the EU's biodiversity and ecosystem protection objectives. The latter aim to reduce levels of and deposition from air pollution – which causes acidification, eutrophication and ozone damage – to below the critical loads and levels[8] set out by the Air Convention.

In addition, the NECD was intended to address some of the shortcomings in implementing the predecessor legislation. It aimed to do this by better coordinating national policy, reducing pollution through the most cost-effective sectoral measures, and improving the information base through better reporting.

The **intervention logic** underpinning the NECD is summarised in the figure below. It shows the needs that triggered the interventions, and the objectives of those interventions. It explains how the interventions were expected to work (activities that were expected to be carried out) and the achievements expected in the short, medium and long term (expected outputs, results, impacts). External factors and other EU policies that influence the implementation of the Directive are also reflected in the intervention logic.

[7] It was also considered important for the EU to ratify the amended Gothenburg Protocol in order to stimulate wider ratification by non-EU parties, to promote the green economy in non-EU countries and ultimately to reduce the impact of non-EU countries on EU air quality.

[8] The critical load or level refers to a threshold below which the ecosystem can absorb pollutants deposited from the atmosphere without disruption. Deposition above this threshold is likely to disrupt terrestrial and aquatic ecosystems and lead to changes in species diversity.

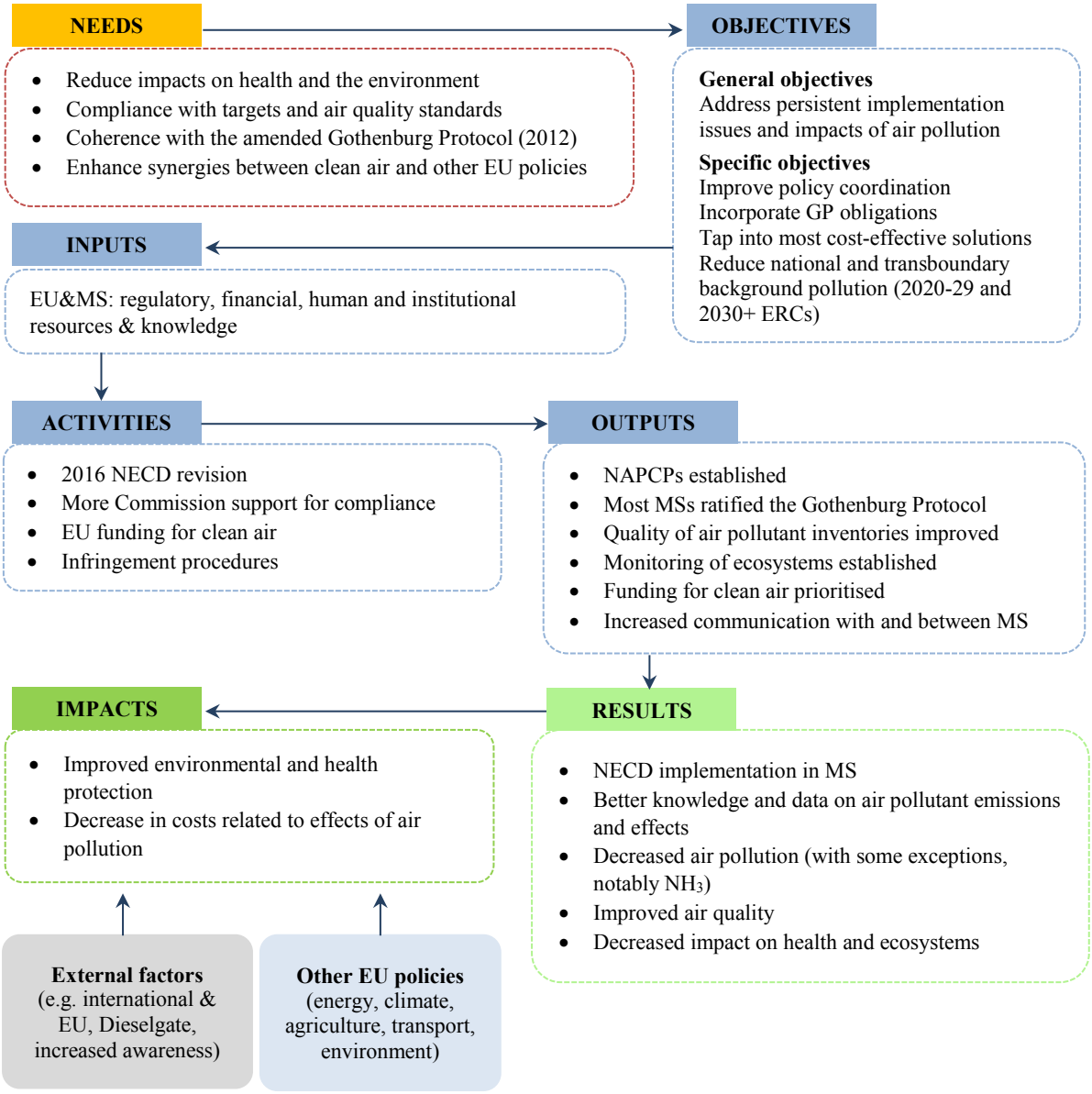

Figure 1 – Intervention logic of the NECD

The core of the NECD consists of the national **emission reduction commitments** (ERCs) for five main air pollutants. These are set for the period 2020-2029, with stricter ones for 2030 onwards (2030+). The ERCs are defined in percentages in relation to emission levels for the five main air pollutants in the base year 2005.

The ERCs vary among the Member States depending on national situations and among pollutants depending on technical abatement potential and costs. In consequence, for most Member States ERCs are lower for ammonia and higher for SO_2. The 2020-2029 ERCs align EU requirements with the international commitments set out in the amended GP. They had to be attained by 2020 and be, at least, maintained throughout that period. The 2030+ ERCs reflect a cost-effective strategy for attaining a higher level of health and environmental protection across the EU, which Member States must reach starting from 2030.

The NECD sets an indicative emission level for 2025 that is based on a linear reduction trajectory between the 2020 and 2030 ERCs[9]. This indicative benchmark has been used to see whether Member States are on track towards achieving the 2030+ ERCs and help direct effort to areas where they are falling short. Member States may deviate from the linear trajectory, if justified, but few Member States have seen the need to use this option.

The Commission, with the support of the European Environment Agency (EEA), checks whether Member States comply with the ERCs on the basis of yearly air pollutant emission inventories. **Inventories** consist of emission estimates for different sectors produced using **well-established methodologies** set out in the **EMEP Reporting Guidelines, the EMEP/EEA air pollutants emission inventory guidebook and further guidance material adopted under the UNECE Air Convention**. These methodologies are regularly updated based on evolving scientific knowledge. The Commission verifies the transparency, accuracy, consistency, comparability and completeness of the emission inventories, and whether they have been prepared in accordance with approved methods. Member States may apply for flexibilities to become compliant under certain conditions, such as non-compliance due to using improved inventory methods; due to exceptional weather conditions; due to power failure or failure of the heat supply or production system; or when effecting a pollutant swap (compensating for non-compliance of one pollutant by reducing another pollutant by an equivalent amount)[10].

Member States also have to submit **projections** of future national emissions reflecting known policies and measures. The Commission and the EEA also review projections to ensure that they are as reliable as possible. These projections have been assessed against the 2025 benchmark.

The reporting on air pollutants for which ERCs have been established is complemented, for monitoring purposes, by reporting requirements for other major air pollutants, such as carbon monoxide, heavy metals and black carbon. Based on data reported by Member States, the Commission reports to the Air Convention on behalf of the EU.

These programmes set out policies and measures (PaMs) across different sectors, whether adopted or planned, which are decided upon nationally to tackle air pollution. The NAPCPs provide timetables for implementation; describe impacts on emission reduction, air quality and the environment; and ensure coherence with plans and programmes under other relevant policies. Where emission inventories or projections show that ERCs are not complied with or there is a risk of non-compliance, Member States must update their PaMs. The NAPCP thus constitutes an essential policy instrument for Member States. It ensures coordination across policy areas and

[9] This follows from Article 4(2) of the NECD, which states further that 'Member States may follow a non-linear reduction trajectory if this is economically or technically more efficient and provided that as from 2025 it converges progressively on the linear reduction trajectory and that it does not affect any emission reduction commitment for 2030'. Member States need to justify in their NAPCP the reasons for following a non-linear trajectory.

[10] The pollutant swap flexibility was added to help Member States comply with their ERCs, where these had been set at a more stringent level than the cost-effective reduction modelled for that pollutant and Member State (see Annex III 2.5 for details).

ministries, bringing a system-level focus on reducing air pollutants that is unique in the clean air policy field.

BOX 2. Policies and measures (PaMs) included in national programmes (NAPCPs)[11]

The Commission reviews the NAPCPs and publishes NAPCP review reports for all Member States[12]. Most PaMs target emissions from the agriculture (21%), energy (26%) and transport (29%) sectors. Examples of the most common objectives of PaMs are presented below:

- **Agriculture:** improved animal waste management systems (NH_3); improved livestock management and rearing installations (NH_3); low-emission application of fertiliser/manure on cropland and grassland (NH_3).
- **Energy**: increase in renewable energy (NO_x, NMVOCs, $PM_{2.5}$, SO_2); improvement in the energy and transformation sector (NO_x, NMVOCs, $PM_{2.5}$, SO_2); efficiency improvements of buildings (NO_x, NMVOC, $PM_{2.5}$, SO_2); efficiency improvement of appliances ($PM_{2.5}$, NO_x, SO_2).
- **Transport:** fast adoption of zero emission vehicles, shift to less polluting modes of transport (NO_x, NMVOCs, $PM_{2.5}$).

Annex III Part 2 of the NECD sets out a list of obligatory and optional measures related to agriculture, to be addressed through the NAPCPs. This annex reflects the significant contribution of agriculture to NH_3 and $PM_{2.5}$ emissions and the potential to address them through concrete actions proposed at EU level. NH_3 is a direct contributor to eutrophication and an important precursor for the formation of secondary particulate matter in the atmosphere[13]. The NECD explicitly requires for an evaluation to assess the latest scientific evidence and the evolution of measures in the context of the CAP, the IED and the Air Convention[14].

To assess whether emission reductions are effective in reducing impacts on the environment, Member States are required to monitor and report the impacts of air pollution on water and terrestrial ecosystems. When setting up appropriate monitoring systems, Member States may use existing monitoring systems that have been established for example under the Air Convention.

The figure below provides a visual summary of the workings of the NECD. Annex VI provides a more detailed description of the requirements of the NECD.

[11] For further information on PaMs, see the detailed analysis on effectiveness (Annex III 2.2.2 on the additional PaMs selected and Annex III 2.2.5 as well as Table A-64 in Annex III 5.3.4 on additional agricultural measures under Annex III Part 2 of the NECD) and examples on Member State approaches to reducing ammonia (Annex IX).

[12] https://environment.ec.europa.eu/topics/air/reducing-emissions-air-pollutants/national-air-pollution-control-programmes-and-projections_en

[13] Gaseous ammonia can be transformed through chemical reactions in the atmosphere into aerosols (secondary particulate matter) such as ammonium sulphate. Similarly, sulphur dioxide and nitrogen oxides can be transformed into nitrates and sulphate aerosols.

[14] See Annex III, Sections 5.1 and 5.3.

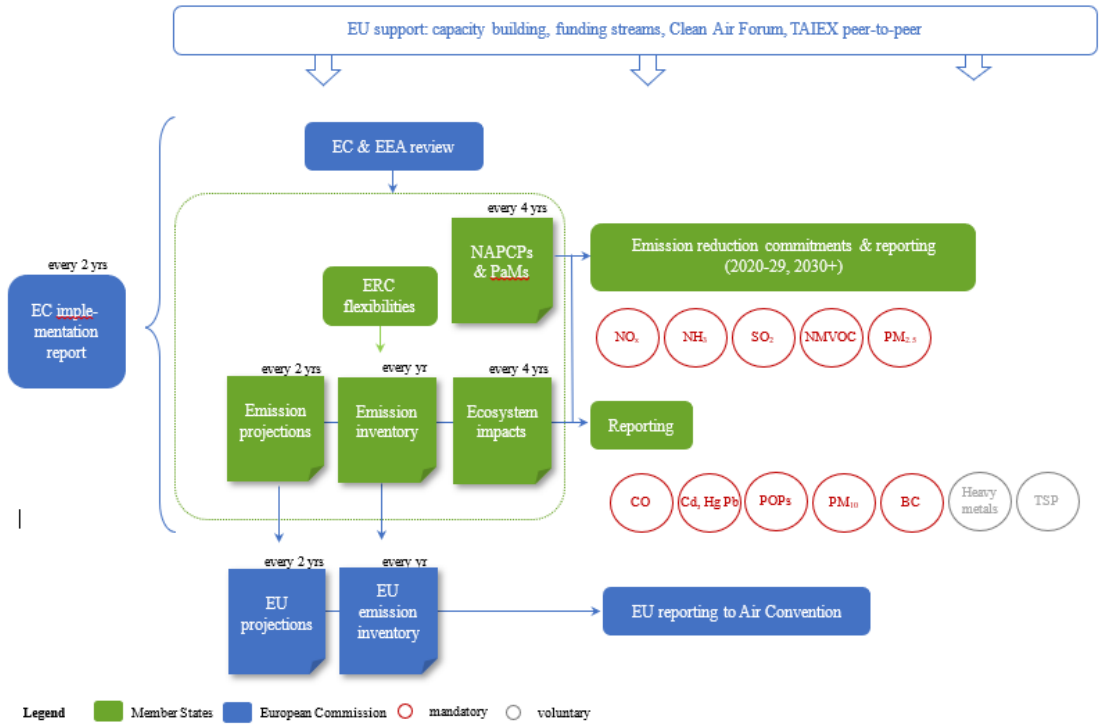

Figure 2 – Main elements of the NECD

2.2 Points of comparison

As outlined in the Better Regulation Guidelines, points of comparison are based on the expected results and impacts of the **preferred option, as defined in the 2013 impact assessment accompanying the NECD proposal** (NECD IA)[15]. However, changes to the proposal during the legislative process limit the possibility of using the NECD IA as a point of comparison. The main changes affecting points of comparison were:

- methane ERCs and reporting requirements were deleted, affecting compliance costs and environmental impacts;
- the ambition of ERCs for the five main air pollutants were lowered, affecting compliance costs and environmental impacts;
- the frequency of NAPCP submissions, inventories for gridded data and large point sources (LPS) was reduced from every two years to every four years, affecting administrative costs;
- the use of ecosystem monitoring indicators annexed to the Directive were changed from mandatory to optional, affecting compliance costs;
- several of the agricultural measures annexed to the Directive were changed from mandatory to optional, affecting compliance costs and environmental impacts.

In most cases, it was not possible to provide a reliable, quantified point of comparison for elements connected to these changes based on the NECD IA. This was mainly due to the fact that the IA did not break down related cost items. It was not possible to

15 Impact assessment accompanying the proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC (and three other documents), SWD(2013) 531 final

reconstruct the calculations based on the information available (see details in Annex III Section 3).

Evaluation questions check the expected results and impacts against the actual implementation of the Directive for all evaluation criteria in the evaluation period:

- **Effectiveness** looks at compliance with national ERCs for the five pollutants covered in the NECD and at whether the expected health and environmental benefits have been attained. The evaluation first and foremost checks whether Member States have attained the currently applicable ERCs, based on past emissions data. In addition, it attempts to assess whether the efforts made by Member States have been sufficiently effective to put them on track towards meeting the more ambitious 2030 ERCs. It analyses the role of specific NECD requirements, of other policies and of EU international commitments in reaching the objectives. The analysis relies on extensive documentation from the Member States, including national policies and measures and their effects; emission inventories and projections; and reviews of those inventories and projections.
- **Efficiency** analyses administrative costs (mainly for Member States, as the addressees of the Directive and main bearers of such costs) and abatement costs (for Member States and businesses, e.g. farmers reducing ammonia emissions). It also investigates the cost of inefficiencies, for example due to overlaps between similar but not identical requirements of EU policies. It contrasts costs with benefits, such as the monetised health and economic benefits of improved air quality. This analysis focuses on the cost of actions taken over the evaluation period (2016 to 2025).
- **Coherence** investigates both coherence within the NECD (internal coherence) and coherence with related EU policy and the relevant EU international commitments (external coherence). It analyses synergies, overlaps, incoherences and how they have changed over the evaluation period.
- **Relevance** checks the NECD objectives and delivery mechanism against the evolution of related EU policies, technical and scientific progress, and other external factors. It examines whether the scope of pollutants covered by ERCs or by reporting requirements is pertinent, and whether emission reduction measures for agriculture are relevant (Annex III Part 2 of the NECD).
- The **EU added value** criterion checks the extent of transboundary pollution and examines scenarios in which Member States take action via national policies or act within the international framework of the GP.

The analysis systematically integrates input from stakeholder consultation. The evaluation matrix[16] summarises the points of comparison, the indicators used to assess them, the sources and the methods used.

3 HOW HAS THE SITUATION EVOLVED OVER THE EVALUATION PERIOD?

When the NECD was adopted in December 2016, Member States were required to bring into force provisions related to reporting inventories and projections by 15 February 2017, and to fully **transpose** (i.e. integrate into national law) the Directive by 1 July 2018. The Commission subsequently checked the conformity of the national

[16] See Annex III Section 1 of this evaluation.

measures notified and launched nine infringement procedures due to national legislation not being in conformity with the requirements of the Directive. All but one[17] of those procedures have since been closed.

The first NAPCPs had to be submitted to the Commission by 1 April 2019, but only seven Member States did so by that deadline. The Commission opened infringement procedures for late submission of NAPCPs for five Member States which were subsequently closed once the programmes were submitted. The reporting of NAPCPs continues to see serious delays. Only six Member States updated their NAPCPs on time.

Member States have reported yearly emission inventories since 2017, building a solid base of emissions data. The inventory reviews show that inventory quality has improved over time[18]. Overall, reporting of inventories has been complete and on time[19], with a just a few cases of delays. There has been one case of emission inventories and projections not being reported, which led to an infringement procedure being opened.

Put simply, emissions are calculated by multiplying activity data with emission factors at detailed sectoral level. As such, inventories reflect changes in production patterns observed over time, including changes in the activity level of certain economic activities[20] and changes in the way a given economic activity is conducted[21].

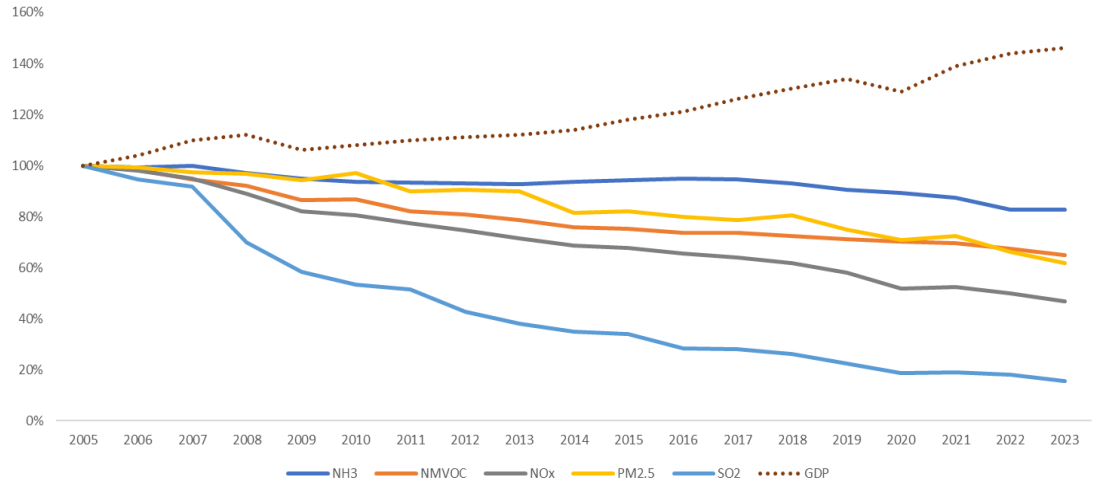

Figure 3 – 2005-2023 trends in EU emissions of NH_3, $PM_{2.5}$, NMVOC, NO_X and SO_2, as percentages of 2005 levels, set against EU Member States' GDP as a percentage of 2005 GDP (source: EEA NECD briefing 2025)

Emissions of the five main pollutants have decreased at EU level. **Error! Reference source not found.** shows the **trend in the emissions of the five main pollutants** since

17 The procedure that is still open is against Poland, as it has failed to transpose some requirements into national law (e.g. it has not included the obligatory emission reduction measure in NAPCPs and the requirement to conduct transboundary consultations) and it has failed to set penalties for breaching the Directive.

18 Inventory reviews per Member State and horizontal inventory reviews: https://environment.ec.europa.eu/topics/air/reducing-emissions-air-pollutants/emissions-inventories_en.

19 Annex III 2.2.1 has a detailed overview of timeliness of reporting under the NECD.

20 Such as due to increased uptake of new activities, e.g. shift from fossil fuel combustion to non-combustible renewable sources of energy.

21 Such as through abatement techniques to render an existing activity less polluting (e.g. end-of-pipe abatement by installing particle filters in mobile or stationary combustion or changes in the way animal manure is handled).

2005, the base year against which the NECD sets ERCs. This is based on emission inventory data submitted annually by Member States (reported data). Emissions have **decreased most for SO_2 (-85%)** and **least for NH_3 (-17%)**, reflecting the different targets of ERCs. This, however, hides differences in Member State performance. The evolution of emissions per pollutant and Member State over time are detailed in EEA publications[22].

The Commission has been carrying out compliance assessments against the ERCs since 2022, when Member States reported emissions data for the first time for the year 2020[23]. Based on these assessments, **overall compliance is relatively good for all pollutants except ammonia**, for which 11 Member States failed to reduce emissions sufficiently in 2020. This number progressively reduced to 8 Member States in 2022 (based on the 2024 submission), with the latest submission from 2025 indicating that, in 2023, 5 Member States were non-compliant for ammonia. The compliance situation for all other pollutants is considerably better and, in the latest submission, only 1 Member State is non-compliant per pollutant (see Table 1 below and the more detailed overview in Annex III Section 2). As ERCs are set for 5 pollutants across 27 Member States, there is a total of 135 pollutant-Member State combinations for which compliance is checked. Table 1 shows that the number of ERCs not met out of that total has progressively reduced over time (from around 14% to 6% of all 135 combinations). The Commission has followed up on the non-compliance cases by starting infringement proceedings, as summarised in Annex III, Section 2.1.6.

Table 1 – Overview of Member States non-compliant with 2020-2029 ERCs per pollutant since the first inventories were submitted for 2020

Year	NH_3	$PM_{2.5}$	NMVOCs	NO_x	SO_2	No of ERCs not met/all ERCs
2020*	11	3	2	2	1	**19/135**
2021**	10	3	3	2	1	**19/135**
2022***	8	2	1	2	1	**14/135**
2023****	5	1	1	1	1	**9/135**

*According to inventories reported by Member States in 2022 (on which the letters of formal notice issued in January 2023 were based).
**According to inventories reported by Member States in 2023 (on which the letters of formal notice and reasoned opinions issued in November 2023 were based).
***According to inventories reported by Member States in 2024.
****According to inventories reported by Member States in 2025.

Comparing 2023 air pollutant emissions with the more ambitious 2030+ ERCs shows that all but 4 Member States[24] need to reduce emissions in the future for one or more pollutants. Some pollutants need to be reduced substantially. All but 10 Member

22 For pollutant trends per country, see EEA National air pollutant emissions data viewer 2005-2023. For the latest state-of-play on distance to compliance per Member State and an overall assessment of progress, see EEA NECD briefing 2025.

23 Member States submit emission inventories covering a full time series on an annual basis (Article 10(2) of the NECD), but with a two-year time lag between the last emissions and the submission of the data.

24 Belgium, Estonia, the Netherlands, Finland (EEA NECD briefing 2025).

States[25] need to reduce emissions to ensure they are on a linear reduction trajectory in 2025[26].

Member States also submitted **projections** of air pollutant emissions. These provide insights as to whether the policies and measures that have been implemented and planned are likely to be successful in reducing emissions going forward. Projections 'with measures' (WM) take into account the effects of PaMs that have been adopted. Projections 'with additional measures' (WAM) take into account also the effects of PaMs that Member States are planning to adopt to further improve the compliance situation by 2025, as well as in view of 2030+ ERCs. When considering also additional PaMs, four Member States project non-compliance in 2025 against the 2020–29 ERC, and 9 in 2030 against the 2030+ ERC.

In addition to Member State projections, the **Clean Air Outlook reports** provide a consistent set of EU projections for the main air pollutants. It is based on an updated baseline that reflects the latest developments in EU and national policies (modelled data). The latest edition (CAO4) was published in March 2025[27]. The CAO4 baseline projects that 7 Member States will have ammonia emissions that exceed the maximum allowed level defined by their ERC in 2025 (2 Member States for NO_x and 1 Member State for $PM_{2.5}$). 18 Member States are on track to meet the ERCs currently applicable for all five pollutants in 2025. The assessment worsens when compared with the linear reduction trajectory in 2025, with 17 Member States projected to exceed the indicative 2025 level for ammonia alone, and only 8 Member States in line with the indicative 2025 levels for all pollutants. Finally, only 4 Member States are on track to meet their 2030 ERCs for all pollutants (with 21 projected to exceed the 2030 ERC for ammonia alone).

Table 2 – Number of Member States projected not to meet their ERCs based on 4th Clean Air Outlook projections

Scenario	Year	NH_3	$PM_{2.5}$	NMVOC	NOx	SO_2
Baseline	2025	7	1	0	2	0
Baseline	2025 (indicative)	17	5	1	2	0
Baseline	2030	21	8	3	2	0

Note: 2025 (indicative) means that the assessment is carried out against the linear reduction trajectory.

The difference in performance across pollutants can also be seen when looking at how key **indicators tracking progress against health and environmental objectives** have evolved: The EEA indicator on the number of premature deaths attributable to exposure to $PM_{2.5}$ over time registers a decrease of 45% between 2005 and 2022 (with a 16% reduction achieved over 2016-2022, i.e. since the adoption of the NECD). Latest EEA data show a decrease of 57% between 2005 and 2023[28]. The EEA indicator on the total

25 Belgium, Croatia, Denmark, Estonia, Finland, France, Greece, Netherlands, Slovenia, Spain.

26 Article 4(2) of the NECD requires Member States to take the necessary measures aimed at limiting their 2025 emissions to the indicative level determined by the mid-point between the maximum allowed levels according to their 2020-2029 and 2030+ ERCs.

27 Fourth Clean Air Outlook Report from the Commission (COM(2025) 64 final), and its underlying support study by IIASA et al. (2025): https://environment.ec.europa.eu/topics/air/clean-air-outlook_enhttps://environment.ec.europa.eu/topics/air/clean-air-outlook_en.

28 https://www.eea.europa.eu/en/analysis/indicators/health-impacts-of-exposure-to. The EEA assessment is based on WHO recommendations regarding the relationship between the concentration of an air pollutant to which a population is exposed and a health outcome (e.g. mortality) and the

area where nitrogen deposition exceeded the critical loads for eutrophication, which is a key indicator for assessing the impact of air pollution on the environment, fell by only 13% between 2005 and 2022[29]. This in turn is mirrored by the **assessment comparing performance with the EU's zero-pollution targets**, with the Zero Pollution Monitoring and Outlook 2025 confirming that the EU is **on track to reduce premature deaths attributable to $PM_{2.5}$** by 55% by 2030 compared to 2005, but that it is **unlikely to reduce the area where biodiversity is at risk from air pollution by 25%** by 2030.

Policies and legislation affecting air pollution have evolved since the adoption of the NECD. In 2019, the Commission adopted the European Green Deal. In 2021, the ZPAP followed. The more stringent energy and climate policies adopted under the Fit for 55 package have been particularly relevant for reducing EU greenhouse gas emissions by at least 55% by 2030 with a view to putting the EU on the path to achieve climate neutrality by 2050. The 2023 Biodiversity Strategy and the related 2024 Nature Restoration Law (NRR) also impact the links between air pollution and ecosystems. Later, as a response to Russia's unprovoked military aggression against Ukraine, the European Commission then adopted the REPowerEU package. At the same time, the Commission prepared the ground for more ambitious ambient air quality standards, with the revised AAQD adopted in October 2024[30]. The revised IED, adopted in 2024, is expected to have a positive impact, with some limitations[31].

Error! Reference source not found. Figure 4 shows the stages of implementing the NECD alongside the development of key EU policies and other external factors. These are addressed in more detail in Chapter 4 below.

counterfactual concentrations above which health impacts are considered (see the section on 'Supporting information' under above link). As can be seen when looking at the time series of the indicator, the number of estimated attributable deaths is subject to a certain interannual variability.

29 https://www.eea.europa.eu/en/analysis/indicators/eutrophication-caused-by-atmospheric-nitrogen

30 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).

31 As shown in IIASA et al (2025) 'Support to the development of the fourth clean air outlook', reduced ambition of the revised IED for agriculture (compared to the Commission's proposal) results in higher ammonia emissions in 2030.

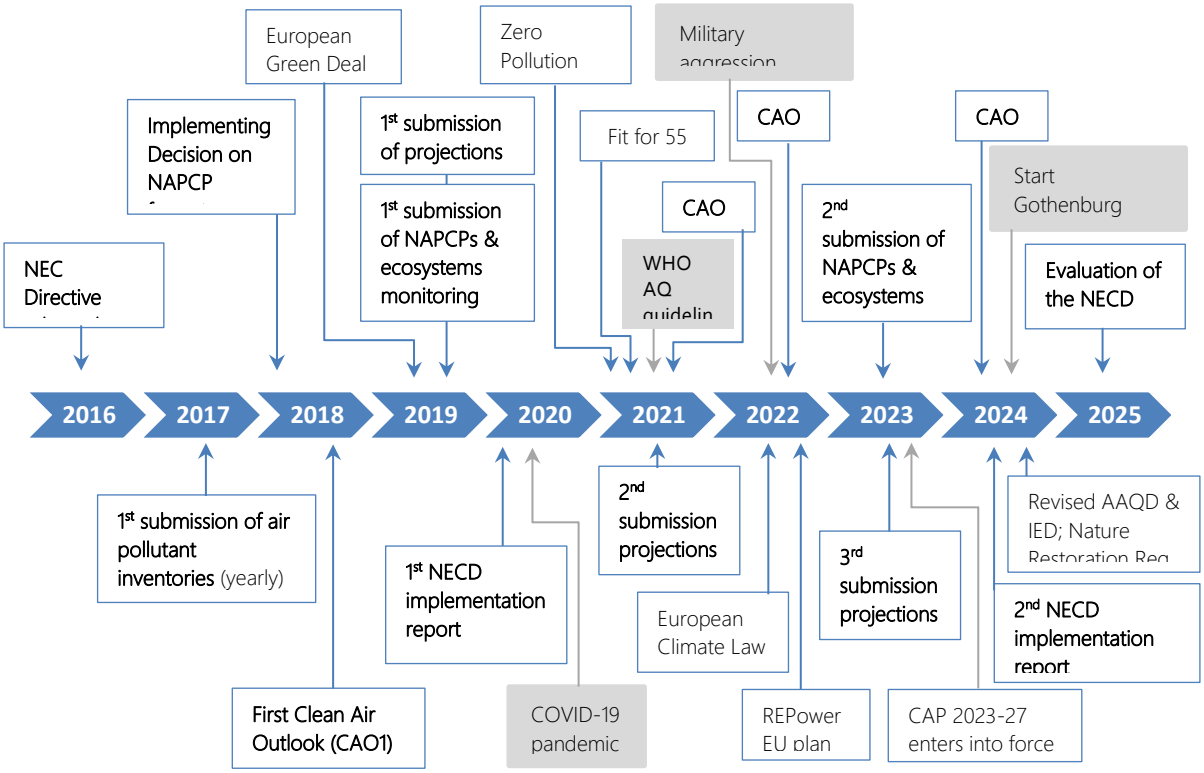

Figure 4 – Implementation of the NECD alongside key EU policy developments and external factors

4 EVALUATION FINDINGS (ANALYTICAL PART)

4.1 To what extent was the intervention successful and why?

This chapter analyses whether the implementation of the NECD over the evaluation period has been effective, efficient and coherent (notably in relation to other policies). It builds on the detailed analysis in Annex III, Sections 2, 3 and 4.

4.1.1 An effective and coherent policy framework for reaching national emission reduction commitments and moving towards zero-pollution targets

The effectiveness of the NECD in reaching ERCs is examined from two perspectives, both relating to the expected situation of Member States in 2025:

- Whether Member States comply with the current ERCs based on information available in 2025 (with 2023 data being the latest reported data available). Member States had to achieve their 2020-2029 ERCs in 2020 or in any year afterwards within this period.
- Whether Member States are on a linear reduction trajectory in 2025 to meet their ERCs applying from 2030 onwards. The evaluation includes this aspect, as Member States had to take action to realistically be able to reach the stricter ERCs in 2030 (Article 4(2) of the NECD). 2025 is the midway point towards this milestone.

Chapter 3 provided the current state of play regarding compliance with the Directive's 2020-2029 ERCs. In summary, **out of the 135 ERCs (5 per Member State) that became applicable in 2020, Member States had achieved 116 in 2020 and 126 by 2023**. Despite a significant decrease in emissions of the five main air pollutants at EU level compared to 2005, **some non-compliances still remain at Member State level**.

According to emission inventories for 2023 (submitted in 2025)[32], 5 Member States did not reach their 2020-2029 ERCs for ammonia (BG, LV, PT, SE and SK), and 1 Member State did not reach its 2020-2029 ERCs for each of the other four pollutants (LT for NO_x and NMVOCs, CY for SO_2 and RO for $PM_{2.5}$). The Commission has followed up on the non-compliance cases by starting infringement proceedings, which are an essential tool for enforcement. They help keep the issue on the agenda in Member States, trigger regular checks and dialogue between the national and EU administrations, and can thus help in defining adequate ambition for NAPCPs and PaMs. This contributes to effectively implementing the NECD – and provides added value compared to the GP, which lacks the strong implementation and enforcement mechanisms available under EU law.

In a few cases and limited to 4 Member States, the use of **flexibilities** available under the Directive has helped Member States to comply with their ERCs. Nonetheless, in most of these cases there have still been continued efforts to tackle the emission source despite the use of flexibility (analysed in detail in Annex III 2.5).

The reductions in emissions of the five main air pollutants are the combined result of efforts to comply with the NECD and other relevant legislation. Source legislation, the NECD and the **AAQD** form the three pillars of clean air policy. While the AAQD regulates exposure of the public to pollutant concentrations at local level, the NECD addresses pollutant emissions at national level. There is a virtuous loop of effectiveness between the two: the NECD focuses on the most important transboundary air pollutants, thus contributing to reducing overall background air pollution. This, in turn, contributes to achieving AAQD air quality standards at local level in Member States. The pollutants covered by the two directives are largely complementary. Ozone as a secondary pollutant is not covered by the NECD, but some ozone precursors are, in particular NO_x and NMVOCs, methane being an exception. The **NECD and AAQD provide a coherent, mutually supportive, clean air policy framework**. **This also holds for the 2024 revised AAQD**. Though the application of the revised AAQD does not fall within the evaluation period, the entry into force of stricter air quality standards under the AAQD coincides with the application of stricter ERCs under the NECD as from 2030. The revised AAQD additionally recognises the role of NAPCPs in tackling ozone precursors and contributing to the establishment of air quality plans.

BOX 3. Internal coherence of provisions in the NECD

The analysis of internal coherence took into account the NECD, as well as Commission Implementing Decision (EU) 2018/1522 on a common format for NAPCPs and the Guidance for the development of NAPCPs, both adopted based on Article 6 of the NECD. The assessment (see Annex III, 4.1 for details) concludes that, in most cases, the provisions of the NECD are coherent. Nonetheless, the timing for adopting and submitting updated NAPCPs and PaMs is not clear, as the provisions under Articles 6(3), 6(4), 10(1) and 10(2) do not fully interlink. Furthermore, while the NECD and Commission Implementing Decision on the common format of the NAPCP are detailed as to the content of the first NAPCP, they are less explicit with regard to updating NAPCPs and PaMs. This has led to some variation in submissions from the Member States.

The third pillar of EU clean air policy comprises **policies that target emissions from specific sources** (e.g. emissions from transport or industry) and policies addressing pollutants directly or indirectly (e.g. climate and energy policy, agricultural policy). The 2013 NECD IA stressed the role of the Directive as a framework to deliver the

[32] The Commission had not yet reviewed these inventories at the time of writing this evaluation. Therefore, information on compliance status might change.

additional reductions needed (on top of those achieved through source legislation) to reduce emissions in line with long-term health and environmental targets. This role is encapsulated in recital 11 of the NECD: 'This Directive should contribute to the progressive reduction of air pollution, building on reductions delivered by Union source-based air pollution control legislation which addresses emissions of specific substances.'

This evaluation analysed the possible extent of the role of the NECD in driving emission reductions over the evaluation period.

A first step was to analyse the policies and measures (PaMs, reported data) that Member States have adopted and described in their NAPCPs to achieve compliance with their reduction commitments. Member States had to indicate whether the PaM was linked to other EU policies. An analysis of this data suggests that most measures (62%) were put in place specifically to implement the NECD. This number is likely an over-estimate, as some Member States did not link their PaMs to other policies even where there was a clear link. Despite this weakness, **the percentage shows that a significant proportion of PaMs resulted directly from the NECD,** and therefore, emission reductions are partially attributable to the NECD. Thus, the **exact share of emission reductions due to the NECD cannot be quantified**.

In a second step, a detailed analysis of the contribution of other EU policies to reaching NECD objectives was undertaken (Annex III Section 2.7). This was based on impact assessments and evaluations of other EU policies to understand their impact on air pollutant emissions. The analysis concluded that **in most cases it was not possible to quantify the contribution of other policies**, mainly because reliable and comparable data series were lacking. Comparability was affected by several methodological differences, including sources included, emission factors used, and the base year chosen. Therefore, in most cases only qualitative conclusions could be drawn.

Other EU policies contributed to the objectives of the NECD mostly in a positive way[33]. In some cases, this was due to **coherent policy design** (e.g. transport policy including Euro 6 emission standards, legislation on roadworthiness and alternative fuel infrastructure, IED, Water Framework Directive, Regulation on the Governance of the Energy Union and Climate Action). In other cases, **there were major co-benefits** (e.g. climate policy including governance and effort sharing regulations, legislation on vehicle CO_2 emission standards, Energy Efficiency Directive).

Policies targeting sources that are high emitters brought the highest contributions over the NECD evaluation period. Based on the analysis, it is estimated that the Euro 6/VI standards contributed around 30% to the reduction of NO_x from road transport. The estimated contribution of the IED to the reduction of air pollutant emissions covered by NECD ERCs in the period 2016-2023 is 33% for NO_x, 12% for NMVOC, 22% for NH_3 and 97% for SO_x[34]. These percentages also show that reaching the ERCs is a common effort: source legislation brings down pollution per source, but it takes additional action at national level, triggered by the NECD, to bring down total emission levels according to the ERCs, with subsequent benefits for air quality.

[33] See detailed analysis in Annex III section 2.7.2.

[34] Please note that the NECD inventories cover SO_2 emissions only. The numbers give an order of magnitude, as also the effects of the IED are intertwined with that of other sectoral legislation.

In some cases, the contribution to emission reductions was limited to a specific product group, with uncertain impacts on the reduction of emissions (e.g. relevant product groups under the Ecodesign Directive).

The **CAP** has built-in coherence with the NECD. For example, it specifies reducing ammonia emissions as an objective that CAP strategic plans (SPs) can prioritise, bans the burning of arable stubble as part of the conditionality, and through cross-compliance in the previous CAP. The *potential* to reduce NH_3 emissions is thus significant. Member States can decide to address the needs identified (e.g. reduction of ammonia) using CAP instruments or other policy measures (see examples in Ireland and Austria in Box 7). This makes measures to reduce ammonia dependent on being prioritised at national level (using CAP support or other instruments). This can potentially limit synergies and actual reductions achieved.

From an assessment of Member States' NAPCPs and PaMs, and further information provided by Member States for this evaluation, 18 Members States mention support via the CAP to implement NECD Annex III Part 2 agriculture measures, in most cases without specifying exact amounts of funding[35]. Under the 2014 to 2020 CAP funding period, 28 Rural Development Programmes in 16 Member States provided measures to reduce NH_3 emissions[36]. As further explained in Section 4.3.3.3 of Annex III, the 2023 to 2027 CAP cycle shows improved coherence with the NECD, with Member States required to indicate how their CAP strategic plans contribute to the objectives of the NECD. Under the 2023 to 2027 CAP funding period, 14 Member States proposed in the CAP Strategic Plans 30 rural development interventions that support the reduction of air pollution in farming, the majority of which are partially relevant and include other objectives[37]. Reducing ammonia emissions has been identified as a need in most CAP Strategic Plans (SPs), with high (14 Member States) or medium (10 Member States) priority. A total of 19 Member States (20 CAP SPs) set a target for the indicator 'R.20 air quality ammonia emissions'. In addition, 24 CAP SP linked the support provided under investments to air pollution (including for manure management and low emission fertiliser application). The mapping and analysis of CAP SPs concluded that the CAP SPs will likely contribute to reducing air pollution across the EU. 'Productive investments in improved manure storage' is one of the most common interventions[38] supported 21 times in 17 CAP SPs[39] and aligned with the voluntary measures under the NECD.

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35 See the support study to this evaluation: Logika Group, RPA Europe, Aether, IIASA, EMRC & the University of Hertfordshire (2025), Final report on supporting the evaluation of Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NECD) and its appendices. Clean air tracking of the EU budget shows an estimated €1.1 billion over 2014-2020 from the European Agricultural Fund for Rural Development, and an estimated contribution of €1 billion over 2021-2025. Under the 2023-27 CAP, the contribution is estimated to increase reaching a total of €1.79 billion over 2021-27.

36 See support study section 3.3.2.

37 See support study section 3.3.3.

38 Other interventions may include equipment for low-emission slurry spreading (N20), precision farming equipment (N20), investments in anaerobic digestors (N20), and investments in energy efficiency (C20).

39 *Mapping and analysis of CAP strategic plans – Assessment of joint efforts for 2023-2027*, Publications Office of the European Union, 2023.

Considering that ammonia emissions have seen the slowest reduction over the evaluation period, with the highest number of Member States falling short of the 2020-29 ERCs, further action is needed at Member State level (further analysis below in section 4.1.2 and Annex III 4.3.3)[40].

The **Nitrates Directive** and the NECD are considered coherent overall (see Annex III 4.3.3). Implementing them jointly at national level, also together with provisions and implementing rules relevant to livestock under the **IED**, is expected to create synergies in reducing emissions of ammonia. An integrated approach, where applied (e.g. Ireland – see Box 7 – and examples provided in the support study in Chapter 3.4), can also ensure the right balance between the different types of nitrogen pollution risk when implementing the measures. For example, where the Nitrates Directive requires a longer manure storage period, this *could* increase NH_3 emissions, especially when the manure stored is not properly covered. In the event that both nitrate and ammonia emissions are problematic, both directives contribute in their own way to managing the underlying driver of pollution, i.e. excessive manure due to concentrated livestock production.

The only case where there is a negative contribution to emission reductions is linked to biomass. Under the Renewable Energy Directive (RED), biomass is seen as a contribution to the renewable energy target (subject to the sustainability criteria, which, however, do not cover pollutant emissions), even if the use of biomass in small, inefficient heating appliances in households contributes to $PM_{2.5}$ and NMVOC emissions[41]. This is the main conflicting issue revealed by the coherence analysis. NECD policies and measures in some Member States (e.g. information about correct wood burning, promoting the replacement of heating systems) and other EU policies (e.g. ecodesign for solid fuel local space heaters) are helping to address this problem. The cascading principle governing uses of biomass (laid down in the 'Fit for 55' communication) also provides a useful safeguard for minimising associated air pollutant emissions.

Overall, **the coherence analysis confirmed the finding that action is mostly coherent across EU policies, and that changes in legislation over the evaluation period mostly reinforced coherence** (see Annex III 4.3 for details). For example, the NECD and legislation on Euro emission standards are coherent, as emission standards help Member States reach their ERCs by reducing air pollutant emissions from transport. The NECD does not include any specific measures related to transport, thus avoiding any duplication or contradiction between the two. At the same time, the NECD limits air pollutants with considerable emissions from the transport sector at national level. It therefore helps to accelerate action on cleaner transport. The Euro 7 Regulation strengthens this coherence: it reduces air pollutant emissions by limiting emissions from brakes and tyres, and by introducing stricter exhaust emission limits for new heavy-duty vehicles. The analysis found similar interplay for other transport legislation

[40] More stringent source legislation at EU level could also play a role in the future. Of relevance to emissions from intensive livestock rearing, it is worth noting that the Commission will, by the end of 2026, produce a report under the revised IED to assess the need for Union action to comprehensively address emissions from livestock, in particular from cattle, and propose legislation, where appropriate.

[41] Small-scale biomass combustion led to an increase in $PM_{2.5}$ emissions, which is estimated to have prevented an additional emission reduction of 6 percentage points for this pollutant over the 2005-2022 period (see Annex III 2.7.2). There is a similar effect on NMVOCs, but its extent is unclear.

and Ecodesign[42]. The 2024 revision of the IED also reinforced coherence by including additional sources of pollution, by strengthening rules on the emission limits to be stated in permits, and by increasing the number of exploitations under its remit. The Commission will, by the end of 2026, produce a report under the revised IED to assess the need for Union action to comprehensively address emissions from the rearing of livestock, in particular from cattle, and propose legislation, where appropriate. The analysis also confirmed the mutual reinforcement mechanism between energy and climate policies and the NECD, and potential reinforcement mechanisms between the NRR and the NECD. For biodiversity-related policies, it found coherence in fighting eutrophication and acidification.

While energy and climate policies and the NECD are coherent overall and in fact synergistic, the analysis found that **the links between the Energy Union and Climate Action Governance Regulation and the NECD could be further strengthened.** The issue relates to insufficient coordination in Member States during the preparation of national energy and climate plans (NECPs) and NAPCPs. This is further hampered by the fact that the timing of reporting under the Governance Regulation and the NECD are not aligned.

BOX 4. Linking national air programmes (NAPCPs) and climate/energy plans (NECPs)

Air pollutant emissions are influenced by national choices on the energy mix. Air and energy/climate legislation is connected and requires links to be made between the NAPCPs and the NECPs submitted under the Governance Regulation. The Commission's guidance on developing NAPCPs specifically invites Member States, when drafting their NAPCPs, to consider the PaMs also in the light of climate and energy obligations. In turn, Commission guidance on drafting NECP updates encourages Member States to update their NECPs in line with their NAPCP updates, paying special attention to better assessing the impact of planned policies and measures on air pollutant emissions[43].

While there is scope for further strengthening coherence, according to the 2024 horizontal assessment[44], the NAPCPs generally describe the energy and climate change priorities as part of the policy framework well. 14 Member States included information on the key targets for reducing greenhouse gas (GHG) emissions, renewable energy and energy efficiency objectives. Similarly, the majority of additional PaMs selected for adoption were found to be coherent with NECD and NECP objectives[45].

According to the Commission's 2023 assessment of draft updated NECPs[46], more than half of the submitted plans did not include the required information on the impact of policies on projected emissions of the main air pollutants under the Directive, or on the alignment of NAPCPs with energy and climate programmes. The 2025 assessment of final updated NECPs[47] encourages Member States to further

[42] The Commission is reviewing existing legislation on ecodesign and energy labelling for solid fuel local space heaters (mostly biomass stoves) and solid fuel boilers. The aim is to set new ecodesign measures and update and rescale the applicable energy labels. The review is exploring with stakeholders the potential for improving energy efficiency and reducing air pollutant emissions, in particular PM.

[43] In Annex I, Section A, Paragraph 5(1)(i) of the Governance Regulation. The NECD calls in Article 1 for enhanced synergies with climate and energy policies; in Annex III, Part 1 for consistency in policy priorities in NAPCPs; and in Annex IV, Part 2 for consistency in projections.

[44] https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/31b32689-c97b-4ae4-b6c6-53881b14ae6d/details?download=true

[45] See also Annex III, section 2.2.2.

[46] Commission Communication on the EU-wide assessment of the final updated national energy and climate plans – An important step toward the more ambitious 2030 energy and climate objectives under the European Green Deal and RePowerEU, COM(2023) 796 final.

[47] Commission Communication on the EU-wide assessment of the final updated national energy and climate plans - Delivering the Union's 2030 energy and climate objectives, COM(2025) 274 final.

consider synergies and trade-offs between the planned measures and air pollution when implementing their updated NECPs.

4.1.2 Effectiveness of national measures to address emissions of air pollutants

We have shown above that, **overall, Member States have put in place effective national measures to meet their ERCs under the NECD**. At the same time, from assessing both inventories and projected emissions against the indicative 2025 levels and the 2030+ ERCs, it appears that many Member States have not yet put in place sufficiently effective measures to ensure they are on the right track towards the more ambitious ERCs (this conclusion holds across CAO4 and national projections – all projections are modelled data). According to CAO4, **this is true in particular for NH_3 and $PM_{2.5}$.**

Several Member States deviated from the linear trajectory. Most of these deviations were temporary, with Member States complying with their ERCs or expected to comply with a linear trajectory in the second half of the 2020-2029 period. There were only two cases where the Member State provided an explanation for the deviation in their NAPCP: LT referred to the efficient design of measures (without providing further details) and PL explained that it was technically unfeasible, as matching the linear trajectory would have required most PaMs to be implemented in the first years of the decade[48].

BOX 5. What measures could Member States have taken to be on a linear reduction trajectory in 2025 – a modelling perspective

As part of the 4th Clean Air Outlook, an 'ERC scenario' was modelled to show the additional emission reductions necessary to meet ERCs, as well as the abatement options Member States *could* have taken up to 2025 to be on track for the indicative ERCs in 2025. For **NH_3**, key additional measures are in agriculture. They include wider adoption of improved mineral nitrogen fertiliser application and manure management systems (including measures for different animal categories in relation to housing, storage and application of manures on fields). Accelerated introduction of more efficient stoves and boilers in the residential heating sector, as well as an effective ban on the ground of agricultural residue burning in specific Member States (in addition to measures adopted under the CAP – GAEC 3) would achieve much of the additional reductions needed in **$PM_{2.5}$** emissions. Fewer Member States require additional reductions of NO_x and NMVOCs. For **NO_x**, measures include improving inspection and maintenance to reduce emissions from high-emitting vehicles with either malfunctioning or tampered-with emission control systems, and further rolling out cleaner vehicles across a number of vehicle classes. For **NMVOCs**, it is mainly about further controlling emissions from solvents.

As regards **$PM_{2.5}$**, **62% of EU emissions in 2022 were from** the 'residential, commercial & institutional' sector, in other words, **small-scale combustion of solid fuels (coal and biomass), mostly for residential heating**. The bulk of $PM_{2.5}$ emissions is thus from **a sector characterised by many small emission sources**, meaning many parties are involved. This makes it difficult to abate emissions effectively. Joint Research Centre (JRC) authors have analysed the sources of emissions in the residential sector. While coal use has decreased, there has been a shift towards biomass combustion[49], leading to important particulate matter (PM) emissions. The shares of different energy sources differ widely, with forest-abundant Member States recording

[48] The Commission will comprehensively check performance against the linear trajectory in 2027, when Member States submit emission data for the year 2025.

[49] A shift towards natural gas was also observed.

high shares of fuelwood use, whereas in others natural gas is the dominant fuel in the residential subsector[50].

EU legislation has introduced mandatory ecodesign requirements for solid fuel boilers and local space heaters that address PM emissions[51]. However, residential stoves and boilers have a relatively long lifespan. It therefore takes a long time to improve the stock of appliances in a Member State.

A study commissioned by the European Commission[52] identified around 130 measures implemented (in the EU and some non-EU countries) to address the adverse impacts of small-scale bioenergy use on air pollution. These have been classified according to four broad categories: operational measures, aimed at improving the emissions from existing appliances (including improved fuel quality); stock replacement measures, aimed at improving the emission performance of installed appliances by replacing them with lower or zero-emission alternatives; restrictions that prevent the use of all or certain categories of bioenergy appliances under given conditions; and information and training.

Overall, it concludes that **measures have been put in place to address air pollution from bioenergy use in most, if not all, Member States**. However, variations in the use of bioenergy at domestic level, e.g. as a primary or secondary heating source, and in the age and type of appliances, etc., means that the **precise issues and challenges vary between Member States. The level of ambition** shown in controlling air pollution emissions also varies. The study did not investigate whether measures were triggered by the NECD specifically. Rather, it is likely that clean air policy in general, i.e. the AAQD and NECD being applied in harmony, is motivating Member States to take measures, given that the AAQD sets air quality standards for both $PM_{2.5}$ and PM_{10}.

BOX 6. Examples of addressing air pollution from residential combustion[53]

Denmark: Denmark's Wood Stove Order[54] empowers municipalities to increase restrictions and enforcement on wood burning and impose additional regulations on wood use in their jurisdiction. Furthermore, it allows municipalities to ban the use of wood-burning stoves and fireplaces produced before June 2008 in areas with district heating or natural gas from 1 January 2023. Public information campaigns have been run at national level by both public authorities and industry. The LIFE Clean Heat project also supported reduced and better wood burning in Denmark.

France: A 2016 Ministerial Decree[55] authorises prefectures to temporarily suspend the use of inefficient biomass combustion devices. There are further geographical bans under the Atmosphere Protection Plan[56] applicable in agglomerations greater than 250,000 inhabitants where air quality standards are not complied with.

Germany: There are rigorous requirements for regular chimney sweeping, with chimney sweeps going through an intensive, three-year training programme. They test fuels as part of chimney sweepings. All

50 Banja, M and Ebeling, A (2023), Improving the estimation of air pollutant emissions from small-scale combustion sector, Publications Office of the European Union, Luxembourg, 2023.

51 A review of both requirements is ongoing (solid fuel boilers; local space heaters).

52 EC (2024), Increasing policy coherence between bioenergy and clean air policies and measures.

53 Ibid.

54 Danish Wood Stove Order (2022), https://www.retsinformation.dk/eli/lta/2022/199.

55 Arrêté du 7 avril 2016 relatif au déclenchement des procédures préfectorales en cas d'épisodes de pollution de l'air ambiant, https://www.legifrance.gouv.fr/loda/id/JORFTEXT000032376671/.

56 Direction Regionale et Interdepartementale de l'Environnement et de l'Energie (2017). Atmosphere protection plan for Ile-de-France 2018-2025, https://inis.iaea.org/records/1djt1-pbk69.

data collected is entered into a nationwide harmonised database, which generates data on national fuel statistics and numbers of appliances.

Bulgaria (Sofia): Two key measures are applied in Sofia: a Low Emission Zone (LEZ) for transport and household heating, and an appliance replacement scheme. The LEZ for household heating covers mostly central areas of Sofia and entails a ban on solid fuel heating (wood and coal, but not wood pellets)[57]. The appliance replacement scheme is linked to a LIFE IP Clean Air Programme project which aims to help transition from heating with wood and coal towards heating with pellets or gas, or heating using the central heating network.

Given that **ammonia** is the pollutant that has registered the highest number of non-compliance cases under the NECD, it is worth focusing further on why ammonia emissions have not decreased as expected in some Member States and on how a number of Member States are nevertheless making progress. In 2023, over 94% of NH_3 emissions originated from the agricultural sector[58]. As mentioned above, under the CAP, **ammonia reduction measures depend on prioritisation at national level**. They are widely proposed in the existing CAP strategic plans, but Member States can decide to address their needs using a broader policy mix, with mandatory measures accompanied by financial support. Despite most CAP SP having identified reducing ammonia emissions as a need, this need is addressed mainly using investments, and not all Member States made use of eco-schemes and agri-environment-climate commitments to address livestock-related issues. Hence, the corresponding targets in the CAP SPs vary widely[59]. Given the voluntary nature of CAP interventions, they also rely on farmers' willingness to adopt the practices: participation rates vary across Member States. The actual uptake on the ground continues to be monitored.

According to the support study, Member States flagged that interventions addressing ammonia were often difficult and expensive to implement, and small farms might face financial difficulties despite CAP support[60]. The CAP simplification package[61] found that certain practices and needs are not yet sufficiently taken into account in the CAP Union legal framework, which does not permit Member States to adjust the various instruments to the specific circumstances, especially in the case of livestock. The recent package adopted by the Commission will make it possible to grant payments per livestock unit for agri-environmental-climate management commitments and therefore extend the scope of eco-schemes in this sector. The cases of Austria and Ireland (Box 7) show that where a Member State decides to use CAP funding for ammonia reduction and complement this with mandatory measures and/or a comprehensive cost-effective strategy, compliance can be achieved. The dynamics and trends of the agricultural sector during the last two decades should be analysed back-to-back with the trends of ammonia emissions. The increase of crops and animal production (e.g. milk and meat)[62] drive e.g. higher use of fertilisers or increasing housing periods for livestock, thus of ammonia emissions. A wider and targeted adoption of mitigation measures is therefore even more important to decouple ammonia emissions from sectoral growth.

57 Center for the Study of Democracy (2023), Reversing the Trend: Smart Enforcement of the Low-Emission Zone in Sofia, Bulgaria.
58 EEA data viewer 2025
59 Mapping and Analysis of CAP Strategic Plans, p. 484.
60 See support study section 3.4.1 on 'Barriers and limitations', as well as Annex III .4.3.3.2.
61 COM(2025)236.
62 Statistics on agricultural production (apro)| Eurostat

Generally speaking, it is more challenging to address emissions from many small emission sources and many actors involved[63], compared to e.g. addressing emissions from a few large industrial installations.

The NECD sets out concrete mandatory and optional measures that apply specifically to the agriculture sector to help it reduce NH_3 and $PM_{2.5}$ emissions. The mandatory measures for NH_3 emission reductions in Annex III, Part 2 of the NECD concern establishing a national advisory code of good agricultural practice (NACGAP) and prohibiting the use of ammonium carbonate fertilisers. The support study for this evaluation found that **19 Member States have fully implemented both of the mandatory measures**. Another 6 Member States have adopted rules prohibiting ammonium carbonate fertilisers and are preparing to adopt a NACGAP, and 2 Member States have adopted only a NACGAP. **Member States have applied optional measures to varying degrees**. For example, between 10 and 16 Member States have applied optional measures for mitigating NH_3 emissions from applying and storing manure and from manure in animal housing. The reasons for the lower uptake of optional measures may be linked to their voluntary character, higher costs and lower effectiveness, or to the fact that they are less relevant in specific circumstances in some Member States. It is worth recalling in this context that all the measures in the Commission's proposal for the NECD were mandatory.

The results of the OPC indicated that **stakeholders** perceived the measures in Annex III, Part 2 as somewhat helpful to achieving the Directive's objectives (27 respondents, corresponding to 66%). According to some of the respondents to the TSC, the fact that Member States can decide whether to apply voluntary measures is one of the reasons why those measures do not contribute significantly to the emission reduction objectives. The support study found that there does not appear to be a clear correlation between the uptake of the measures in Annex III, Part 2 and meeting the ERC for ammonia. This makes it difficult to establish the extent to which these measures have been effective in reducing emissions.

Annex IX provides examples for strategies to reduce NH_3 emissions and shows the trend of these emissions – summarised in Box 7 below. These examples underscore that Member States face very distinct challenges. Denmark's agricultural sector is characterised by intensive livestock production, meaning that BAT conclusions under the IED have played an important role. CAP funding has helped Austria and Ireland to make progress towards achieving the ERCs. The analysis suggests that, depending on the Member State context, NH_3 emissions can also be successfully reduced through regulatory measures (such as mandating certain practices), coupled with winning support for such measures through extensive dialogue with the main stakeholders involved, notably the farming sector.

BOX 7. Reducing NH_3 emissions in Denmark, Ireland and Austria

Denmark started addressing NH_3 emission from agriculture in 1987 and applied best practices early on. The NECD set a relatively ambitious ERC of 24% for Denmark for both the 2020-29 and the 2030+ period. Policies for tackling NH_3 emissions included the use of IED BAT conclusions, complemented with additional provisions. This is particularly relevant in Denmark, where 90% of the agricultural land

[63] The agriculture sector is predominantly represented by very small and small farms (output below €8,000 per year accounted for two-thirds (63.7 %) of all farms in the EU in 2020). Small farms under 5ha were typical in Romania (90.3% of farms), Malta (96.6%), Cyprus (87.5%), Greece (74%), Portugal (73.4%), Croatia (70.6%), Hungary (64.9%) and Bulgaria (64%) (source: Eurostat).

is dedicated to intensive production. Furthermore, requirements on the use of manure and its storage, as well as voluntary agreements on animal feed were put in place. Although inventories for 2020 and 2021 showed non-compliance with the 2020-29 ammonia ERC, 2022 and 2023 inventories display compliance. Projections for the ERCs of 2030+ also indicate compliance.

Austria's agricultural sector is characterised by many small-scale farms, often operating in mountainous areas and engaged in animal husbandry. NH_3 emissions rose between 2005 and 2017, but have fallen since then, with the pace of the reductions accelerating in recent years. The NECD sets an ERC for NH_3 of 1% over 2020-29, and of 12% for 2030+.

Austria used CAP support to promote NH_3 reduction measures but considered that complementary mandatory measures are needed. To reach agreement on mandatory measures, Austria conducted extensive consultations across ministries and with key stakeholders (also from the farming sector) and obtained detailed background knowledge on reduction measures and activity data. Austria adopted an ammonia reduction ordinance (in force since January 2023), which makes the rapid (within four hours) incorporation of fertilisers and covering manure storage obligatory. Inventory data for 2020-2022 indicated a lack of compliance with the ERC. The inventory for 2023 (submitted in 2025) indicates compliance, with a reduction of nearly 6% having been achieved since 2005.

In **Ireland**, NH_3 emissions increased significantly between 2011 and 2018. This was due to the country's agricultural sector increasingly specialising in livestock production, particularly beef and dairy, and the removal of EU milk quotas leading to increased production. The NECD sets an ERC of 1% for the current period, and 5% for 2030+. Inventory data for 2020-2022 indicated a lack of compliance with the ERC for NH_3. The implementation of measures to improve farm efficiency and mitigate harmful emissions (in particular, low-emission slurry spreading and the use of inhibited urea fertiliser) have to some extent counteracted higher emissions from increased production. Ireland has recently intensified efforts to increase the uptake of these and other measures. Teagasc (the Agriculture and Food Development Authority) provided a marginal abatement cost curve for ammonia that quantifies not only the reduction potential for abating ammonia emissions but also the associated costs and benefits, and therefore serves as an evidence base for selecting measures.

Support is available under the 2023-27 CAP SP and several measures benefit commitments under both the NECD and the Nitrates Directive. Irish authorities actively seek synergies between these two Directives. Direct engagement with farmers has also been noted as a factor for success. The inventory for 2023 indicates compliance, with a reduction of 6% having been achieved since 2005.

BOX 8. Why did Member States not achieve their ERCs? A stakeholder view

Stakeholders who responded to the OPC and the TSC shared some reasons why certain reduction commitments have not yet been achieved by Member States.

Business stakeholders focused on **insufficient support for abatement technologies and their application**, mentioning that this was a particular obstacle for small and medium-sized enterprises. This was also echoed in the OPC by a consumer organisation that cited structural difficulties in critical sectors (e.g. agriculture and transport) that require technical changes and significant investments. In the OPC and the TSC, some public authority respondents also highlighted the need for large investments (e.g. to modernise industrial plants, resolve traffic problems, incentivise better agricultural practices and provide subsidies and solutions for alternative heating for households) as being a barrier to achieving the ERCs. Some public authorities also stated in the TSC that ammonia was a particular challenge that would require a closer link with the CAP. In the TSC, a public authority also highlighted the contradiction between climate/energy policy and the NECD with regard to **the use of wood combustion for heating**. Seven members of the public who responded to the OPC also cited the widespread use of wood burning as an obstacle to achieving the ERCs.

One business stakeholder indicated **insufficient implementation in national law** and **a lack of urgency** to address the issue as a reason for not achieving the ERCs, while in the OPC, one consumer organisation highlighted **insufficient implementation of national policies**. Environmental organisations responding to the consultations thought that the lack of urgency was due to the ERCs being too lenient, while other NGOs responding also referred to the lack of urgency and thought that enforcement should also consider whether Member States are on track towards 2030+ ERCs. In the OPC, some public authorities cited insufficient ambition in the NAPCPs, while others indicated in the TSC that the ERCs were too ambitious and risked negative socio-economic impact. According to individuals who responded to the TSC in a

professional capacity, failure to achieve the ERCs was due mainly to a lack of political will, structural problems and gaps in EU legislation (especially in the agriculture sector).

In the TSC, public authorities added that inventories were not of sufficient quality, or that **the timing and duration of measures meant that their effects were not noticeable**.

Some business and public administration stakeholders cited **misalignment between EU policies**, such as the AAQD, transport policies (Euro 7, the Non-Road Mobile Machinery Regulation) and agricultural policy.

4.1.3 Effectiveness of reporting

As explained above, the Member States have numerous reporting obligations under the NECD, many of which are fully aligned with the GP requirements and refer to the same reporting guidebook and templates. Reporting reliable data is essential to ensure the effective implementation of the NECD and provides a reliable basis for prioritising clean-air-related policies. Member States need high-quality inventories and projections of emissions to detect source sectors where more needs to be done to reduce emissions in line with ERCs. Member States report emissions data online to the Central Data Repository managed by the EEA. The Commission relies on these data for compliance checks and enforcing the NECD.

The timeliness of reporting has improved overall throughout the evaluation period and most Member States now submit national emission inventories, national emission projections and related documentation on time, with the submission of emissions projections accounting for most of the delays in the past[64]. On the whole, those delays did not prevent the Commission from assessing progress, but they made it more difficult to obtain a comprehensive and timely overview to steer ambition towards compliance with the ERCs.

In line with Article 10(3)(a), the Commission, assisted by the EEA, regularly checks Member States' emission inventories 'to verify the transparency, accuracy, consistency, comparability and completeness of information submitted'. These checks monitor achievement of the ERCs and improve the **quality of reporting**. Inventory reviews focusing on the five main pollutants that are subject to ERCs have been conducted since 2017. The reviews result in findings for each Member State that are summarised in national review reports, as well as an EU-level summary or 'horizontal' review report[65].

As well as assessing the quality of the submissions, the reviews establish a dialogue between the review team and the inventory compilers in Member States to increase the quality of inventories over time. Reviews are thus also capacity-building opportunities that the Commission provides to Member States. The Commission has also provided the following additional targeted support to Member States to improve the quality of inventories:

- a dedicated capacity-building component as part of the 2017 inventory review, to ensure high-quality emission estimates for 2005, the base year of the NECD;
- dedicated capacity-building on how to develop national emission inventories in 2021, including the preparation of guidance material for inclusion into the EMEP/EEA Guidebook;

64 An infringement procedure was opened for one Member State for failure to submit its emissions inventory, projections, and the accompanying informative inventory report.

65 All reports are available on the NEC webpages.

- the development (by the JRC) of the Agricultural Emission Estimation (AgrEE) tool[66] to help Member States produce more accurate estimates for emissions from agricultural sources, which is valuable given the ammonia compliance challenges; and
- the TAIEX Peer-2-Peer tool to provide practical support to help Member States improve their inventories.

Although **the quality of inventory submissions has improved over time** across Member States, the quality of a few inventories could still be significantly improved. Also, some areas could still be improved across all sectors and pollutants[67], especially as regards:

- the transparency of the assumptions that inform the compiling of inventories (and of projections) in the informative inventory report submitted by Member States alongside their data tables;
- some remaining accuracy issues, particularly related to data on emissions from the agricultural sector (this is linked to the use of simpler 'lower tier' estimation methods that rely on default values in instances where more detailed and up-to-date national data depicting the particularities of Member States is not readily available – for example regarding the extent of abatement measures employed).

The **quality of both emissions data for 'non-ERC' pollutants** (for which the NECD does not set emission reduction commitments) and other types of data (i.e. LPS and gridded data) **showed limited improvement** over time. Annex III, Section 2.3.2 provides more detail.

Member State **projections**, which are submitted every two years, provide information on future compliance prospects. The Commission also assesses the quality of the projections against the five criteria of transparency, accuracy, consistency, comparability and completeness (set in Annex IV, Part 2 of the NECD). A lack of transparency about assumptions is the most commonly raised issue for most Member States. The accuracy of the projections varies significantly, and some submissions suffer from inconsistencies (e.g. with the historical inventory). Overall, there has been **slower improvement in the quality of projections over time**, with some more marked improvements in the last submission of 2025. Slower progress may be due to fewer resources being dedicated to compiling projections than to compiling inventories.

No generalised statements can be made on the quantification of the impacts of air pollution on ecosystems across the EU on the basis of the findings from analysing the **data on the monitoring of the ecosystem impacts** that have been reported for the two reporting cycles that have taken place so far (2018-2019 and 2022-2023). This is due to the considerable differences between the datasets reported by Member States during the two cycles (both spatially and temporally, and in terms of monitoring site types, measurement protocols and the parameters monitored). In other words, the **current quality of submitted data is too low to assess the Directive's longer-term effectiveness** in reducing the impact of air pollution on ecosystems. To draw meaningful conclusions from the submitted data, there is a need for greater consistency and coherence both within and between the data submitted by Member States. This would require reducing the variability in Member State approaches to collecting and

66 https://edgar.jrc.ec.europa.eu/agree_tool/public/ (EU Login required to access).

67 These conclusions are supported by the horizontal review reports issued in recent years.

submitting ecosystem impact data. This could mean providing clearer guidance to Member States, beyond the templates and guidance notes already provided, to steer them towards a clearer common purpose.

The stakeholder feedback gathered corroborates the above-mentioned current challenges related to ecosystems monitoring and reporting. Targeted engagement of competent authorities revealed that they consider ecosystems monitoring to be **ineffective largely due to its voluntary design**. One Member State went on to suggest that the requirement as it stands does not produce data as intended and that it should either be removed, or more specific requirements or guidance should be developed **to ensure that the data produced is more comparable across Member States.**

4.1.4 Efficiency of the intervention

4.1.4.1 Summary of administrative costs to public bodies and authorities[68]

'Administrative burdens' are defined as specific types of compliance costs incurred by enterprises, public authorities, and citizens in meeting administrative obligations. Such NECD-relevant items include reporting, provision of data, as well as monitoring and assessments needed to generate the information[69]. The analysis followed the Standard Cost Model (SCM) guidance under the Better Regulation Toolkit to assess the administrative burden associated with compliance with the NECD. The analysis covers all the costs associated with reporting under the NECD, which includes the 'information requirements' imposed on Member States, businesses and the European Commission itself. The analysis is based on reported data that often covered work strands related to several EU policies and the GP.

The key obligations of **Member States** quantified in this analysis[70] are: (i) the development of NAPCPs; (ii) the submission of emission inventories and projections; and (iii) reporting on the monitoring of impacts on ecosystems.

Table 3 – Summary of estimates of the administrative burden of the obligations under the NECD and related policy drivers – average cost per Member State (based on those who completed the targeted engagement of competent authorities, reported data) (in EUR, at 2025 prices)

Obligation (main policy drivers)	Upfront cost (range) – first reporting period	Ongoing cost (range) per reporting period	Ongoing cost (range) per year	Representative annualised ongoing cost (central)
Inventories and projections (NECD, GP)	Not assessed	n/a	EUR 749 000[71] (range EUR 56 900 - EUR 3 080 000)	EUR 749 000
NAPCPs (NECD, Governance Regulation)	EUR 207 000 (range EUR 11 400 – 290 000)	EUR 137 000 (range EUR 5 720 – 500 000)	n/a	EUR 34 000
Ecosystems monitoring and reporting (mainly NECD-driven)	EUR 337 000 (range EUR 17 000 to EUR 1 200 000)	EUR 1,152,000 (range EUR 7 430 - EUR 6 720 000)	n/a	EUR 287 000

68 A detailed assessment of these administrative costs is provided in Annex III Section 3.1.

69 See Tool 58 of the European Commission's Better Regulation Toolbox.

70 Member States provided information on administrative costs through the targeted stakeholder consultation, a specific follow-up engagement with competent authorities and related interviews.

71 This figure excludes cost data from Member States that provided a global cost for the NECD and GHG inventories (ES, FR, LU, PT and SE). If we assume a 50/50 split between the two reporting streams, the average cost amounts to EUR 728 000 (range: EUR 56 900 – EUR 3 080 000), bringing the total annual representative ongoing cost to EUR 1 049 000.

TOTAL	Not assessed[72]	n/a	n/a	**EUR 1 071 000**

Note: Member State figures often represent the totals for several work strands, including the GP, the AAQD and the GHG inventories under the Governance Regulation. Figures were excluded from the average cost across Member States where Member State data did not allow costs to be split between air pollutant and GHG inventories. In the case of ecosystems reporting and NAPCPs, it was not possible to make an adjustment to allow the costs of the NECD to be identified more precisely. However, Member States noted that these costs were mainly NECD-driven. In the case of ecosystem monitoring, some costs might also be due to obligations stemming from, e.g., Water and Marine Strategy Framework Directives. The analysis did not attempt to split costs between reporting for the NECD and GP that both NECD and GP require.

The wide ranges above indicate differences that are due to national circumstances. Member States' compliance with the ERCs results in key differences for the NAPCPs. Administrative effort is greater in the case of non-compliance, as Member States need to identify, develop, assess, cost and consult on additional PaMs. The burden for ecosystems reporting can depend on whether the Member State taps into existing networks (e.g. those set up for monitoring under the Water Framework Directive and the Marine Strategy Framework Directive), and on how many sites they monitor. The number of sites varies greatly, from 3 sites in Malta to 2 003 in Germany. The resulting ranges in costs might also reflect Member States' flexibility in implementing certain provisions, with the monitoring of ecosystem impacts being a good example. In terms of inventories and projections, differences often depend on the availability of data. Other factors are: (i) the Member State's process for reporting; (ii) the national governance structure; (iii) the extent of transboundary consultation; and (iv) the take-up of voluntary actions.

A representative estimate of the total administrative burden facing a typical Member State could be around **EUR 1 071 000 per year** (2025 prices). Given the differences between Member States and the partial coverage of the data, this number is not reliable and is indicative only.

The findings suggest that the costliest recurrent obligation associated with the NECD (in terms of annualised ongoing costs) relates to the development, submission, and reporting of annual emission inventories.

The analysis concluded that the NECD IA underestimated the administrative burden on Member States for NAPCP updates and the total costs of ecosystems monitoring, while it overestimated the effort of developing the first NAPCP and the cost of ecosystems monitoring per site. These comparisons have limitations, as the IA's preferred option does not correspond to the NECD as adopted (see Section 3.2.1 in Annex III**Error! Reference source not found.**). Furthermore, the IA did not quantify costs related to emission inventories and projections, as it did not consider these as additional to the precursor legislation or to Gothenburg Protocol obligations. That approach has been rejected here to give a more complete picture of the administrative burden linked to the NECD, even if some obligations are close or identical to those under the GP.

[72] A total for the upfront cost was not estimated as: (a) no data were available on upfront costs (probably because these activities were broadly carried forward from the previous Directive 2001/81/EC and had therefore been implemented many years ago); and (b) the initial costs are likely to be very different from the ongoing annual cost (therefore it is not appropriate to attempt to use ongoing annual costs as a basis for estimating initial costs).

The evaluation also quantified **costs incurred by the European Commission and the EEA**[73]. The average annual staff cost for the European Commission is estimated to be around EUR 520 000, with a total estimated burden of around EUR 5 200 000 between 2016 and 2025[74]. The contract values for outsourced work within the same period totalled EUR 12 100 000. Together, the **total estimated costs for the European Commission are therefore EUR 17 300 000 over the 10-year period, or EUR 1 730 000 on average per year**. Although it was not possible to break staff time down by specific obligations, contract values have been broken down by work areas. The area where most resources were deployed was inventory reviews (roughly 43% of contract values), whereas the lowest outsourced cost item relates to NAPCP reviews (roughly 5% of contract values).

The **EEA** also supports the implementation of the NECD. The data provided relate to budget, contractor costs and EEA staff time. Between 2016 and 2025, the EEA's average costs were estimated to be around **EUR 230 000 per year, or EUR 2 300 000 over the 10-year period** (2025 prices). EEA staff time dedicated to reporting was the costliest task item in most of the years during that period.

4.1.4.2 Summary of administrative costs to business

The NECD places direct obligations only on Member States' competent authorities and the European Commission. Thus, any administrative cost for business can only be **indirect**. Information was gathered through stakeholder consultations, including additional engagement with businesses and competent authorities; and a review of information provided in Member State NAPCPs and in informative inventory reports (reported data, see a detailed analysis in Annex III 3.3).

Based on the **open stakeholder consultation**, businesses and business associations consider that administrative costs for businesses are moderately high (10 out of 23 private sector respondents), with 5 responses stating that administrative costs were high.

The analysis of data gathered from businesses, discussed in Member State reporting and provided through targeted engagement with competent authorities showed that most Member States use data and information gathered from businesses to develop emission inventories and projections, with some using the information for other obligations too (e.g. NAPCPs). However, **the NECD is only rarely the primary or sole driver for collecting this information.** (This is the case for only 2 Member States out of the 14 that responded to this question, namely Estonia and Germany). Instead, competent authorities reported that the information is already collected or made available under different legislation or a different process, e.g. the IED, the E-PRTR (and IEPR)[75], the Large Combustion Plant and Medium Combustion Plant Directives, data available as part of permits, energy and climate legislation, as well as many overlaps with the GP.

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73 These costs were not taken into consideration in the 2013 NECD IA.

74 Based on DG BUDG (2023), *Average costs to be used for estimates of 'Human Resources'* in the Legislative Financial Sheets (unpublished).

75 According to the supporting study to the Fitness check of monitoring and reporting obligations arising from EU environmental legislation (IEEP, 2017), most of the burden from the E-PRTR Regulation stems from internationally derived obligations through the UNECE Kiev Protocol.

The support study for this evaluation attempted to provide an **approximate order of magnitude** for the cost elements provided by Member States that was based on estimates of the number of days needed to compile the information and the average wage rates compiled by Eurostat[76]. Where Member States indicated that there were policy drivers other than the NECD, the analysis either applied a 50% split or the split provided by the Member State, where available. The illustrative range of annual costs at Member State level (comprising the costs of all businesses affected) was between EUR 815 for Hungary and EUR 1 840 000 for Slovakia (which was significantly higher than for other Member States). This range is affected by: (i) the availability of data in the Member State; (ii) the extent to which competent authorities research existing data; (iii) whether and to what extent additional information is sought; and (iv) what the competent authorities replying to the targeted engagement considered to be pertinent to the NECD. In the case of Hungary, the low cost estimate reflects that the competent authority contacts only a few important industrial plants for additional information or data validation and otherwise relies on data in its information system. In the case of Slovakia, about 8 000 operators are required to provide data annually, with the main driving force being the IED and the Medium Combustion Plant Directive. Discounting these two outliers, **the average administrative cost for businesses at Member State level is close to EUR 100 000 per year**. **The likely administrative burden on businesses is thus very low, in contrast with stakeholder perceptions**.

4.1.4.3 Opportunities for simplification[77]

The coherence analysis and input from stakeholder consultation helped identify inefficiencies, unnecessary overlaps and potential opportunities for simplification. The analysis quantifies cost reduction opportunities where data on administrative costs enable such a quantification (see previous sections and Annex III, Section 3.1). Estimates are based on assumptions (notably on the number of person-days needed to carry out a given task) and are indicative only.

The **development of NAPCPs** by Member States and their review by the Commission provided opportunities throughout the evaluation period to gather input on the common format and its implementation[78]. The analysis combines that input with input from the stakeholder consultation. The key areas for potential simplification are summarised below.

- The NAPCP format could be simplified and clarified, especially regarding the **update of NAPCPs** (as opposed to the development of the first NAPCP) and the level of detail **for Member States that comply with the ERCs**. This is a gap in current guidance that can be addressed in the short to medium term by adapting the Commission Communication or the Implementing Decision and, therefore, without amending the Directive. For illustrative purposes, **on average, adapting the format of reporting could enable each Member State to save approximatively EUR 7 000 per year** (the savings relative to average annual ongoing costs per Member State for developing the NAPCP are estimated to be EUR 34 000). Some public authorities also suggested updating the NAPCPs only if emission projections indicate non-compliance for any of the five main air pollutants. The consequences of those authorities' suggestion

[76] See a detailed analysis in Annex III Section 3.3.
[77] See a detailed analysis in Annex III Section 3.5.
[78] See reports on the NECD webpages.

would need to be analysed in greater depth. This would potentially require amending the Directive.

- The **timing for developing the NAPCP could be aligned more closely with the timing of the NECP**[79]. This could mean adopting the NECP's cycle of reporting every five years instead of every four and keeping the deadlines closer together (which would require amending the NECD). According to input from competent authorities during the stakeholder consultation, **a one-month difference between the deadlines** would be sufficient to avoid excessive effort. However, reviewing all the NAPCPs at the same time would increase the costs for the Commission. **This alignment could simplify matters, but further reflection is needed to identify the most efficient approach.** The support study estimated the efficiency gains from streamlining preparatory work between the two instruments to be roughly EUR 3 420 per Member State per year (assuming that Member States save 10% of their average annual ongoing costs (estimated to be EUR 34 200) for developing the NAPCPs).
- Through the targeted engagement, competent authorities suggested options to improve the user-friendliness of the **PaM tool**. These suggestions included: (i) the possibility to work on the PaMs **offline**, also to avoid the risk of errors or data loss; and (ii) to **include pre-filled data** where possible. A further possibility could be to **reuse NECP-related PaMs or previous NECD PaMs.** While the feasibility of some of these points would need to be explored in the future, these suggestions could be implemented in the short term without amendments to the Directive. Although the evaluation could not quantify the potential cost savings related to this item, these actions could lead to **significant time savings**.

One Member State suggested aligning the **frequency of projections** with the GP by reporting projections every four years instead of every two. **This could achieve average savings of EUR 187 000 per Member State per year** (relative to annual average ongoing costs for inventory and projection development, estimated to be EUR 749 000 per year per Member State)[80]. However, receiving projections every two years is valuable for compliance checks and enforcement, and has thus been useful for the Commission in its role as guardian of the treaties. Further reflection would therefore be needed before reducing the frequency, as this would also require amending the NECD.

Regarding **inventories,** the analysis for this evaluation identified the following potential simplification options[81].

- Stakeholders have questioned the role of **large point source (LPS)** data. Data on LPS pollutant emissions (including into the air) are available yearly via the Industrial Emissions Portal (IEP - former E-PRTR- set up by the 2024 IEP Regulation), whereas the NECD air pollutant data are delivered every four

[79] Part 2, point 3 of Annex IV to the NECD requires that the NECD emission projections be consistent with the NECP projections.

[80] This will vary greatly between Member States, in line with the differences between Member States indicated in Section 4.1.4.1. This figure is merely illustrative.

[81] We note that professionals involved in developing inventories, as well as users of the data (modellers) considered that all the data reported were relevant.

years. At the same time, the Air Convention also requires its Parties to report LPS data every four years[82], thus a potential change to reporting LPS must be examined in the light of **compliance with the Air Convention**.

- The analysis **of reporting on non-ERC pollutants**[83] indicated that modellers and users of national emissions data do not use data on heavy metals and persistent organic pollutants (PoPs) (both of which need to be monitored under the GP). Therefore, the potential simplification of no longer reporting them could be considered. Furthermore, the reporting of total suspended particulate (TSP) could be further evaluated, likewise due to limited use. Further analysis is needed to understand the impact of this potential simplification on the EU's and Member States' **compliance with international obligations.**
- According to a competent authority**, aligning review activities between the NECD and the GP** could reduce the burden for both the Commission and the GP. This option would depend on agreements between the GP and EU bodies and its **feasibility is unclear**.
- The Copernicus Atmosphere Monitoring Service (CAMS) could also leverage Earth observation and related data products and applications to simplify the compilation and verification of inventories in the future. This might require additional research and development.

BOX 9. Copernicus and Earth Observation in clean air policy

Earth Observation and CAMS is currently already used under the NECD for supporting the analysis of flexibility applications based on Article 5(2), which allows for averaging emissions over several years based on exceptional meteorological conditions; and for the analysis of potential impacts of sectoral policy measures. Current capabilities of CAMS make it also suitable for quality assurance of inventories: the Sentinel-5P satellite provides data on emission hotspots and can help verify the spatial consistency of inventories. The Sentinel-4 mission (starting in 2025) strengthens these capabilities by facilitating near real-time profiling of emission events. The Sentinel-5 mission (starting in 2025) will provide daily, global measurements of air quality, climate, ozone and UV radiation. Further detail is provided in Annex III Section 3.5.11.

Artificial intelligence (AI) techniques are not yet suitable for autonomous emission reporting or review. Its role could be explored for assisting data processing, anomaly detection and verification under expert supervision. This area is developing fast, and the ability of AI to simplify reporting should be reviewed regularly.

For both inventories and projections, the differences between NECD and **GP** reporting are limited[84]. The key differences are due to the following EU policy choices: (i) introducing ERCs for the 2030+ period and following a linear trajectory towards them in 2025; (ii) not counting some agricultural sources of air pollutants towards compliance with ERCs (see also the relevance analysis in Section 4.3.4); and (iii) some additional circumstances for applying a flexibility under the NECD. Some of these

[82] UNECE (2013), Decision 2013/4 on reporting of emissions and projections data under the Convention and its protocols in force.

[83] Analysis prepared by Aether, CITEPA and Ricardo, published as: European Commission: Directorate-General for Environment, *Analysis of and recommendations for the inventory reporting requirements under Directive (EU) 2016/2284 not linked to emission reduction commitments – Final report*, Publications Office of the European Union, 2023.

[84] Logika Consultants for the European Commission (2023), *Comparison between the NECD and the amended Gothenburg Protocol under the UNECE Air Convention*.

policy choices contribute significantly to the NECD's effectiveness (e.g. the 2030+ ERCs) or are considered essential by some Member States (e.g. greater range of flexibilities). The two reporting streams use the same template, and both are submitted via the EEA. Thus, although **it would, in principle, be possible to have a single submission, cost savings would be minimal**.

Indicators under **ecosystems reporting are voluntary**, but costs proved to be significant, depending on the extent of the monitoring network and the number of indicators covered. Member States report highly heterogeneous data[85] and the lack of comparability makes it impossible to analyse the status of ecosystems at EU level, or to ascertain with confidence whether Member States' sites are representative, as required by the NECD. The following are some of the suggestions made by competent authorities.

- **Monitoring should be less comprehensive, but of better quality.** Key parameters that can realistically be monitored and that give a good picture of the status of ecosystems should be identified to improve the quality of the data reported. Given the data's current incomparability and heterogeneity, this could improve the present situation. If this route is taken in the future, additional work would be needed to identify core parameters and quality requirements. Work can be started in the short term, and there is no need to amend the NECD.
- **Alignment should be achieved with the UNECE Air Convention's International Cooperative Programmes** (ICPs) related to ecosystems[86]. This could help the Member States that are currently participating in ICPs to make their reporting more efficient but would entail an initial (and potentially significant) cost for the Member States that do not participate. This cost would be driven by the establishment of new monitoring networks. Currently, 11 Member States are active in the ICP integrated monitoring, 21 in ICP Vegetation, 26 in ICP Forests and 12 in ICP Waters. Potential cost savings cannot be estimated with any certainty, given the heterogeneous approaches to monitoring in different Member States. Based on input from competent authorities, the average efficiency gains for countries that already participate in ICPs could amount to approximately **EUR 115 000 per year and per Member State** (relative to the annual average ongoing cost of ecosystems monitoring, which is estimated to be EUR 288 000 per year per Member State)[87]. **Further analysis of this option is needed**. Analysis can start in the short term.

A 2022 Commission report[88] found Member States needed guidance to strengthen the links between national measures defined under the NECD and those required under the **AAQD** air quality plans, mostly to help them coordinate reporting and ensure coherence. The analysis carried out under this evaluation found that the two policies were designed to be complementary. Thus, the NAPCP template requires Member States to put PaMs in the context of air quality-related efforts under the AAQD; while

85 Williamson, T et al., *Ecosystem data reported by Member States under Directive 2016/2284*, 2024.

86 Integrated Monitoring of Air Pollution Effects on Ecosystems (IPC IM), IPC Vegetation, ICP Forests, ICP Waters, ICP Modelling and Mapping.

87 This will vary greatly between Member States, in line with the differences between Member States indicated in Section 2.2.1. This figure is merely illustrative.

88 European Commission: Directorate-General for the Environment, *Strengthening of air quality monitoring, modelling and plans under the Ambient Air Quality Directives*, Publications Office of the European Union, 2022.

under the revised AAQD, Member States have to rely on the NAPCPs to overcome exceedances of ozone target values and to co-ordinate between NAPCPs and air quality plans and roadmaps. Therefore, the **opportunities to strengthen synergies and exploit efficiencies across the NECD and the AAQD arise more from improving practices at Member State level** to weave these two pillars together.

4.1.4.4 Summary of adjustment costs

Adjustment costs are defined in the Better Regulation Guidelines as investments and expenses that businesses, the public, or public authorities have to bear in order to adjust their activity to the requirements contained in a legal rule. In this evaluation we also use the term 'abatement cost', as the expenses and investments are related to reducing (abating) the emissions of the five main air pollutants.

This evaluation analysed: (i) the expected adjustment costs identified in the NECD IA; (ii) information on adjustment costs available through the CAOs (modelled data); and (iii) Member States' cost indications in NAPCPs and PaMs.

Given that the **NECD IA's** preferred option did not correspond to the requirements in the adopted NECD, the impact assessment cannot be considered a suitable point of comparison. The support study identified the options closest to the solution implemented in the Directive and relied on sensitivity analysis carried out for the impact assessment to approximate the expected adjustment costs for the NECD as adopted. These costs are EUR 2.8 - 3 billion per year for the period up to 2030 to achieve the ERCs that will apply from 2030. (The 2020-29 ERCs as adopted were erroneously considered to represent no additional cost compared with the baseline). The impact assessment also assumed that national air pollution control measures represented 33% of the total costs, resulting in a cost estimate of around EUR 1 billion per year in the period up to 2030 for national measures.

Successive CAOs published since 2018 have used the GAINS model[89] to calculate abatement costs under various emissions reduction scenarios. The GAINS model attempts to stay as close to reality as possible. Thus, each CAO involves a detailed review of EU policies and the most recent Member State NAPCPs, to align the starting point for the modelling with the abatement measures taken in practice. This is further complemented by consultation meetings with Member States. It is important to note that the GAINS model captures the effect of all relevant EU and national policies on emissions. Thus, **costs related to the NECD only cannot be isolated**. Therefore, the abatement costs related to the NECD provided in the following paragraphs are overestimated.

The support study for this evaluation carried out an additional analysis that uses the GAINS model to better understand additional (compared with the pre-NECD situation) adjustment costs. The support study developed a **counterfactual scenario** to the version of the GAINS model used for CAO4. The modelling underpinning the CAOs was designed in such a way that the model's baseline gradually includes developments in the EU and national policy landscape and then forecasts future developments that are in addition to progress already achieved. To better understand the additional effort carried out since the adoption of the NECD in 2016, the analysis froze emission controls (policies that affect emissions, e.g. the IED, climate and energy policy, etc.) at the 2015 level (the year available in modelling that is closest to the NECD adoption date). By

[89] See a description of the GAINS model in Annex II.

comparing this counterfactual scenario with the CAO4 baseline (which includes all EU and national-policy-linked controls in 2023), the analysis sought to explain how emission controls contribute to the costs of achieving ERCs relative to other factors, in particular, changes in economic activity (e.g. a reduction in coal-based electricity production and an increasing proportion of wind- and solar-derived electricity). This analysis gives the most accurate picture of the effect and costs of controls over the evaluation period, including those carried out as a result of the NECD, the effect of which cannot be isolated.

Using this approach, **the total (discounted) costs associated with additional air pollution control measures linked to all policies (including the NECD) adopted after 2015 are estimated to be EUR 92 billion[90]**. Given that this estimate includes the effect of a range of policies, it is an **overestimation** of the costs attributable to the NECD and represents an upper limit[91]. The cost of the measures adopted after 2016 is **equivalent to 0.08% of GDP in 2020 and to 0.14% of GDP in 2025.**

To compare modelled data with available data, the evaluation included an analysis of **abatement cost information provided by Member States in NAPCPs and PaMs** (reported data). This analysis showed that this optional information was rarely provided. Only 4% of the measures in the December 2024 version of the PaMs database included costs. Thus, available evidence on the abatement costs related to national measures linked to the NECD is mainly only anecdotal. The box below provides examples of the evidence available for Romania (which provided the most complete cost-benefit information) and Hungary (which provided information on the cost of agricultural measures).

BOX 10. Examples of cost information in the PaMs database

In the PaMs database, **Romania** provides cost data for measures across five sectors: waste management, industrial processes, transport, energy consumption, and energy supply. The absolute annual costs identified amount to almost EUR 371 million. The 'costs abated' range from EUR 4 per tonne of NMVOC abated (for industrial processes – 'Improving the reporting/recording of Category 2.D.3.a NMVOC emissions related to the use of household solvents') to EUR 26 655 per tonne of $PM_{2.5}$ abated (for energy consumption – 'Residential sector package'). Absolute annual benefits from the measures quantified exceed EUR 584 million. Both absolute costs and benefits are greatest for the energy consumption and transport sectors in Romania, although the benefit-cost ratio of these sectors (at 1.4 to 1.5) is similar to the waste management and energy supply sectors. However, the industrial processes sector has a drastically higher benefit-cost ratio (at 690) than any of the other sectors, making this by far the most cost-effective sector for NECD measures according to this example from the Romanian NAPCP.

In the NAPCP and supporting documents, **Hungary** provides a detailed overview of costs associated with measures in the agriculture subprogramme. By way of example, Hungary estimates that the additional cost of applying litter manure would be EUR 220-290/ha on average, and that of applying slurry would be EUR 140-360/ha, depending on the method of application and the conditions at the place of production. The cost of being required to cover slurry stores would be EUR 2-1 200 per storage

[90] This is a gross figure reflecting costs only (benefits are not considered).

[91] Table A-40 in Annex III presents the costs extracted from the NECD IA and CAO series and the relative change versus the 2015 baseline, as well as a cumulative present value cost between 2016 and 2025. Based on the most up-to-date CAO4 baseline scenario, the total present value of costs from the adoption of the NEC Directive in 2016 until 2025, is estimated to be EUR 37.8 billion. However, this cost estimate is influenced by the underlying changes in activity (e.g. changes in the energy mix). The corresponding value from the IA is EUR 95 billion, which represents an impressive overall reduction in costs driven by the clean transformation of the EU economy.

facility if the cover is made of organic material, and EUR 240-40 000 if plastic or other films are used as the covering material.

More details are available in Annex III, Section 3.2.4.1.

Adjustment costs for businesses

The IA analysis (modelled data) suggested that most costs were related to 'households' (32% of total costs) and 'agriculture' (31%). These were followed by 'other energy-intensive' sectors (8%), refineries (7%) and electricity supply (6%). The IA also presented macroeconomic modelling, which captures how these first-order effects are passed through supply chains and the wider economy. Accounting for this, several economic sectors that face direct costs also benefit from additional demand and see a net output increase. However, two economic sectors were estimated to face a net burden: the agriculture and the refinery sector.

The CAO series (modelled data) replicated the analysis under the IA and reached similar conclusions. **Agriculture, in particular, was repeatedly found to be the sector likely to face the greatest reduction in output from meeting the ERCs**. Sensitivity modelling demonstrated that the wider policy context may affect which sectors bear the costs. For instance, under CAO3, the REPowerEU scenario[92] shifted costs to the power sector.

Respondents to both the open and targeted online **stakeholder consultation** indicated that abatement costs for business are among the top cost categories related to the implementation of the NECD. Of the 23 businesses and business associations responding to the OPC, 14 considered this to be a high cost (3 considered it a moderate cost). Of the 9 associations responding to this question in the targeted consultation, 3 associations considered the abatement costs for business to be high and 3 associations considered those costs to be moderate. However, stakeholders also felt that Member States had themselves faced significant costs, with the public also sharing some of the impact (with the general caveat that these results are based on surveys with a low response rate).

Regarding the agriculture sector, a survey on requirements[93] revealed that about one third of the farms responding considered that compliance with most of the environmental and health requirements was challenging. A similar result emerged for requirements related to air pollution, with 33% of respondents noting that meeting requirements was difficult and 21% stating that the requirements were not clear.

PaMs put in place by Member States and at EU level and the way they were funded determined where costs have ultimately fallen. Information from funding trackers suggest that the level of EU funding contributing to air quality improvement either directly or as a co-benefit, has been significant, i.e. EUR 171.4 billion over the 2021-2025 period, corresponding to EUR 34.3 billion per year. Clean air is expected to remain a priority in EU funding in the future, with the proposal for the 2028-34 EU

92 See Annex II for descriptions of the different scenarios modelled.

93 Simplification – the farmers' point of view shows first insights into the results of the survey running from 7 March to 8 April 2024. 26 886 farmers replied to the survey.

budget[94] including a 35% climate and environment spending target and an improved system to EU spending on green objectives and the corresponding results. Most of EU funding for clean air in recent years has come from the Recovery and Resilience Facility (RRF): it amounted to EUR 131 billion over the 2021-2025 period (EUR 26.5 billion per year on average)[95]. The RRF funded numerous projects that have the added benefit of improving air quality, such as those that encourage cleaner energy production, more sustainable transportation and greater energy efficiency in buildings. In some Member States (e.g. Lithuania and Slovenia)[96], this is complemented by national funding. Although it is difficult to compare funding figures directly with estimates of abatement costs[97], it appears that **a significant proportion of the costs of achieving ERCs will be covered by public funding, thereby shifting the direct burden from businesses and households to the public sector.**

BOX 11. Do non-EU businesses face adjustment costs related to air pollution?

Annex VIII analyses the legal requirements in countries that are principal trading partners of the EU[98] and the air pollutant trends in the evaluation period compared with 2005 (the base year of the NECD ERCs).

Air pollution is a global issue, with 99% of the world's population exposed to unhealthy concentrations of air pollutants, and with the economic costs estimated to be nearly 5% of global GDP[99]. In response to this, 67% of the countries in the world have introduced air quality standards. All the EU's principal trading partners, except for Türkiye and the Russian Federation, have introduced legal standards. Thus, the EU is not acting alone[100].

In terms of emission reductions, the EU, China, Japan, Norway, Switzerland, the UK and the USA have comparable levels of abatement, depending on the pollutant. Reductions have been achieved against a backdrop of growing global GDP, suggesting that a gradual decoupling of emissions and GDP is also taking place beyond the EU.

China and India have the highest air pollutant emissions. China is expected to reduce these significantly over the coming decades, while emissions in India are lower but are increasing. Further reductions are expected over the coming decades for all pollutants in most of the countries included in the analysis, except for NH_3, which is increasing in most of the countries.

When looking at emissions of air pollutants per million inhabitants in 2025, we see that the EU is situated in the mid-range, with only its SO_2 emissions being below the average of the countries included in the analysis. The EU is at the lower end of the 'air pollutant emissions per billion euro of GDP' indicator (due to its lower emission intensity), while Canada, Japan, South Korea, the UK and the USA have similar values, depending on the pollutant.

The analysis thus suggests that the EU's principal trading partners are making efforts to achieve abatement. Although the extent of these efforts varies across pollutants, many of the EU's partners are making similar efforts to the EU.

94 Proposal for a regulation of the European Parliament and of the Council establishing a budget expenditure tracking and performance framework and other horizontal rules for the Union programmes and activities, COM(2025) 545 final.

95 Calculated according to the clean air tracking methodology, see Section 4.4.1 of Annex III for further information.

96 Examples reflect the limited data available on funding in NAPCPs.

97 Limitations include the approach to modelling costs in the CAO series vs the range of activities considered in clean air tracking. Climate and energy actions are part of the CAO baseline and not captured as leading to additional cost; whilst funding tracking considers these actions as contributing to clean air objectives (at least partially).

98 Eurostat (2024), International trade in goods by partner.

99 The World Bank (2025) – Accelerating access to clean air for a liveable planet.

100 WHO air quality standards database.

4.1.4.5 Costs for SMEs

The analysis did not find that the administrative burden is passed on to SMEs. The few informative inventory reports that provide information on this topic (the reports from Germany and Finland) state that SMEs are not requested to provide information to the authorities. Likewise, targeted engagement of businesses did not reveal issues linked to the NECD. Instead, it highlighted the potential future impact of larger companies asking smaller farmers for data on the basis of other legislation (e.g. the Corporate Sustainability Reporting Directive [101] and GHG reporting).

The response to the consultations **did not reveal any evidence to suggest that SMEs had faced higher or disproportionate adjustment costs** compared with other economic stakeholders. In response to the targeted engagement with businesses, stakeholders reported that the abatement costs for the agriculture sector had been high. One stakeholder explained that farms are required to use various emissions-reducing practices and technologies related to, e.g., manure handling, storage, spreading, and feeding, with some measures incurring significant costs (e.g. tightly covering a manure storage facility can double its cost)[102]. Some respondents reported that while costs were specific to each farm, **both smaller and larger farms have faced additional costs**, with one stakeholder believing (without providing any evidence) that the costs placed on SMEs were disproportionate. However, respondents also highlighted that it was not possible to isolate the effects of the NECD from other connected legislation.

4.1.4.6 Summary of benefits

The ERCs set by the NECD aim to reduce emissions of harmful air pollutants. Member States put in place policies and measures aimed at reaching the ERCs. Thus, they contributed to reduce exposure to these pollutants, leading to **improvements in human and environmental health**. Abatement measures taken to meet ERCs may also deliver wider benefits, for example energy and raw material savings and lower GHG emissions. Beyond direct effects, further benefits are likely to trickle down through wider supply chains and the economy [103]. In addition to GHG emission reduction, stakeholder engagement also points out that the NECD has delivered (to varying degrees) other related benefits, specifically: environmental protection (e.g. of ecosystems); reduced economic costs linked to air pollution; and energy and fuel cost savings.

The **NECD IA** represents the point of comparison. It identified a range of benefits, including **human health benefits corresponding to between EUR 63 bn and 223 bn per year** (adjusted to 2025 prices). However, changes during the co-legislative process reduced the amount of benefits delivered compared to the IA figures.

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[101] Note that the Commission proposal amending Directives 2006/43/EC, 2013/34/EU, (EU) 2022/2464 and (EU) 2024/1760 as regards certain corporate sustainability reporting and due diligence requirements (COM(2025) 81 final) proposes removing small companies from the scope of the CSRD.

[102] Measures such as manure storage are not specific to the NECD and are also used to deliver on other parts of the EU *acquis* (e.g. the Nitrates Directive to prevent pollution of adjacent water streams, or biodiversity/soil pollution prevention).

[103] For example, policy measures to abate pollution increase demand for goods and services contributing to pollution abatement. Reducing sickness related to air pollution may also lead to a positive feedback loop, where households have more income and time available for activities with positive economic impact. The CAO series and linked studies explore these benefits through macroeconomic modelling.

The **CAO series** (modelled data) used methods similar to the IA to estimate the benefits in its emission reduction scenarios. The CAO reports **estimate significant additional benefits of achieving the ERCs relative to the baseline.** However, throughout the series, the benefits' absolute value has decreased (alongside costs) as more policies to reduce emissions are included in the baseline.

The support study relied on the counterfactual scenario (see Chapter 4.1.4.4) to identify the benefits of all emissions controls taken up after the adoption of the NECD over the evaluation period. This avoids the problem of having these increasing amounts of abatement action captured by the baseline, and hence not reflected in the net benefit assessed relative to that baseline in the scenarios of the CAO reports. **The analysis estimates that emission reductions associated with additional controls taken up over the evaluation period have delivered significant benefits.** Depending on whether the value of a potential life year (value of life year – VOLY) or the value of preventing a fatality (value of statistical life – VSL) is considered, the estimated benefit is **around EUR 372 billion or EUR 1 180 billion**[104]. These figures **reflect all (EU and national) policies** with an impact on emission reductions; the specific effect of the NECD could not be isolated. However, these figures **can be used as reference values to compare costs and benefits**, as they capture the joint effects of EU and national emission control policies.

The analysis provided additional estimates of benefits using other approaches.

- Building on annual emission inventories reported by Member States for the years 2016-2023, the total estimated **benefits since the NECD adoption** amount to **EUR 506 billion (VOLY) or EUR 1 580 billion (VSL).** As inventories provide an overview of the level of emissions in a given year, they also capture the effects of other EU policies and external factors.
- The **foregone benefit** of not reaching ERCs applicable since 2020 was estimated at **EUR 2.4 - EUR 3.6 billion per year** (VOLY); or at **EUR 7.9 - EUR 8.9 billion per year** (VSL)[105].

Most **stakeholders** responding to the OPC and TSC considered that the NECD delivered either large or some benefits in terms of protecting human health (44 of 53 respondents to the OPC and 28 out of 41 respondents to the TSC). This was followed by benefits such as protecting the environment (e.g. ecosystems, 43 replies OPC, 27 TSC); reducing costs linked to air pollution (34 replies OPC, 22 TSC); reducing GHGs (26 replies OPC, 20 TSC); and energy or fuel cost savings (19 replies OPC, 13 TSC).

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104 The CAO series calculates benefits using the VOLY (value of life year) and VSL (value of statistical life) approach. VOLY is an estimate of damage costs based on the potential years of life lost from a specific risk, based on an estimated life expectancy. Therefore, the result is affected by the age at which deaths occur. VSL is an estimate of damage costs based on the value a given population places *ex ante* on avoiding the death of an individual – therefore, it yields higher values (definition sources: OECD, *Mortality risk valuation in Environment, Health and Transport Policies*, 2012). Opinion amongst economists is divided as to whether mortality valuation is better represented by using VOLY or VSL. It has therefore been standard practice in clean-air-related policy assessments to present both. See also Box 8 in Annex III 3.4.3.

105 DG Environment, EMRC, Logika Group and RPA Europe (2025), Update of the costs of not implementing EU environmental law. The values presented here were adjusted to 2025 prices.

4.1.4.7 Benefit-cost ratio

The analysis yielded adjustment cost and benefit figures that include the impact of all policies affecting air pollutant emissions. Thus, the benefit-cost ratio is not specific to the NECD but rather shows the general efficiency of clean air policy. The figures are used as indicative values only, to reach a conclusion on the typical relationship between costs and benefits in this area, which also applies to the NECD. The ratio was calculated relying on cost and benefit figures generated by applying the same approach to ensure that only comparable figures are used.

Across all modelling studies, from the IA through the CAO series, **the benefits of meeting the ERCs are shown to significantly and consistently outweigh the costs**. For example, in CAO4, **the benefits of achieving ERCs with additional mitigation over and above the baseline were estimated to be 14 (VOLY) or 46 (VSL) times higher than costs**. In these modelling studies, the benefits remain greater than the costs even under much more ambitious scenarios delivering emissions reductions beyond the ERCs.

This conclusion also holds in counterfactual scenario, which compares the costs and benefits of all additional emissions controls taken up since the adoption of the NECD in 2016: **the benefit-cost ratio of additional emissions controls implemented over the 2016-2025 period through all policies is estimated at 4:1 (VOLY) or 13:1 (VSL).** As the costs and benefits generated through this analysis most closely reflect the effects of emission controls, this is the reference figure used for this evaluation.

Due to limited data and differences in timeframes and methods, it was **not possible** to establish a benefit-cost ratio for **policies implemented at Member State level**. An attempt was made to understand the relationship between costs and benefits for Member States whose NAPCPs and PaMs provide the highest levels of details on costs. However, the figures are too uncertain to draw conclusions from them. What is clear from the order of magnitude of the figures is that the **benefits systematically outweigh the costs**.

14 out of the 53 **stakeholders** responding to the OPC thought that the benefits greatly outweighed the costs. For the TSC, that number was 12 out of 41. 7 OPC respondents and 6 TSC respondents thought that the benefits somewhat outweighed the costs. 8 OPC respondents and 5 TSC respondents thought that the costs outweighed the benefits. Public authorities, NGOs and citizens more commonly considered benefits to outweigh costs, while business associations more commonly thought that the costs and benefits were in balance or that the costs outweighed the benefits.

4.2 How did the EU intervention make a difference and to whom?

4.2.1 Why Member State action is not sufficient and why the objective is better achieved by the EU

Air pollution is the number one environmental health problem in the EU. One of the factors influencing air quality is transboundary pollution - pollution that crosses borders from one country to another. Due to geographical factors, transboundary air pollution originating from Member States and non-EU countries is a common challenge in the EU. The justification for legislative EU action on air pollution has long been established based on the transboundary nature of air pollution. The legal basis for action is Article 192(1) of the Treaty. At present, transboundary pollution continues to be a significant source of pollution in most EU Member States: a large share of $PM_{2.5}$

background concentration in individual Member States is generated in other Member States and neighbouring countries. This is projected to remain the case in the future. In 2020 the share of population-weighted $PM_{2.5}$ background concentrations originating from outside sources (EU and non-EU) ranged from 29% to 92%. For most Member States, this share was in the range of 40% to 70%[106]. At the same time, pollution from sources outside the EU has been increasing (particularly for Member States sharing borders with non-EU countries).

Effective air emission reduction policy therefore requires action and cooperation at global, European, regional, national and local levels. Neither national legislation nor national jurisdictions alone can be employed effectively against pollution that has its origin in another country. At international and pan-European level, the Air Convention provides a system that sets reduction commitments for an entire region, which includes both EU Member States and countries in the EU's neighbourhood (in particular the Western Balkans and the Eastern Europe, Caucasus and Central Asia region). However, the Convention and its protocols have proven less effective than action at EU level, because they lack the strong implementation and enforcement mechanisms which are available under EU law. The view that air pollution is a cross-border problem that requires coordinated EU action, including in order to ensure a fair and consistent approach across Member States, is also shared by **stakeholders**.

4.2.2 *EU added value for different actors and in different territories (including urban, rural, outermost regions)*

Section 4.1 highlighted a significant net benefit associated with the implementation of the NECD. This benefit also arises from the unique role of the NECD in "capping" total air pollutant emissions from different sources regulated by specific legislation (see also in section 4.3). The question then arises about how these benefits have been distributed among different actors and across the EU.

EU citizens and regional impacts: Air pollution has both short-term and long-term effects on human health. In the short term, exposure to pollutants like particulate matter, NO_2, SO_2 and O_3 can exacerbate respiratory conditions such as asthma and bronchitis. Vulnerable populations, including children, older adults and those with preexisting health conditions, are particularly at risk. Long-term exposure to air pollution is linked to more severe health outcomes, including the development of chronic respiratory diseases, cardiovascular diseases, and lung cancer. Moreover, prolonged exposure is associated with premature mortality and reduced life expectancy.

Chapter 3 has shown a downward trend in emissions of the main air pollutants. Emissions of air pollutants translate into ambient concentrations of pollutants; and higher levels of concentration lead to more adverse health impacts. In contributing to reducing emissions of the main air pollutants, the NECD has therefore delivered public health benefits.

BOX 12. From emissions of air pollutants to concentrations, to health impacts

Air pollutant emissions influence ambient concentrations both directly (e.g. $PM_{2.5}$, NO_x and SO_2 emissions contribute to $PM_{2.5}$, NO_2 or SO_2 ambient concentrations) and indirectly (e.g. primary air pollutants undergo chemical reactions in the atmosphere to form secondary air pollutants, such as ozone). Concentrations are also influenced by meteorological conditions that influence dispersion

[106] GAINS calculations done by IIASA et al (2025), 'Support to the development of the fourth clean air outlook', Publications Office of the European Union.

(wind speed and direction, precipitation) and orography (valleys can trap pollutants, leading to higher concentrations, whereas coastal regions might experience more immediate dispersion due to sea breezes). So, while there is an established link between pollutant emissions and concentrations, the exact relationship differs at the local scale. Health impacts are assessed on the basis of concentration response functions that link the risk of health impacts (such as premature mortality, or diseases associated with air pollution) to changes in the concentration of a given air pollutant in ambient air (see Annex II 2.2 for a step-by-step explanation).

Over 2016-2022 (latest data available), population-weighted $PM_{2.5}$ concentrations in the EU decreased by 17%[107]. The (prototype) zero pollution dashboard for regions shows how concentrations of $PM_{2.5}$ have changed over 2016-2022 at the level of EU regions. It shows that from 2016 to 2020, air quality improved in 97% of regions, with 17 regions having improved air quality by one third or more. Reduced concentrations of $PM_{2.5}$ can be attributed to reduced emissions at the national level, driven by the NECD working in synergy with source legislation.

Reduction in exposure translates into reduced health impacts. Reduction in exposure translates into reduced health impacts. According to EEA calculations, the number of premature deaths attributable to exposure to $PM_{2.5}$ decreased by 45% between 2005 and 2022[108], with a 16% reduction achieved over 2016-2022[109].

How are the benefits from reduced health impacts distributed across the EU? While EU clean air policy is based on the principle that citizens across the EU have the same right to clean air (hence the same air quality standards apply throughout the EU), air quality concentration maps[110] show that large disparities remain across Europe, as well as within a given Member State, with a clear urban-rural divide. The two directives are complementary: the NECD sets ERCs at national level, and the AAQD addresses local air quality issues, such as high air pollutant concentrations in cities. EEA analysis furthermore points out to persisting air quality inequalities between wealthier and less well-off regions[111].

Despite such remaining disparities, the effectiveness analysis in this evaluation showed that, overall, remarkable progress in air emission reduction and improved air quality was made over the evaluation period. This has benefitted all Member States, with improvements also in countries that started from much lower levels of air quality. As regions with the highest level of pollution were the largest recipients of EU funding, EU funds may have had a significant role in achieving these results[112].

BOX 13. Treatment of outermost regions

[107] EEA Burden of disease of air pollution (Countries & NUTS). Reduction in population-weighted NO_2 concentrations were 23% over the same period.

[108] Latest EEA data show a decrease of 57% between 2005 and 2023. As can be seen when looking at the time series of the EEA indicator, the number of estimated attributable deaths is subject to a certain interannual variability.

[109] Reduction of NO_2 attributable deaths was 34% over the period 2016-2022.

[110] Provided in Annex III, Section 2.1.4.

[111] Earlier EEA analysis ('Unequal exposure and unequal impacts') found that 'uneven distribution of the impacts of air pollution […] on the health of Europeans closely reflects the socio- demographic differences within our society', that 'in many European countries, such disproportionate exposure occurs in urban areas', and that regions that are both relatively poorer and suffering from higher PM pollution 'are located mainly in eastern and south-eastern Europe'. However, 'the link between socio-economic status and exposure to PM is also present at a finer-scale, local level'.

[112] See Annex III, section 6.4.

Article 2(2) of the NECD excludes the **EU's outermost regions** from its scope: 'This Directive does not cover emissions in the Canary Islands, the French overseas departments, Madeira, and the Azores'. Article 4(3)(b) furthermore excludes 'emissions from national maritime traffic to and from the territories referred to in Article 2(2)' from the national total of emissions that is used as a basis for compliance checks against the ERCs. So, neither does the NECD regulate emissions occurring in the outermost regions, nor does it address the emissions associated with national maritime transport to and from those regions.

Ecosystems: Air pollution not only harms humans but also affects ecosystem health through acidification, eutrophication and ozone impacts. Besides addressing human health impacts, the NECD set out to contribute to reducing such negative effects on the environment[113].

Acidification is now less of a concern than in the past[114], primarily as a result of measures that have successfully reduced SO_2 emissions over the past decades, including measures taken under the NECD and its predecessor.

The situation is considerably less positive when looking at eutrophication[115]. The EEA estimated that in 2022, 73% of the ecosystem area in the EU was above the critical load for eutrophication. The total area where nitrogen deposition exceeded the critical loads for eutrophication fell by a mere 13% between 2005 and 2022[116].

Ground-level ozone concentrations have fluctuated considerably year-to-year. Despite decreases in emissions of 'precursor' pollutants (of which NO_x and NMVOCs are regulated in the NECD), which react to form ozone in the atmosphere in the presence of sunlight and heat, there are not yet any signs of significant decreases in ozone levels in the EU. In 2022, almost one third of Europe's agricultural lands were exposed to ground-level ozone concentrations above the threshold value set for protection of vegetation in the AAQD[117]. Ozone exposure has direct economic consequences for forests (reduced timber production) and cropland (reduced yields).

Economic operators: The benefits of reduced exposure to air pollution trickle down to economic operators as well, as a healthy population also means a healthier labour force. In other words, productivity losses and the number of workdays lost due to air pollution are reduced. The Clean Air Outlook reports regularly assess workdays lost, with the latest CAO 4 estimating a 13% reduction in air pollution-induced workdays lost between 2020 and 2025 (49% compared to 2005)[118].

With respect to costs, this evaluation shows that the administrative costs to businesses are low, and in all cases indirect (as the NECD places obligations only on Member States, the European Commission and the EEA). Adjustment costs for businesses differ

[113] The 2025 implementation report on the Water Framework Directive found that the most significant pressures for surface water bodies in all reporting Member States is pollution from atmospheric deposition (affecting 59% of waterbodies).

[114] EU ecosystem area affected by acidification reduced by 63% over 2005-2020 (CAO4).

[115] Assessed as area of ecosystems where nitrogen deposition exceeds the critical loads.

[116] https://www.eea.europa.eu/en/analysis/indicators/eutrophication-caused-by-atmospheric-nitrogen, and by 12% over 2005-2020 (CAO4) for comparison with acidification.

[117] EEA web report no 22/2024, Impacts of air pollution on ecosystems in Europe.

[118] Findings that reduced air pollution leads to greater productivity have been confirmed by a 2019 OECD working paper on "The economic cost of air pollution: Evidence from Europe", based, however, on data preceding the evaluation period (2000-2015). The study estimated that a 1µg/m^3 increase in $PM_{2.5}$ concentration causes a 0.8% reduction in real GDP in the same year, predominantly due to reductions in output per worker, which can occur through greater absenteeism at work or reduced labour productivity.

by economic sector. Successive CAOs analyses and feedback from stakeholders suggest that the agricultural sector is amongst the sectors likely to face the greatest net cost or largest reductions in output from meeting ERCs.

As part of this evaluation, we also looked at whether non-EU businesses have likewise faced adjustment costs of clean air policies. This analysis suggests that the EU's principal trading partners are undertaking their own pollution abatement measures. Although the extent of the measures varies depending on the pollutant, a significant number of partners are matching the EU effort, and thus EU businesses are not disproportionately affected.

Economy-wide, all evidence gathered suggests that clean air policies adopted to meet the requirements of the NECD have yielded benefits that significantly outweigh the costs, with the benefit-to-cost ratio estimated, under the more conservative assumptions, at 4:1. This estimate is based on using (partly back-casted) data on costs and benefits over the evaluation period from the GAINS model. While very little information on adjustments costs actually incurred is available from Member States, and while the available estimates are hardly comparable across Member States, a rough comparison of costs and benefits for certain Member States also shows that the benefits outweigh the costs.

4.2.3 *Subsidiarity*

Obligations stemming from the NECD, like all requirements under EU legislation, are subject to the principle of subsidiarity, which is fundamental to the functioning of the EU. The NECD sets national ERCs for each Member State following a staged approach (and based on international agreements) but leaves a substantial margin to the Member States in deciding how best to achieve their obligations. Thus, recognising that implementation largely relies on national, regional and local measures tailored to specific needs and circumstances, the NECD is in line with the principles of subsidiarity and proportionality.

4.3 Is the intervention still relevant?

4.3.1 Objectives of the NECD and how these reflect (current and future) needs

The NECD set out to reduce impacts of air pollution on human health and the environment, by helping to (i) achieve EU air quality standards; (ii) ensure the EU delivers on its international commitments (GP); and (iii) ensure synergy between clean air and other EU policies.

Addressing air pollution to reduce impacts on human health remains an urgent objective. Air quality has improved in the EU over the last decades, thanks to joint efforts by the EU and national, regional and local authorities and to a coherent framework of EU clean air legislation working hand in hand with source and other legislation. Since 2005, the EU's GDP has grown by close to 50% while emissions of the main air pollutants have decreased by 17% to 85% depending on the pollutant[119]. Exposure to ambient concentrations and the associated health impacts have been reduced accordingly, as discussed in the previous sections. However, **significant negative health impacts remain**, with approximately 182 000 premature deaths per year attributable to exposure to $PM_{2.5}$ in the EU, 63 000 to O_3 and 34 000 to NO_2 in the

[119] EEA NECD briefing 2025

EU in 2023[120]. The harmful effects of air pollution are well established, and new evidence has been presented over the past decade. Indeed, the 2021 edition of the WHO Air Quality Guidelines confirms that for several air pollutants, **adverse health impacts occur at concentration levels below what had been stated in previous editions**[121]. EEA analysis further shows that air pollutant concentrations in 2023 remained well above the guideline exposure levels recommended by the WHO and that most people living in urban areas in the EU were exposed to air pollution at levels that to some degree damage their health[122].

Stakeholders across all stakeholder groups strongly agreed on the continued relevance of the NECD, stating that air pollution remains a major environmental and public health risk, and that the NECD plays a critical role in addressing it. With its continued attention to human health effects, the NECD, alongside the AAQD, improves knowledge of the potential benefits of addressing emissions also through related policies.

Regarding **ecosystem impacts**, eutrophication[123] of ecosystems linked to air pollution **remains a serious concern,** with an estimated 73% of the ecosystem area in the EU being above the critical load for eutrophication in 2022[124]. The relevance of this issue is underscored by the recently adopted European Water Resilience Strategy and European Ocean Pact. There are also important ecosystem impacts from exposure to ground-level ozone, with direct economic consequences for forests (reduced timber production) and cropland (reduced yields). In 2022, almost one third of Europe's agricultural lands were exposed to ground-level ozone (O_3) concentrations above the EU threshold value set in the AAQD, leading to losses in wheat and potato yields of up to 10% in individual Member States[125]. Achieving lower levels of air midway through the period to 2030, this evaluation found that the downward trend in air pollutant emissions has continued in recent years and that current progress towards meeting the ERCs is relatively good, apart from the targets for NH_3 emissions. However, Member States have not yet taken sufficient action to be on a linear downward trajectory towards the more ambitious 2030 commitments. Additional action is needed for all pollutants. The outlook to 2030 is most promising for SO_2 and most challenging for NH_3, NO_x and $PM_{2.5}$ emissions. The analysis also showed that **even if the 2030 ERCs are delivered, harmful impacts of air pollution will remain**.

New policy needs and legal requirements have arisen over the evaluation period. These include the targets related to clean air of the ZPAP for 2030 and the revised air quality standards of the 2024 AAQD. The more stringent exposure guideline levels of the 2021 WHO Air Quality Guidelines are also relevant for the long-term air quality

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120 EEA (2025), Harm to human health from air pollution in Europe: burden of disease status. This estimate (for the year 2023) is based on air pollution concentration monitoring and only includes premature deaths attributable to air pollution above WHO air quality guidelines level. Estimates for the environmental burden of disease are made individually for the respective air pollutants, and cannot be added up as they are correlated, especially in the case of $PM_{2.5}$ and NO_2.

121 See Annex 10 of the impact assessment underpinning the Commission's proposal to revise the AAQD (SWD(2022) 545 final, PART 4/4).

122 European Environment Agency *Air quality status report 2025*, 2025.

123 Assessed as area of ecosystems where nitrogen deposition exceeds the critical loads.

124 https://www.eea.europa.eu/en/analysis/publications/impacts-of-air-pollution-on-ecosystems-in-europe

125 EEA web report No 22/2024, *Impacts of air pollution on ecosystems in Europe*.

objective for the NECD. In addition, Article 1 of the revised AAQ Directive sets out the aim of achieving a toxic-free environment by 2050.

How does the NECD fare against these new needs? The latest two editions of the CAO and of the Zero Pollution Monitoring and Outlook report have shown that under current policies:

- the EU is **unlikely to meet** the 2030 zero-pollution target of reducing the ecosystem area where air pollution threatens biodiversity by 25% compared to 2005 (expected reduction between 2005 and 2030 is 19%).
- the EU is **on track** to meet the 2030 zero-pollution target of reducing premature deaths due to $PM_{2.5}$ exposure by 55% compared to 2005.

The ecosystem-related target is also missed in a scenario where Member States meet the more ambitious 2030 ERCs. **The current ambition level of the ERCs is thus insufficient to address the need to reduce negative impacts on the environment** and to ensure that the EU meets the zero-pollution target for ecosystems.

Compliance with **air quality standards set in the AAQD** has improved over time. For 2023, Member States reported 27 zones in exceedance of the annual mean for NO_2 compared to 119 zones in exceedance for 2016. They also reported 38 zones in exceedance of the daily mean in 2023 for PM_{10} compared to 96 zones in exceedance for the year 2016. Therefore, while broad compliance has been reached for several key pollutants, poor air quality remains a concern in specific locations. As a result, several infringement cases related to exceedances of EU limit values set by the AAQD are currently ongoing. While 2030 air quality limits have already been met at a majority of stations, closing the gap to full compliance will require additional reductions. WHO guideline exposure levels are currently being met at a minority of stations only[126].

CAO4 provides projections of air quality and population exposure to $PM_{2.5}$ and NO_2 concentrations in 2030, to gauge what is possible to achieve with current policies, including the ERCs applicable currently and from 2030 onwards. Pollutant concentrations are expected to continue falling over time. As background concentration levels decrease, the number of people living in areas with clean air is set to rise in the EU. In 2030, 14% of the EU population (just over 64 million) will, however, still be exposed to $PM_{2.5}$ concentrations above 10 $\mu g/m^3$ (the then applicable EU limit value) under current policy assumptions. In a scenario where Member States meet their 2030 ERCs under the NECD, that portion would decrease to just under 13% (or around 56 million). This shows that, while having the potential to bring air quality closer in line with revised air quality standards, **compliance with the 2030 ERCs is not sufficient for meeting air quality limits for $PM_{2.5}$ everywhere in the EU**, and by extension, even less so to ensure air quality in line with the WHO guideline levels.

Clearly, given the more stringent air quality objectives ahead, **continued efforts to reduce air pollution at national level under the NECD are needed to effectively complement measures taken at local or regional level**. This is also in line with the goal of increasing sustainable production in the EU as set out, for example, in the Clean Industrial Deal. Swift and full implementation of recent and upcoming initiatives (such as the NRR, the upcoming Circular Economy Act, and the Water Resilience Strategy and European Ocean Act) could help in further accelerating NECD compliance.

[126] See Annex III, Section 5.2.1.

4.3.2 Continued relevance in view of developments in related policies

The objectives of the NECD and the means of achieving them remain highly relevant in light of developments in related policy fields. More stringent energy and climate legislation and more ambitious goals set in source legislation adopted under the European Green Deal have contributed to reducing emissions of the main air pollutants regulated by the NECD, yielding important co-benefits. However, these co-benefits do not equally affect all the main air pollutants. Reductions in SO_2 and NO_x emissions in particular have been achieved through more ambitious targets for energy efficiency, less reliance on solid fossil fuels and stricter emission standards for vehicles (and more reliable emissions tests in real driving conditions), as well as due to growing electrification rates in road transport. For $PM_{2.5}$, while many energy and climate measures achieve reductions in particulate matter, the growing reliance on bioenergy for heating (a significant source of particulate matter emissions and other pollutants), promoted alongside other renewable energy sources, means that dedicated pollutant abatement strategies continue to be needed and relevant[127]. The upcoming revision of Ecodesign standards for solid fuel boilers and local space heaters is an important lever for continued and steeper reductions of $PM_{2.5}$ to ensure Member States get onto a linear reduction trajectory to meet 2030 ERCs. Of the five main pollutants, NH_3 has seen the least reductions and is the one that is the least addressed by other legislation. At the same time, it is a major precursor for particulate matter and contributes to its associated negative health effects. It is also a direct contributor to the eutrophication of ecosystems. Therefore, specific action on NH_3 remains highly relevant.

Source legislation on its own cannot cap the overall, combined impact of relevant sources (e.g. road transport, domestic heating, industrial emissions), as it regulates what a single source (e.g. a car, a stove, an industrial installation) emits. The NECD draws attention to the combined effect of these sources and provides a legal framework to bring them down at national level. This mechanism is unique to the NECD and remains relevant in the evolving policy context, considering also the continued need to address the main air pollutants (as discussed in 4.3.1).

4.3.3 Continued relevance in view of scientific and technical progress

EU clean air policy is based on scientific evidence, including relevant WHO air quality guidelines and programmes. This already well-established evidence has been further developed over the past decade, with the 2021 edition of the WHO guidelines confirming that for several air pollutants adverse health impacts occur at concentration levels below what had been stated in previous editions.

Technical progress, for example, breakthroughs in clean technologies or end-of-pipe abatement techniques, may in time render specific legal and policy actions less relevant. Over the evaluation period, there were no technological innovations affecting the relevance of the NECD. Rather, various developments in other areas, including clean energy and clean industry policies, and external factors (Covid-19, Russia's military aggression against Ukraine), have favoured gradual shifts in economic activity and a gradual uptake of existing abatement techniques that mitigate emissions of air pollutants. For example, the effects of best available techniques under the IED increase

[127] EC (2024), Increasing policy coherence between bioenergy and clean air policies and measures includes a 'toolbox' addressed at policy makers on how to best manage air quality trade-offs from using bioenergy.

with every new permit that is issued in line with the latest BAT conclusions. The rate of stock renewal is an important determinant of how quickly reductions in air pollutant emissions materialise. This holds for appliances with Ecodesign criteria and for vehicles covered by Euro emission standards where the effect is linked to fleet turnover rates. All this means that source legislation continues to contribute (and in some cases increasingly so, see findings on coherence over time in Section 4.1.1) to achieving the objectives of the NECD. **One limitation of source legislation is that it does not limit the number of sources emitting a certain pollutant.** In contrast, the NECD intervenes at Member States level, requiring Member States to act also on the sum total of pollutants, rather than just on pollutants per site or product.

Article 13 of the NECD puts a special emphasis on reviewing **scientific evidence as regards ammonia.** Specifically, the UNECE Guidance Document on Preventing and Abating Ammonia Emissions from Agricultural Sources of 2014 (the 'Ammonia Guidance Document')[128] and the 2015 UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions[129] are referred to in and have informed Annex III, Part 2 of the NECD, which sets out emission reduction measures for ammonia. These guidance documents are under revision at the UNECE, with the involvement of the Commission. A separate Guidance on integrated sustainable nitrogen management was adopted in 2021, covering the wider nitrogen cycle, with a view to harvesting multiple co-benefits of integrated nitrogen management. **Annex III, Part 2 remains relevant** for now, but some revisions might be necessary following the review of the UNECE documents.

To further assess the relevance of the measures under Annex III, Part 2, the support study to the evaluation considered the effectiveness of the techniques included. In particular, it sought to find if there were more effective techniques available not included in the annex. Based on a review of the relevant literature and expert knowledge, and taking into account requirements under related legislation, the support study found that **the measures were potentially effective. Their effectiveness in the abatement of ammonia emissions was estimated as ranging from moderate to high**. Effectiveness sometimes hinges on the practical implementation by Member States. Some measures fully or partially overlap with requirements of the Nitrates Directive and IED, though requirements for these Directives are applicable only to certain farm types[130]. As such, this overlap does not have negative consequences, and overlaps will depend on the implementation at Member State level.

Stakeholders generally consider the measures in the annex effective and relevant to modern farming systems. However, they point out that in some cases the wording in the annex allows for a broad range of implementation options, which may vary in effectiveness. The two mandatory measures, A1 (national advisory code of good agricultural practice) and A3 (prohibiting the use of ammonium carbonate fertilisers), are still considered relevant by the respondents to the targeted stakeholder consultation (23 respondents, 96% of opinions received regarding A1; and 20 respondents, 95%, regarding A3). To strengthen the relevance of the national advisory code, some respondents (NGOs) called for a more ambitious code and others (public authorities) called for more regular updates based on local conditions. Despite the uneven uptake,

[128] Decision 2012/11/EC, ECE/EB/AIR/113/Add. 1.
[129] Decision ECE/EB.AIR/127, paragraph 36e.
[130] Based on location in nitrate vulnerable zone (Nitrates Directive) or based on farm type/size i.e. only pig and poultry farms over certain thresholds under the IED.

the optional measure on national nitrogen budgets was generally considered relevant by stakeholders (18 respondents; 78%).

4.3.4 Assessment of the relevance of the NECD's scope

The evaluation has also assessed relevance in more detail, addressing the Directive's scope in terms of the pollutants and sources of emissions it covers.

The **five main pollutants** that the NECD sets ERCs for **remain relevant**. They were chosen under the GP because of their negative health effects and because they and the secondarily formed pollutants (e.g. ozone) are transported in the atmosphere over long distances (and across borders). The relevance of the five air pollutants is well rooted in scientific evidence (see Section 2.1.4 of Annex III for references). The air pollutant with the biggest human health impact in Europe is $PM_{2.5}$, followed by ozone and NO_x. NO_x, and NMVOC are ozone precursors. Ammonia contributes to the formation of $PM_{2.5}$. The continued relevance of these pollutants and their effects on human health have been addressed specifically in the latest WHO air quality guidelines. Also, the ongoing revision of the GP does not question the choice of these pollutants but rather considers adding – at least for monitoring purposes – additional pollutants such as methane, which is a major ozone precursor. Likewise, the majority of stakeholders responding to the TSC (20) supported this view, while 11 respondents thought that the range was not relevant anymore, proposing further relevant pollutants. When expanding their replies, most stakeholders raised the need to include further pollutants, with methane, black carbon and ultrafine particles quoted most often across OPC and TSC replies.

During the evaluation period, the understanding of the **condensable part of particulate matter** improved, which was also reflected in the EEA/EMEP Guidebook. These are emissions initially in vapour form (inside or close to the stack) that transform into particulate matter when discharged into ambient air. They affect air quality and are therefore relevant to the NECD objectives. They stem mostly from domestic heating. Progress in their reporting would allow them to be included systematically in inventories in the future.

Several conclusions emerge from the **analysis of other pollutants and types of data.** The knowledge base on some pollutants expanded during the evaluation period, allowing a potential inclusion of these pollutants in reporting (without them necessarily being subject to ERCs).

- Black carbon emissions currently have to be reported if available. Developments now would allow them to be reported systematically, which several stakeholders call for. Another potential addition would be organic carbon.
- Methane is already reported under EU and international climate change regulations and has a major role as an ozone precursor (see the box below). Several stakeholders raised the need to address methane through the NECD.
- Ultrafine particles and additional contaminants such as additional heavy metals and per- and polyfluoroalkyl substances (PFAS). A few stakeholders mentioned the need to include their reporting.

The relevance of reporting inventories for **heavy metals** and **POPs**, as well as for **TSP** was questioned, since these data are not used by modellers or users of national

emissions data (see also Section 4.1.4.3). Reporting **gridded data** under the NECD still appears to be relevant, but the accuracy of the reporting should be improved.

Finally, **LPS** data reported under the NECD **has limited relevance**, as they largely overlap with data reported under the European Industrial Emissions Portal.

BOX 14. Non-inclusion of methane in the scope of the NECD

This evaluation has also addressed methane and the continued relevance of excluding it from the NECD[131]. The 2013 Commission proposal had included ERCs for methane given its role as an ozone precursor. During the negotiations methane was excluded, leading the Commission to issue a Declaration on the Review of Methane Emissions, placed at the end of the NECD.

Methane emissions in the EU have decreased (by 38% since 1990), thanks to reductions of emissions from energy supply, waste and – to a lesser extent – agriculture, which is the main source of emissions and accounts for around half of current EU methane emissions. All methane emissions, including from agricultural sources, are covered under the Effort Sharing Regulation. Emissions from the energy and waste sectors are targeted via the Regulation on the reduction of methane emissions in the energy sector, the IED and waste legislation[132]. The IED also addresses methane emissions from refineries, the chemical sector and large combustion plants, as well as from intensive pig and poultry rearing. The CAP includes interventions to reduce GHG emissions generally (i.e. including methane).

While methane emissions are decreasing in the EU, global methane emissions and the relative contribution of methane to global warming are increasing. Global methane emissions also significantly influence ground-level ozone concentrations in Europe[133]. Action on methane at international level is taken via the Global Methane Pledge launched in 2021. However, the future effectiveness of this global voluntary framework, initiated jointly by the EU and the USA, needs to be closely observed. The possibility of including methane in the GP is also being discussed. Evidence from modelling studies makes a strong case for tackling methane globally, alongside other precursors, in order to reduce ozone levels effectively. Therefore, there is still an urgent need to address methane, given its role both as a potent GHG and as an ozone precursor. It remains to be seen which framework would be most effective for taking further action to reduce methane.

This evaluation also assessed **whether it is still justified to exclude certain sources of emissions** for assessing compliance with ERCs in accordance with Article 4(3) of the NECD. Member States report estimates for these sources of emissions in their emission inventories. This makes it possible to analyse the significance of these sources, how they have developed over time, and the robustness of the emission estimates[134].

Recent available evidence confirms that the impact of **aviation cruise emissions** on ground-level concentrations of air pollutants and of ozone is limited[135]. The main source of air pollutant emissions, such as soot, NO_x and SO_x, remains take-off and landing, with emissions occurring around airports[136]. Furthermore, including aviation cruise emissions under the scope of the NECD would make relatively little difference to the trend in emission reductions over time, and therefore to compliance with ERCs across the EU, although in some Member States impacts are more pronounced. Excluding aviation cruise emissions is also fully in line with GP reporting. Therefore, while there

131 The detailed analysis is contained in Sections 4.6 (coherence) and 5.3 (relevance) of Annex III.

132 Waste Framework Directive and the Landfill Directive.

133 EEA (2025), Methane, climate change and air quality in Europe: exploring the connections, EEA Briefing No 01/2025.

134 Annex III, Section 5.3, as well as in the support study to this evaluation, chapters 4 to 6, contain the detailed analysis.

135 A recent modelling study was done by Concawe (2023), more evidence is summarised in the annex and the support study (Chapter 5).

136 See for example Contrails and aviation's other hidden emissions | T&E.

are **reasons to consider the current exclusion relevant**, given the limited recent evidence on the impact of cruise emissions on ground-level air pollutant concentrations, this **should be kept under review**.

Excluding emissions from international maritime transport[137] is fully in line with the GP. However, this approach may not provide an accurate reflection of the extent to which shipping activities affect concentrations of air pollutants. Recent literature suggests that shipping emissions as a whole (of which international shipping is a major component) have a significant impact on concentrations of some pollutants in coastal areas, even outside port areas and well into the mainland[138].

That said, shipping emissions are addressed by several pieces of international and EU legislation, partly driven by climate action. At international level, the International Maritime Organization's MARPOL Convention includes several mechanisms to reduce air pollution from ships of all flags, regardless of whether they are calling at European ports or simply transiting. These mechanisms include global sulphur caps and sulphur and NO_x emission control areas, which are far less stringent than those applying on land, however. These mechanisms are not complemented by many targeted measures at national level.

Therefore, while **there may be grounds for keeping international maritime transport emissions outside the scope of the NECD**, the increasing relevance of maritime shipping emissions for pollutant concentrations in ports and coastal areas means that **they should be kept under close scrutiny**, including whether international maritime shipping emissions close to ports and coastal areas should be reported and added to the national total for compliance. At the latest, the review of the AAQD by 2030 (Article 3 of the recently revised AAQD) would be a good opportunity to assess how international maritime shipping is dealt with, given its contribution to ambient concentrations, and whether the exclusion remains relevant or not[139].

Some of the NO_x and NMVOC emissions excluded from agricultural activities and agricultural soils/crop cultivation are relatively large and would substantially change the relative contributions from source sectors to the national compliance totals if they were included. In some countries where the contribution of these emission sources is particularly large (e.g. NMVOC emissions for Ireland and the Netherlands), including them would flatten emission trends considerably over time.

Some of these sources are difficult or particularly expensive to control (e.g. NMVOC from standing crops). It is nevertheless reasonable to question whether this is a valid reason for excluding these sources from the compliance total, as the abatement costs

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137 Article 4(3) also excludes emissions from national maritime traffic to and from the EU's outermost regions. This is justified given their specific situation and in particular their remote location. The analysis here therefore does not further address this exclusion from the scope of the NECD.

138 The impact assessment underpinning the Commission's proposal to revise the AAQD (SWD(2022) 545 final) demonstrated that the comparative share of shipping for NO_2 will increase over time as a result of more effective abatement of other transport modes (in particular road).

139 Increased EU-level action on maritime emissions could also be considered. Article 11(2) of the NECD requires the Commission to 'investigate the need for further action' and, where appropriate, 'present legislative proposals, including new source-based air control pollution legislation, in order to ensure compliance with the commitments of this Directive', if non-achievement of ERCs 'could be the result of ineffective Union source-based air pollution control legislation'.

would be taken into account in the integrated assessment modelling studies used when setting ERCs and ambition levels more generally.

A major reason for excluding these sources at the time was that emission estimates were considered particularly uncertain. While this was a reasonable consideration, this approach was not applied consistently across all other emission sources. There were some limitations to existing methods available in the EMEP/EEA Guidebook, but this was addressed by improvements made to the Guidebook. As for other sources, Member States can also pro-actively develop more accurate country-specific methods, which would reduce uncertainty and reflect the impact of mitigation measures in their inventories.

Excluding agricultural emission sources creates an inconsistent approach between the NECD and the GP, since these sources are included in the GP for compliance checks. While the GAINS model, which was used for modelling cost-effective ERCs for both the 2012 GP and the 2016 NECD revision, did not include these sources at the time, this has since changed, and a further developed version of the model now underpins the modelling to inform the ongoing revision of the GP. All in all, **this evaluation considers that excluding agricultural emission sources is no longer relevant**[140]. Consideration should therefore be given to including these sources in the NECD in the future, following the approach under the GP revision.

5 WHAT ARE THE CONCLUSIONS AND LESSONS LEARNT?

5.1 Effectiveness and coherence

The clean air policy framework – including the **NECD – has been largely successful in reducing emissions of the five main air pollutants** in the Member States, albeit with some exceptions. Emissions of all five pollutants have followed a downward trend at EU level since the reference year 2005, while the GDP has increased over the same period[141].

In 2023[142], 19 Member States had met their 2020-29 ERCs for all 5 air pollutants, 7 Member States did so for 4 air pollutants, and 1 Member State was in compliance only for 3 of its emission reduction commitments. While ERC non-compliance for NO_x, NMVOC, SO_2 and $PM_{2.5}$ is down to 1 case each, NH_3 is the outlier and poses the greatest challenge: 5 Member States have still not met their 2020-29 ERC. Non-compliant Member States are subject to infringement procedures and will have to step up their measures.

Meeting reduction commitments and contributing to better air quality has been most successful where EU and Member State policies acted coherently to tackle major sources of an air pollutant. **Coherence between the NECD and the AAQD is high**. An exception is ozone, where the NECD ERCs only cover a subset of relevant precursor pollutants (namely NO_x and NMVOC but not methane). The NECD is therefore failing to meet its full potential to achieve the EU air quality standards for ozone set in the AAQD. Coherence has further improved with the revision of the AAQD, which

[140] The Commission's 2013 proposal for a revised NECD did not propose such an exclusion.
[141] EEA NECD briefing 2025
[142] 2023 is the latest year for which data have been reported by Member States in 2025.

introduced additional direct references to the NECD to increase the use of data reported under the NECD for air quality assessment and management.

Coherence between the NECD and other relevant policies is generally good and was reinforced over time with policies covering a wider range of emission sources (e.g. the IED) or through strengthened rules (e.g. energy efficiency targets, Euro emission standards for vehicles, the IED). The analysis found that further integration between planning tools under the NECD and climate and energy policies (i.e. NAPCPs and NECPs) could improve synergies. An area of **incoherence** is the fact that under the Renewable Energy Directive (RED), biomass is seen as a contribution to the renewable energy target (subject to the sustainability criteria, which, however, do not cover pollutant emissions), even if the use of biomass in small, inefficient heating appliances in households contributes to $PM_{2.5}$ and NMVOC emissions. NECD policies and measures in some Member States (e.g. information about correct wood burning, promoting replacing heating systems) and EU policies (e.g. ecodesign for solid fuel local space heaters) are helping to address this problem. Furthermore, given the challenge of meeting NH_3 ERCs, even though the revised IED is expected to make a further contribution to reducing ammonia emissions, due to its extended scope covering pig and poultry farms, additional reductions will have to be considered. As the rearing of livestock and related activities constitute a significant source of pollutant emissions into the air, the co-legislators agreed that the Commission should assess the need for Union action to comprehensively address the emissions from rearing of livestock, in particular from cattle. Another important lever to address NH_3 emissions identified in this evaluation is increasing Member States' (and eventually farmers') uptake of funding streams and voluntary measures available under the CAP.

The **NAPCPs** proved instrumental in this context, as their development promotes coordination between different sectors and different parts of government. Clarifying requirements on the timing of the update of NAPCPs and PaMs as well as on their content and presentation could make NAPCPs even more useful.

At international level, the **NECD has helped** Member States and the EU **to comply with their obligations under the Gothenburg Protocol** to the Air Convention.

As regards meeting a linear reduction trajectory towards the 2030+ ERCs, **several Member States have not yet taken sufficient action**, as only 15 Member States project **to reach the indicative 2025 levels for all pollutants** under the current measures (18 when considering the 'with additional measures' scenario). Additional action is needed for all pollutants (with the outlook for 2030 being most promising for SO_2).

At EU level, the target to reduce the number of premature deaths by 55% by 2030 compared to 2005, as set out in the ZPAP, is nonetheless expected to be achieved. Although the relationship is not quantifiable, reductions of emissions of air pollutants through the NECD contributed to reducing background concentrations for the most impactful pollutants, namely $PM_{2.5}$, NO_2 and, to a lesser extent, ozone (through its precursors, NOx and NMVOC). On the other hand, to meet the ZPAP objectives on ecosystems, the current set of measures targeting ammonia are not yet sufficient, unless more coordinated approaches to tackle eutrophication affecting ecosystems are taken at both national and EU level.

5.2 Efficiency

A representative **annual administrative cost** across all NECD-related Member State reporting obligations amounts to EUR 1 071 000. As only part of the costs could be split and assigned directly to the NECD, this is likely an over-estimate. The total average annual cost for EU bodies (the Commission and the EEA) is EUR 1 960 000 (based on reported data). The obligations related to yearly emission **inventories** represent the largest cost item for both Member States and the Commission. For the Commission this concerns the review of inventories. Inventories are necessary to assess compliance with ERCs and GP obligations and are the basis for Member State decisions on additional policies and measures. Good-quality inventories are therefore also key for the effectiveness of the NECD.

Administrative costs differ significantly across Member States. This is due to a wide set of variables, including governance structure and process for reporting, the extent of non-compliance, data availability, the approach to implementing certain obligations (e.g. ecosystems monitoring) and the take-up of voluntary actions. The analysis identified **opportunities for simplification** regarding improvements to the NAPCP format and PaM tool, certain aspects of emission inventories (LPS data, reporting on heavy metals and PoPs), and ecosystems monitoring (some of which would require targeted legislative changes). Further opportunities lie in improving synergies with NECPs and the GP processes.

Some of the reporting obligations for Member States **indirectly affect businesses** (where data collection is passed on to businesses), albeit **to a very limited extent,** as the NECD is only rarely the primary or sole driver for collecting information. The average administrative cost for businesses at Member State level is low at approximatively EUR 100 000 per year. The analysis did not find that the administrative burden was passed on to SMEs.

An important cost category for business are **adjustment (abatement) costs**. Abatement costs are a result of all policies that are affecting air pollution. In most cases, it is impossible to determine the main policy driver of these costs. Given the **well-established coherence and synergy across existing EU policies,** separating out the effects of different policies will remain a challenge: these policies represent an ecosystem rather than single, unconnected measures.

The evaluation estimated that the **total abatement cost associated with additional air pollution control measures linked to all policies (including the NECD) post 2015 is EUR 92 billion**. A **significant proportion** of the cost in the private sector was likely **offset through EU and national funding**.

The benefits stem from improvements in human and environmental health, which impact the economy, for example in the form of less working time lost to sickness and higher yields. The evaluation could not split benefits per policy. **Emission reductions associated with additional air pollution control measures taken up over the evaluation period linked to all policies (including the NECD) have an estimated benefit of EUR 372 billion (VOLY) or EUR 1 180 billion (VSL)**. **The resulting benefit-cost ratio is 4:1 or 13:1**. This ratio reflects the adjustment costs and benefits of all policies affecting air pollutant emissions but suggests that, for all clean air interventions, **benefits significantly outweigh costs.** This finding was also confirmed

by anecdotal evidence at Member State level. The table below provides a summary of all costs and benefits.

Table 4 – Summary of costs and benefits based on the detailed table in Annex IV

	Who is affected	Quantitative assessment
Costs		
Administrative cost	Public administrations	Member States: EUR 1.1 m/yr (reported data) European Commission: EUR 1.7 m/yr (reported data) EEA: EUR 0.23m/yr (reported data) Administrative cost is NECD-related.
Administrative cost	Business	Indirect cost: EUR 0.1 m/yr (estimate made on very limited reported data using assumptions) Administrative cost is NECD-related.
Adjustment costs	Citizens, business, administrations	Cumulative cost for 2016-2025 (modelled data): EUR 92 bn (EUR 9 200 m/yr). Includes costs of all policies affecting air pollution. Businesses are most affected (agriculture and energy-intensive/-related sectors).
Benefits		
Health	All	Cumulative benefit for 2016-2025 (modelled data): EUR 372 bn (VOLY) or EUR 1 180 bn (VSL). Includes benefits of all policies affecting air pollution.
Environmental health	All	EUR 430 m-EUR 870 m per year in 2030 to meet ERCs, over the baseline (no quantification available for the evaluation period, modelled data).
Economic	Citizens	Meeting ERCs would result in 30 000 to 39 000 additional jobs and an increase in household consumption of between 0.006% and 0.007% in 2030, over the baseline (no quantification available for the evaluation period, modelled data).
Economic	Business	Meeting ERCs would result in a GDP increase of 0.053% over the baseline. Net negative effect only for livestock sector, impact less than 0.15% net cost in 2030 (no quantification available for the evaluation period, modelled data).

5.3 EU added value

Transboundary air pollution remains a significant source of pollution in most EU Member States. **Effective air emission reduction policy therefore requires action and cooperation at global, European, regional, national and local levels**. Neither national legislation nor national jurisdiction alone can be employed effectively against pollution that has its origin in another country.

The Air Convention is the main framework for action beyond the EU and in the EU neighbourhood. It has played a key role in advancing clean air policy in a pan-European and broader hemispheric context over the past decades. However, it is less effective than action at EU level. This is because the **GP lacks the strong enforcement mechanisms available under EU law** (see also 4.1.1).

The NECD has brought **significant benefits to the EU population** as part of the wider clean air policy framework, by contributing to cleaner air in Europe and reducing the negative impacts of air pollution on human health and ecosystems. There are **still**

inequalities when it comes to exposure of the EU population to air pollution[143]. EU funding has been available to address air pollution and can help alleviate financing constraints in lower-income parts of the EU.

Healthier people also mean a healthier workforce. The benefits from reduced exposure to air pollution for both individuals and the environment (with less impressive progress in past years in reducing environmental impacts) trickle down to economic operators as well. Through reduced pollution levels, **productivity losses due to bad air quality and air-pollution-induced workdays lost are reduced**, with other benefits accruing from reduced healthcare costs.

An analysis looking into the question of whether non-EU businesses have likewise faced adjustment costs from clean air policies suggests that abatement efforts are being made by many of the EU's major trading partners. Although the extent varies across pollutants, a wide range of partners are making similar efforts to the EU, meaning **EU businesses are not disproportionately affected**.

National ERCs are set for each Member State following a staged approach while leaving a substantial margin for the Member States to decide how best to achieve the prescribed commitments. It is therefore recognised that implementation largely relies on national, regional and local measures tailored to specific needs and circumstances, which brings the **NECD in line with the principles of subsidiarity and proportionality**.

5.4 Relevance

The needs addressed by the NECD have developed further over the evaluation period. The ZPAP introduced two air pollution-related targets to be met by 2030, and the 2024 revision of the AAQD introduced more stringent air quality standards. The AAQD revision was informed by scientific evidence as summarised in the 2021 WHO air quality guidelines, which confirm that for several air pollutants adverse health impacts occur at concentration levels below what had been indicated in previous versions of the guidelines. **Therefore, there is still a very strong case for having a NECD that helps to keep national emissions in check to achieve cleaner air in all EU Member States and that addresses transboundary pollution**, **bringing a system-level view that considers the combined effect of emission sources.**

The evaluation showed that the **current ambition level of ERCs is insufficient** to address the need of reducing impacts on the environment and to ensure the EU meets the zero-pollution target for ecosystems. It also shows that while having the potential to bring air quality closer in line with revised air quality standards, compliance with the 2030+ ERCs is not sufficient for meeting air quality limit values for $PM_{2.5}$ everywhere in the EU, and by extension, even less so to ensure air quality in line with the 2021 WHO guideline levels.

The analysis showed that the **scope of the NECD remains mostly relevant in terms of pollutants covered.** Discussions are under way on potentially including **methane** under the GP as part of the ongoing revision of the Protocol. Several stakeholders argued for including methane under the NECD, also as a pollutant affecting air quality (a precursor to ozone). **Black carbon** was also frequently mentioned by stakeholders, and improved practice would allow it to be systematically reported. The evaluation

[143] EEA report 22/2018 'Unequal exposure and unequal impacts.

suggests **that excluding certain aviation and shipping emissions** from the compliance checks should be kept under review. This holds true for shipping in particular, given its growing relative contribution to ambient concentrations in port cities and near coasts and the broader, renewed attention to the source-to-sea nexus. **Excluding certain agricultural sources of NO_x and NMVOC from compliance checks appears to have lost its relevance** given our improved understanding of these emission sources and the mitigating measures in place to address them.

The evaluation also found that the **agricultural measures** set out in Part 2 of Annex III to the NECD **remain relevant**, as evidence still suggests that the listed measures are generally deemed to be effective ammonia abatement measures (while their effectiveness on the ground is dependent on actual uptake by Member States, which is particularly true for the voluntary measures). The list of measures also remains relevant in view of the UNECE guidance documents on ammonia, but some revisions may be needed in the future, as the UNECE documents are currently under revision.

5.5 Key lessons learnt

This evaluation was timed for publication midway towards achieving **compliance** with the more ambitious 2030+ ERCs. The above conclusions show that Member States are partially on track: according to the latest emission inventory data for 2023, 19 Member States met their 2020-29 ERCs. The update of the study on the cost of non-implementation of environmental law estimated that the foregone benefit of not meeting the 2020-29 ERCs ranges between EUR 2.4 billion and EUR 3.6 billion[144].

The current reporting, review and enforcement system – alongside the synergies of the clean air policy landscape – drove improvements in compliance over the evaluation period: 14 Member States were found to be non-compliant for at least one pollutant in 2020 based on the 2022 inventories. This figure dropped to 8 in 2023 based on the 2025 inventories, and this downward trend is expected to continue.

Most compliance challenges relate to reducing ammonia emissions, 94% of which stem from the agriculture sector[145]. To improve compliance and reap the associated benefits, in the period leading up to 2030 the possibilities set out below could be considered.

- Improving the availability and take-up of funding, especially for small farms, to boost the implementation of effective voluntary measures to reduce ammonia emissions. Make full use of funding and investment opportunities through the CAP, including by encouraging Member States to better target ammonia-related measures and use national data or other information available to identify key source sectors or activities. In line with the Vision for Agriculture and Food, strategic planning of agricultural spending is essential to ensure that the farming sector is future-proof and contributes effectively to clean air objectives.
- Maintaining and, where possible, strengthening the coherence between the NECD and the instruments addressing ammonia emissions in agriculture, including the CAP, the IED and the Nitrates Directive. As this evaluation found an overall coherent legal framework at EU level, the Member States have an important role to play to ensure that EU provisions on nitrogen management are implemented coherently at national level. The EU could provide support

[144] DG Environment, EMRC, Logika Group and RPA Europe (2025), Update of the costs of not implementing EU environmental law.

[145] EEA data viewer 2025.

through facilitating peer-to-peer exchanges between Member States, because some countries have made more progress in applying integrated approaches. The results of the upcoming evaluation of the Nitrates Directive could provide further indications. The Water Resilience Strategy and the European Ocean Pact also stress the need to limit nutrient pollution of aquatic and marine ecosystems.
- Supporting and ensuring full implementation of the relevant BAT conclusions for pig and poultry farms under the IED and, as from 2030, ensuring full implementation of uniform conditions for operating rules under the revised IED.
- Providing continued support to Member States, including at their request, such as through the TAIEX EIR Peer-2-Peer tool and through relevant funding programmes.

Almost all Member States must take further action on almost all pollutants to meet the more stringent 2030+ ERCs, with SO_2 representing the lowest risk of non-compliance. Some avenues to explore to support convergence with ERCs are:

- taking into account the need to reduce $PM_{2.5}$ emissions from domestic fuel burning under ecodesign and energy labelling rules for solid fuel boilers;
- continuing to accelerate changes to renewable and low-pollution heating solutions via synergies with the NECPs ($PM_{2.5}$);
- ensuring sound implementation of sustainable mobility legislation and policy (NOx).

Although the EU is on track to meet the zero-pollution target of reducing premature deaths due to $PM_{2.5}$ exposure, the current ambition level of the ERCs may be considered to be insufficient for meeting the ZPAP target of reducing threats to biodiversity. Compliance with the 2030+ ERCs is not sufficient for meeting air quality limit values for $PM_{2.5}$ everywhere in the EU, and even less so to ensure air quality in line with the 2021 WHO guideline levels. These insights, coupled with our improved understanding of certain pollutants and their effect on human health, should be taken into account in the **discussions on the ongoing revision of the Air Convention's Gothenburg Protocol**, in relation to issues such as including methane under the Protocol.

Some of the **simplification opportunities** can be addressed without amending the NECD. These include clarifying the NAPCP guidance, including related to the contents of programme updates; developing a more user-friendly interface for reporting PaMs; and amending to the guidance on ecosystem monitoring. The evaluation recommends initiating action or starting analysis in the short term, as appropriate.

However, changing the frequency of reporting (e.g. to better synchronise the NAPCPs with the NECP timelines, and to build synergies with relevant upcoming plans, such as under the NRR) would require amending the NECD, and the consequences of some simplification opportunities require further assessment (e.g. aligning the NECD's ecosystem monitoring with the Air Convention's international cooperative programmes). These issues can be addressed in the long term.

Some simplification opportunities would lead to incoherence with the Air Convention (e.g. removing the reporting of LPS data, heavy metals and PoPs). The evaluation does not therefore recommend taking this route, unless these reporting requirements are removed under the Air Convention.

One of the key limitations of this evaluation was the difficulty of isolating the effects of the NECD to other EU policies. To address this limitation for future evaluations, the

way Member States currently report on links to other EU policies in the PaM tool would need to be improved, while minimising any additional administrative burden. One possible avenue would be to rely on the logic of the Rio markers, and set a weighting on the basis of whether a policy is significantly or principally linked to the NECD.

Annex I PROCEDURAL INFORMATION

1 Lead Directorate-General, Decide references

The evaluation of the National Emission reduction Commitments Directive is led by the Directorate-General for Environment. It was included as item PLAN/2023/2072 in Decide.

2 Organisation and timing

An interservice group (ISG) to steer the evaluation was set up with representatives from the following Directorates-General: Agriculture and Rural Development (AGRI), Budget (BUDG), Climate Action (CLIMA), Communications Networks, Content and Technology (CNECT), Communication (COMM), Competition Policy (COMP), Defence Industry and Space (DEFIS), Economic and Financial Affairs (ECFIN), the European External Action Service (EEAS), Employment, Social Affairs and Inclusion (EMPL), Energy (ENER), the statistical office of the EU (ESTAT), Internal Market, Industry, Entrepreneurship and SMEs (GROW), the Joint Research Centre (JRC), Justice and Consumers (JUST), Maritime Affairs and Fisheries (MARE), Mobility and Transport (MOVE), European Neighbourhood Policy and Enlargement Negotiations (NEAR), Regional and Urban Policy (REGIO), Research and Innovation (RTD), Health and Food Safety (SANTE), the Secretariat-General (SG), the Legal Service (SJ), Taxation and Customs Union (TAXUD) and Trade (TRADE).

Timeline

Date	Who	Description
15 Nov 2023	(COM)	ISG for NECD evaluation established
15 Dec 2023	(COM)	**1st ISG meeting -** exchange of views on • draft intervention logic and evaluation questions; • draft call for evidence; • draft consultation strategy; • draft terms of reference for a support study.
30 Jan 2024	(COM)	**Launch of the service request** to the contractors under Framework Contract ENV.01/FRA/2023/0006 (Ares(2024)685770) (with a deadline for submitting proposals by 20 February 2024)
15 Feb 2024	(EXT)	**Publication of the call for evidence** on the Better Regulation Portal (public feedback closed on 14 March 2024)
17 Apr 2024	(COM)	**Signature of the contractor for the support study** with the consortium led by RPA Europe
27 Jun 2024	(MS)	**Meeting of the Ambient Air Quality Expert Group** dedicated to the NECD, with a session on the evaluation
4 Jul 2024	(COM)	**2nd ISG meeting** – exchange of views on • draft evaluation matrix • draft questionnaire for the open public and targeted consultations

3 Sep 2024	(COM)	Launch of the online **open public consultation and targeted consultation** (end of contribution period for both: 26 November; duration: 12 weeks)
26 Sep 2024	(MS)	**Meeting of the Ambient Air Quality Expert Group – sub-group on ecosystems monitoring.** This meeting focussed on the review of the 2023 monitoring exercise and feedback from Member States on the exercise.
14 Oct 2024	(COM)	**Stakeholder workshop**
13 Jan 2025	(COM)	**Upstream meeting with the Regulatory Scrutiny Board.** This meeting focussed on the Board's suggestions for overcoming complexities in disentangling the effects, costs and benefits of several EU policies contributing to the same objective and on overcoming data gaps.
15 Jan 2025	(MS)	**Meeting of the Ambient Air Quality Expert Group on the implementation of the NEC Directive.** Related to the evaluation, the meeting focused on presenting the initial results of tasks under the supporting study, including on the stakeholder consultation, and discussed data gaps concerning information held by Member States.
23 Jan 2025	(COM)	**3rd ISG meeting –** information and exchange of views on: • initial results from the stakeholder consultation; • comments by ISG members on the interim report of the supporting study; • debrief on the upstream meeting with the Regulatory Scrutiny Board.
30 Apr 2025	(COM)	**Written consultation with ISG members on the draft final report of the support study.** Services had three weeks to provide comments.
15 May 2025	(COM)	**4th (final) ISG meeting – discussing the draft staff working document (SWD)** ISG members had two weeks to provide comments on the draft SWD. Departments could raise issues related both to the SWD and the draft final report of the support study.
16 July 2025	(COM)	**Regulatory Scrutiny Board meeting**
18 July 2025	(COM)	**Opinion of the Regulatory Scrutiny Board**
2 Oct 2025	(COM)	Launch of the **interservice consultation** on the staff working document

Legend
(COM) Interservice group or Regulatory Scrutiny Board
(MS) Member State input via the Ambient Air Quality Expert Group
(EXT) (External) stakeholder input (including stakeholder consultation)

Derogations granted and justification:

No derogations were made during this evaluation.

3 Consultation of the Regulatory Scrutiny Board

An upstream meeting with the Regulatory Scrutiny Board (RSB) took place on 13 January 2025.

The draft staff working document was discussed on 16 July 2025. RSB issued a positive opinion with reservations on 18 July 2025.

The following key issues were raised.

(1) The report does not sufficiently acknowledge the limitation of not being able to disentangle the effects of the evaluated Directive from those of related policies. This is notably the issue when presenting the costs and benefits, the EU added value analysis as well as in the conclusions.
(2) The report does not systematically distinguish between observed/reported data and estimates when analysing impacts, costs and benefits, and broader outcomes.
(3) Regarding the costs, it is not sufficiently clear what the adjustment costs for business are, what the basis for the estimates is, and what the impact of EU and national funding is.
(4) The overall conclusions need to better reflect the limitations in the analysis. Lessons learned need to better reflect improving observational data availability and underlying causes related to challenges with ammonia.

The table below lists the aspects to improve and how these were reflected in the text.

RSB comment – what to improve	*Reflection in text*
(1) The report acknowledges that it is not possible to separate the effects of the Directive from those of related policies but does not apply this systematically, in particular when it comes to the cost benefit analysis and reporting benefit-cost ratio. In addition, the report should better explain the analytical approach linking measures on pollution and health impacts. The application of the VOLY and VSL approaches should be better explained. The report should clearly explain how other factors such as changing patterns of production are taken into account in the analysis.	Where applicable, we have systematically included in the text (main text and annexes) the caveat that the effects of the NECD could not be isolated from the effect of other related policies. We emphasised this particularly in Section 4.1.4.7, discussing the benefit-cost ratio, by adding a new introductory paragraph. We inserted a new Table 4 in the main text, which summarises cost and benefit information, specifying if these cover all policies or where these are specifically NECD-related, and specifying what data sources were used (reported or modelled/estimated information). In Section 4.1.4.6 (Summary of benefits), we added further information on the analytical approach to health impacts. We have also added a more detailed explanation on how health benefits were estimated in Section 2.2 of Annex II. Changes in the patterns of production are reflected in the emission inventories and therefore embedded in the data underpinning much of our analysis. We have added text in Chapter 3 to explain that emissions are estimated by multiplying activity data with emission factors, and as such reflect both changes in the activity level of certain economic activities (e.g. shifts from more to less polluting activities), and changes in the way a given economic activity is conducted (through e.g. application of abatement technologies).

(2) The report needs to better explain the relevance and EU added value of the Directive, considering its role as a monitoring and measurement framework and as enforcement mechanism for the specific legislation on the air pollutants in scope.	We have added information to Section 4.3 (Is the intervention still relevant?) to highlight aspects that assign a unique role to the NECD within the clean air policy landscape. We have highlighted the added value of reporting in Section 4.1.3 (Effectiveness of reporting). We elaborated on the role and value of enforcement within the NECD in Section 4.1.1 (An effective and coherent policy framework) and added a short description of enforcement processes in Annex VI (Overview of the NECD).
(3) It should be clear throughout the report when calculations and resulting findings are based on reported data and when on estimates. The underlying modelling used needs to be better explained notably how the accuracy of inputs based on estimates, such as costs for businesses, is ensured.	We added throughout the text (main text and annexes) systematic references to whether the data points cited in the analysis are reported or modelled data. We highlighted the main limitations better in Section 1.3.3 (Methodology, robustness and limitations). We added more information in Annex II to explain the sources of data used in the modelling, which influence the accuracy of inputs and outputs.
(4) The main report should systematically be clear on which claims relates to events and developments during the period evaluated, and where it instead relies on projections regarding possible future developments. The use of modelling and projections of future events and developments should be clearly explained and strictly limited only where reported data are not available; and in case they are employed at all, the main report should clearly state what assumptions they are based on, the reliability of these assumptions, and how sensitive the outcome of the analysis would be to alterations of the assumptions.	We systematically added indications on whether the data used rely on projections or modelling. A new table (Table 4) in the main text summarises costs and benefits, specifying the source of data. The use of modelling and projections is used for evaluation purposes only where reported data are not available (this is to fill the gap between reported data – data reported in 2025 for 2023 emissions – and the end of the evaluation period, 2025). We supplemented Annex II with new information on the assumptions and the reliability of the model, as well as on the sensitivity analysis performed in the context of validating GAINS modelling results. The fact that we present the benefit-cost ratio using alternative approaches (VOLY and VSL) shows that the conclusion that clean air policies produce benefits that outweigh costs is not sensitive to how health benefits are estimated. Section 3.4.3 of Annex III, 3.4.3 also spells out an alternative approach of estimating damage from air pollution, to test the sensitivity of the results, based on Member States' inventories rather than GAINS modelling. The estimates of the two approaches are comparable.
(5) For costs, the report needs to be clearer about what assumptions are made and present the figures with the necessary caveats. To the extent possible, the estimates should be corroborated by evidence derived from available observational data. In terms of offsetting the compliance costs, the report should better explain the role of Member States and EU financing, in particular regarding the Recovery and Resilience Facility.	We have strengthened the caveats and indications on the nature of the data used to assess costs in the main text and in Annex II. We added further information on the Recovery and Resilience Facility (4.1.4.4). We explained the limitations of comparing adjustment cost information with funding data (also 4.1.4.4). We have also added a further explanation on the coherence between the Recovery and Resilience Facility and the NECD in Sections 4.4.1 and 4.4.2 of Annex III.
(6) The main report should assess why some Member States have considered it more	We have added an assessment of deviations from the linear trajectory and information on the few

politically, technically and/or economically feasible to rely on some other reduction trajectory than the linear reduction assumption.	cases where Member States provided explanations on the reasons for deviating in Section 4.1.2.
(7) Given the shortcomings in reaching targets linked to ammonia emissions, the evaluation should discuss in more detail the root causes of this. It should also analyse more in detail and draw lessons learned regarding the coherence with the Nitrates Directive and CAP and why the compound effect of the policies did not result in delivery on the targets.	We integrated more information in the main text on coherence with the Nitrates Directive and the CAP (4.1.1). We added a discussion of the root causes of specific challenges in the agricultural sector that hamper the achievement of ammonia targets (4.1.2).
(8) Given the difficulties in disentangling the effects of the Directive, the conclusions should systematically be phrased in such a way as to reflect this important limitation. The lessons learned should also reflect the observational data needs for future evaluation.	We have introduced wording in the conclusion to make it systematically clear where conclusions cannot isolate the effects of the NECD. We have included a new final paragraph in Section 5.5 (lessons learnt) on the use of markers for improving the disentangling of the effect of the NECD in the future.

4 Evidence, sources and quality

The evaluation drew on reporting by Member States (emission inventories, projections, NAPCPs, PaMs and ecosystem monitoring) and the Commission reviews of these documents[146]. **Reviewed information is of high quality** and ensures that data reporting is in line with the well-established methods used for the Air Convention (EMEP-EEA guidebook).

The same information forms the basis of further **EEA analysis**, resulting in high-quality overviews at EU level through the yearly NECD briefings, emissions data viewer and PaMs dashboard. This analysis was also used during the evaluation.

The 2013 NECD impact assessment[147] (modelled data) was used to identify points of comparison and to explain the intervention logic.

The Commission publishes **Clean Air Outlook reports** (CAOs)[148] every two years, analysing the prospects for reducing air pollution in the EU by 2030 and beyond. They are based on modelling work and assess (i) the extent to which the emission reduction obligations of the NECD would be met under various policy scenarios; and (ii) the implications of emission reductions in terms of air quality, health, ecosystem impacts and their costs and benefits to society. CAOs also present results informing related policy areas, such as work under the ZPAP and its outlook, interactions between climate and energy policies and clean air, etc. The evaluation relied on the CAOs and underpinning modelling, especially to understand adjustment costs and benefits of clean air policy over the evaluation period, e.g. where no reported data were available or where reported data were too limited to draw conclusions. The models **are well established** (see detailed description

[146] All reports and review results are available via the webpages of the NECD.
[147] Impact assessment accompanying the proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC (and three other documents), SWD(2013) 531 final.
[148] All reports are available via the CAO webpages.

of the GAINS model in Annex II) and were also used to prepare the proposal for the NECD and related analysis.

The Commission commissioned a **study to support elements of the evaluation**. The study focused on conducting and analysing stakeholder consultations, analysing costs and benefits (efficiency), analysing the agricultural measures laid down in Part 2 of Annex III to the NECD (coherence and relevance), and analysing the relevance of the scope of the NECD in relation to certain emission sources not counted towards ERC compliance. The limitations identified in this study are described in Annex II.

In addition, the Commission commissioned a **series of studies** over the evaluation period, on specific aspects related to the implementation of the NECD, including the following studies:

- Increasing policy coherence between bioenergy and clean air policies and measures (2022);
- Analysis of and recommendations for the inventory reporting requirements under Directive (EU) 2016/2284 not linked to emission reduction commitments (2023);
- Comparison between the Directive (EU) 2016/2284 and the amended Gothenburg Protocol under the UNECE Air Convention (2023).

The analysis also relied on **evaluations and impact assessments** of relevant EU policies on effectiveness. Most of those documents were reviewed by the RSB. It is important to note that approaches to assessing the effectiveness of policies differ across those assessments, making it difficult to compare information and draw quantified conclusions, as described in the relevant sections of this SWD.

Data gaps were filled through **stakeholder consultation, including a stakeholder workshop**. Participation in the open public consultation (53 replies) and targeted stakeholder consultation (42 replies) was relatively low. The results must therefore be interpreted with caution, as they are not representative and do not allow for general conclusions to be drawn. Importantly, respondents did not provide quantified information on the costs of implementing the NECD. To fill this gap, targeted engagement with competent authorities and businesses was put in place, complemented by interviews. The response to the targeted engagement with competent authorities was good (14 Member States covered), but limited with businesses (9 responses).

Annex II METHODOLOGY AND ANALYTICAL MODELS USED

1 Overview

This Annex describes the analytical methods and the data and information sources used in the evaluation. It also identifies what evidence gathering and analysis has been completed and by whom, the limitations and caveats in the modelling approaches and evidence base, and the mitigating measures taken to overcome them.

The evaluation was guided by an initial Call for Evidence that outlined the context, purpose and scope of the evaluation, looking in particular at the five evaluation criteria outlined in the Better Regulation agenda. This translated into 18 overarching evaluation questions, covering the criteria of relevance, effectiveness, coherence and EU added value. Following the Call for Evidence, the list of evaluation questions was reviewed and expanded to 21 questions based on an elaborated theory of change and presented alongside indicators and points of comparison in a detailed evaluation matrix.

The evaluation was underpinned by a study undertaken by a consortium led by Logika Group[149]. The support study did not cover all activities and evidence gathering under the evaluation, but instead delivered tasks targeted at areas of the evaluation where the Commission has prioritised the need for support. The specific objectives of this contract were to:

- carry out a public consultation and a targeted consultation, and other forms of evidence gathering (including targeted interviews and stakeholder meetings);
- analyse and synthesise the data gathered from the stakeholder consultation with a view to answering the evaluation questions;
- review the scope and relevance of the NECD regarding emissions from specific sectors, i.e. agriculture, international maritime traffic and aviation;
- assess the state of implementation of the emission reduction measures set out in Part 2 of Annex III to the Directive in each Member State and their relevance in view of technical progress and any update of guidance material and assess overall coherence of the NECD with EU agricultural policy;
- contribute to the analysis of the costs of implementation of the NECD, with a particular focus on the assessment of administrative cost and administrative burden, and to summarise the overall costs and benefits;
- identify possible unnecessary costs and options for simplification;
- draft analytical support documents to inform the evaluation throughout the duration of the exercise.

The final set of evaluation questions is set out in **Error! Reference source not found.** with a mapping to the tasks of the support study. For evaluation questions not falling under the scope of the support study, evidence was collated and analysed separately by the

[149] Logika Group, RPA Europe, Aether, IIASA, EMRC & the University of Hertfordshire (2025), Final report on supporting the evaluation of Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NECD) and its appendices.

European Commission, with the exception of stakeholder engagement activities, which all fell under the scope of the support study.

The analytical approach used to evaluate the NECD was based on the analysis of consultation findings, a triangulation of stakeholder views, literature review and data collection, and qualification and quantification of costs and benefits estimates.

Table 5 – Evaluation questions and mapping of tasks to support study (ticks mark where tasks contribute to the evidence base supporting difference evaluation questions)

Evaluation Criteria	Evaluation Question	Support study task			
		Assessment of costs and benefits	**Coherence and relevance with respect to agriculture policy and developments**	**Relevance regarding emissions from specific sectors**	**Stakeholder engagement**
Effectiveness	1) To what extent has the NECD been successful in reducing emissions of the 5 pollutants for which it establishes national emission reduction commitments, to move towards achieving levels of air quality that do not give rise to significant impacts on and risks to human health and the environment?				✓
	2) To what extent have the following requirements of the NECD been instrumental in reaching the Directive's objectives: a) the NAPCP, its template, the related requirements for transboundary consultations and consideration of the agricultural measures of Annex III, Part 2? b) inventories and projections reporting? c) ecosystem monitoring?		✓	✓	✓
	3) To what extent have the flexibilities established by the NECD in Article 5(1) to (4) hindered or facilitated emission reductions?				✓
	4) To what extent has the use of Gothenburg Protocol related documents (guidelines, templates etc.), as stipulated in the NECD, contributed to the effective implementation of the NECD?		✓		✓
	5) To what extent have other EU policies or external factors affected emissions of the 5 pollutants?		✓		✓
Efficiency	6) What are the costs for implementing the NECD? a) administrative costs of Member State reporting obligations, b) abatement costs,	✓			✓

Evaluation Criteria	Evaluation Question	Support study task			
		Assessment of costs and benefits	**Coherence and relevance with respect to agriculture policy and developments**	**Relevance regarding emissions from specific sectors**	**Stakeholder engagement**
	c) administrative costs and adjustment costs for businesses.				
	7) What are the benefits of the implementation of the NECD (and reversely the costs of not implementing it) and do they outweigh the costs of implementation?	✓			✓
	8) Have inefficiencies been identified, including in the handling and use of reported information? Is there potential for simplification and reduction of administrative costs?	✓			✓
	9) Have other policies or factors affected the costs of compliance?	✓	✓		✓
Coherence	10) Internal coherence: Are the requirements under the NECD coherent with each other, e.g. reporting requirements including their timing?				✓
	11) Is the NECD coherent with the current and revised Ambient Air Quality Directives?			✓	✓
	12) Coherence with other sectoral legislation and wider EU policies: Has the NECD proved coherent with: a) source legislation; b) climate and energy policies; c) Common Agricultural Policy, in particular on ammonia (Article 13(2)(d) in relation to Annex III to the NECD); d) biodiversity-related provisions; e) other EU policies, such as innovation.		✓		✓
	13) To what extent has EU funding contributed to the efficient implementation of the NECD?		✓		✓
	14) Coherence with the international framework: Have the NECD and the Gothenburg Protocol proved to be sufficiently coherent?			✓	✓
	15) To what extent has the non-inclusion of methane in the NECD hampered reduction of methane emissions (from agriculture, waste, energy) at EU and international level?				✓

Evaluation Criteria	Evaluation Question	Support study task			
		Assessment of costs and benefits	**Coherence and relevance with respect to agriculture policy and developments**	**Relevance regarding emissions from specific sectors**	**Stakeholder engagement**
	16) Has coherence changed over time?				✓
Relevance	17) Has the relevance of the objectives of the NECD and of the means of achieving them changed over the past years, in particular in light of developments in: a) related policy fields (e.g. European Green Deal, Union climate and energy policies) b) technical and scientific progress, including with regard to UNECE guidance related to ammonia and BAT under the Industrial Emissions Directive?		✓		✓
	18) How have the needs to which the NECD was meant to address and identified in the Intervention Logic evolved and how would they evolve in the future? Would the current objectives of the NECD still address them?				✓
	19) Does the scope of the NECD remain pertinent: a) In terms of pollutants covered and not covered by emission reduction commitments)? b) In terms of pollutants and type of data covered by reporting obligations, but for which no reduction commitment has been established? c) In terms of sources of emissions accounted for, for complying with the emission reduction commitments? d) In terms of ecosystem impacts covered? e) In terms of the list of emission reduction measures quoted in Annex III on agricultural measures, including the split between mandatory and optional measures?		✓	✓	✓
EU added value	20) To what extent is the initial subsidiarity analysis still valid?				✓
	21) Do needs and objectives addressed by the NECD continue to require action at EU level?				✓

In this evaluation, the following **types of costs and benefits** have been distinguished, following the guidelines as set out in the Better Regulation Toolbox:

'*Administrative burdens'* are defined as '*specific types of compliance costs incurred by enterprises, public authorities, and citizens in meeting administrative obligations. This captures a broad range of administrative activities including labelling, reporting, registration, provision of data, as well as monitoring and assessments needed to generate the information*'[150]. The analysis in this study has followed the Standard Cost Model (SCM) guidance under the Better Regulation Toolkit to assess the administrative burden associated with compliance with the NECD. The analysis captures all costs associated with reporting under the NECD, covering 'information requirements' imposed on businesses, Member States and the European Commission itself.

Adjustment or abatement costs are defined in the Better Regulation Guidelines as investments and expenses that businesses, citizens, or public authorities have to bear in order to adjust their activity to the requirements contained in a legal rule. The NECD sets national emission reduction commitments (ERCs) for five main air pollutants. Member States must decide how to meet their ERC for each pollutant through the deployment of policies and measures to abate air pollutant emissions. These actions will carry associated costs (or 'abatement costs') in the form of upfront investment costs associated with putting the measure in place, and ongoing costs to keep the measure operational over its lifetime.

The *benefits* achieved under the NECD are primarily driven by the ERCs set for the five pollutants which each Member State must meet. These ERCs aim to deliver reduction in the emission of harmful air pollutants, which in turn should deliver reduction in exposure to these pollutants, delivering improvements in human and environmental health. Abatement measures taken to meet ERCs may also deliver wider benefits, for example in terms of energy or raw material savings, and reductions in greenhouse gas (GHG) emissions. There may also be further benefits as these primary benefits (and also the costs) cascade through wider supply chains and the economy.

Cost of non-implementation considers the costs and foregone benefits of the lack of implementation of EU environmental law. The 'implementation gap' is defined as the difference between actual environmental status and the respective environmental target(s). In this case, the analysis compares the 2022 air pollutant inventory emissions (as per inventories reported in 2024, the latest reviewed inventory data available at the time of drafting) to Member State ERCs for 2020-29 and 2030+.

Impact on competition considers whether intervention in markets to regulate the behaviour of businesses may in some cases restrict competition further than is necessary to achieve the desired policy objectives. Competitive markets encourage enterprises to be efficient and innovative, thereby creating more choice for consumers, reducing prices, and improving the quality of goods and services. *Impacts on SMEs* considers the potential effects for small and medium sized businesses specifically, given minimising burdens on SMEs is particularly important, because the costs of regulation often affect SMEs proportionately more than large companies, while the benefits of regulation tend to be more evenly distributed among companies of different sizes. Meeting the ERCs will place costs on a range of economic actors. As such, the NECD has the potential to have impacts on competitiveness and SMEs. To shed light on impacts on competitiveness, this evaluation

[150] Tool 58 of the Better Regulation Toolbox.

investigated whether non-EU businesses also face adjustment costs related to air pollution by considering whether the EU's principal trading partners have introduced similar clean air legislation and have achieved comparable abatement of air pollutant emissions.

2 Modelling approaches

2.1 Introduction of the modelling framework

The evaluation draws on several key supporting studies, specifically the IA supporting the adoption of the NECD and the **Clean Air Outlook** (CAO) reports[151]. These studies have undertaken forward-looking analysis of the prospects for reducing air pollution in the EU by 2030 and beyond, assessing the implications of emission reductions in terms of air quality, health, ecosystem impacts and their costs and benefits to society. These reports are broadly based on the same (but updated) methodological approach, deploying the GAINS integrated modelling system to assess emissions under different scenarios of emission control deployment, with each edition reflecting latest developments in relevant policies at EU and Member State level. The GAINS outputs are then used in linked models to assess the health (Alpha-RiskPoll model) and macroeconomic (JRC-GEM-E3 model) effects associated with the scenarios.

The **GAINS (Greenhouse Gas-Air Pollution Interactions and Synergies) model** explores cost-effective multi-pollutant emission control strategies that meet environmental objectives on air quality impacts (on human health and ecosystems) and greenhouse gases[152]. GAINS, developed and maintained by the International Institute for Applied Systems Analysis (IIASA), brings together data on economic development, the structure, control potential and costs of emission sources, the formation and dispersion of pollutants in the atmosphere, and an assessment of environmental impacts of pollution. The model is available online alongside a more detailed summary[153]. A schematic overview of the flow of information in GAINS is shown in the figure below.

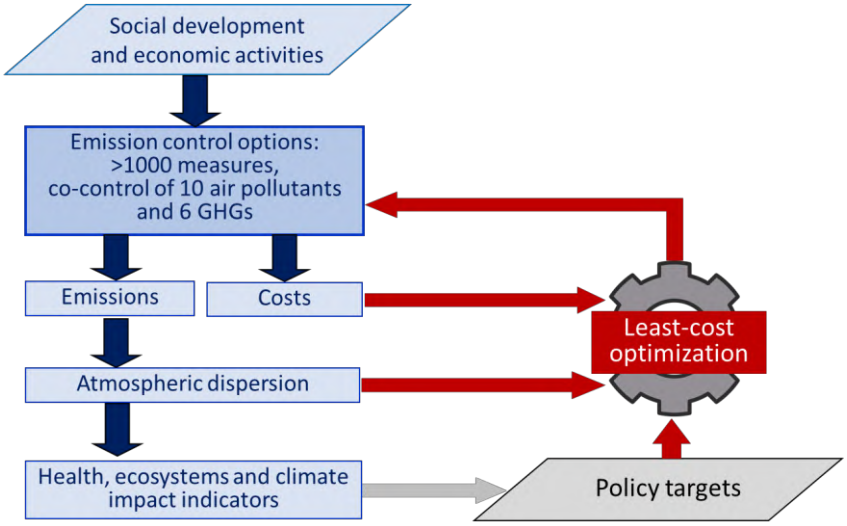

Figure 5 – Schematic overview of the GAINS model

GAINS has been used to address air pollution impacts on human health from fine particulate matter and ground-level ozone, vegetation damage caused by ground-level

[151] https://environment.ec.europa.eu/topics/air/clean-air-outlook_en

[152] M. Amann et al. (December 2011), "Cost-effective control of air quality and greenhouse gases in Europe: Modeling and policy applications," Environ. Model. Softw., vol. 26, no. 12, pp. 1489–1501, doi: 10.1016/j.envsoft.2011.07.012.

[153] IIASA (2025), The GAINS framework.

ozone, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition to soils, in addition to the mitigation of greenhouse gas emissions. GAINS describes the interrelations between these multiple effects and the pollutants (SO_2, NO_x, PM, NMVOC, NH_3, CO_2, CH_4, N_2O, F-gases) that contribute to these effects at the regional scale; for PM (particulate matter), representing primary PM, the model distinguishes explicitly various size fractions (PM_1, $PM_{2.5}$, PM_{10}, TSP), carbonaceous PM, i.e. black carbon and organic carbon[154], as well as mercury (Hg)[155]. To estimate where air pollutant emissions occur, the model relies, inter alia, on up-to-date data on population distribution, road networks, plant locations, open biomass burning, etc. The figure below illustrates the multi-pollutant and multi-effect framework showing how specific pollutants and GHGs link/contribute to various environmental impacts.

GAINS explores, for each of the source regions considered in the model, the cost-effectiveness of more than 1,000 measures to control emissions to the atmosphere. It computes the atmospheric dispersion of pollutants and analyses the costs and environmental impacts of pollution control strategies. In its optimisation mode, GAINS identifies the least-cost balance of emission control measures across pollutants, economic sectors and countries that meet user-specified air quality and ecosystem targets.

	PM* (BC, OC)	SO_2	NO_x	VOC	NH_3	CO	CO_2	CH_4	N_2O	HFCs PFCs SF_6
Health impacts: PM (Loss in life expectancy)	√	√	√	√	√					
O_3 (Premature mortality)			√	√		√		√		
Vegetation damage: O_3			√	√		√		√		
Acidification		√	√		√					
Eutrophication			√		√					
Climate impacts: Long-term							+	+	+	+
Near-term forcing	+/-	-	+/-	+	-	+				

* Includes $PM_{2.5}$, PM_{10} as well as PM_1, TSP, and Hg

Figure 6 – The GAINS multi-pollutant, multi-effect framework. Note: the '+' and '-' indicate warming and cooling impacts, respectively.

Activity projections used in Clean Air Outlook related work originate for the EU from the consistent energy and agriculture modelling framework, i.e. PRIMES model for energy and CAPRI model or agriculture. For each of the source regions considered in GAINS, **emission estimates** for a particular emission control scenario consider (i) the detailed sectorial structure of the emission sources that emerges from the downscaling of the activity projection described above, (ii) their technical features (e.g. fuel quality, plant types, etc.) that make it possible to derive the uncontrolled emission factor, and (iii) applied emission controls (GAINS includes a database of over 1 000 technical measures). GAINS estimates future emissions by varying the activity levels along exogenous projections of

[154] Z. Klimont et al. (July 2017), "Global anthropogenic emissions of particulate matter including black carbon," Atmospheric Chem. Phys., vol. 17, no. 14, pp. 8681–8723, https://doi.org/10.5194/acp-17-8681-2017.

[155] F. M. Brocza, P. Rafaj, R. Sander, F. Wagner, and J. M. Jones (June 2024), "Global scenarios of anthropogenic mercury emissions," Atmospheric Chem. Phys., vol. 24, no. 12, pp. 7385–7404, https://doi.org/10.5194/acp-24-7385-2024.

anthropogenic driving forces and by adjusting the implementation rates of emission control measures. The GAINS model holds relevant databases for all European countries, which employ international energy and agricultural statistics and appropriate emission factors.

The GAINS model, while a modelling tool, is validated against reported data and information. It is informed by data from national and international statistics and reports on levels of economic activity in the sectors covered, on the types of and the degrees at which emission control measures are applied (as represented by source-specific emission factors). Additionally, IIASA validates the model outcomes (atmospheric concentrations of $PM_{2.5}$) against monitoring data. IIASA, as the owner of the GAINS model and in their role as the Commission contractors supporting the development of Clean Air Outlook reports, has conducted detailed consultations with Member States (half-day meetings per Member State followed with bilateral exchange between national and IIASA sectoral experts) to consult assumptions on national policies and data.

The **cost-effectiveness analyses** are conducted with the GAINS optimization algorithm, which identifies cost-effective portfolios of emission reduction technologies that reduce ambient $PM_{2.5}$ concentrations to a desired level[156]. It balances emission control measures across pollutants, economic sectors and contributing emission source regions in such a way that user-defined target levels on the various environmental impacts are met at least cost. The GAINS model estimates costs of emission reduction technologies for all distinguished sources considering both capital expenditures (e.g. in new equipment, add-on measures) and operational expenditure (material, energy and labour costs for operating pollution control equipment) and related cost savings (e.g. from selling by-products, energy efficiency gains, avoided costs of waste disposal). For each of the emission control options included in the model, GAINS calculates their costs of local application considering annualised investments, fixed and variable operating costs, and how they depend on technology, country[157] and activity type. The starting point of any cost-effectiveness analysis are data gathered on the level of uptake of specific technologies and country-specific cost parameters. At each update of the model, a reality check is performed (including discussions with Member States) to check whether the model follows real-world developments sufficiently closely to draw reliable conclusions. Thorough checks are performed with Member States and industry experts. Although not deployed under the support study, the evaluation draws on **assessment and monetisation of health impacts generated using the ALPHA-RiskPoll (ARP) model**. This model was developed by EMRC specifically for air policy scenarios assessment. The model is privately owned, though all technical details are public[158]. The model has been used for several air policy analysis, by the European Commission, the EEA, the OECD, while specific national versions of the model are used in France and Sweden. The model is structured around a logical and sequential impact pathway, going from pollution exposure to health benefits assessment. It can be applied at any scale for which exposure (population x concentration) data are available. The main external inputs to the model are therefore pollution

156 F. Wagner, C. Heyes, Z. Klimont, and W. Schoepp (February 2013), "The GAINS optimization module: Identifying cost-effective measures for improving air quality and short-term climate forcing" IIASA, Laxenburg, Austria, Interim Report IR-13-001.

157 Country-specific parameters considered in the cost calculation include labour costs, energy prices, size distributions of plants, plant utilisation, fuel quality, animal fodder prices, paper collection rates, composting rates, the state of technological development, and the extent to which emission control measures are already applied.

158 Details were first published in: Holland, M. Pye, S., Jones, G., Hunt, A. and Markandya, A. (2013b) EC4MACS Modelling Methodology: The ALPHA Benefit Assessment Model. Subsequent updates are detailed in the underpinning consultant reports to the Clean Air Outlook series.

concentration data, derived either from monitoring or from other models, such as GAINS. The model uses response functions for health impact that follow the recommendations of the HRAPIE study carried out by WHO-Europe on behalf of the European Commission. The model has been updated recently to take into account most recent advancements, including the EMAPEC study results[159]. Background data on incidence and prevalence of healthy conditions come from WHO sources. The model assesses health impacts through mortality (premature deaths) and morbidity effects (such as hospital admissions, incidence of bronchitis, lost workdays). The model has been extensively reviewed and debated since its development and it has been used extensively to provide benefits assessment of air policies, alongside the cost-effectiveness analysis of the GAINS model.

Although not deployed under the support study, the evaluation draws on analysis of **macroeconomic effects using the JRC-GEM-E3 model** deployed under other studies. GEM-E3 is an applied general equilibrium model that covers the interactions between the economy, the energy system and the environment. It represents the whole economy and the interactions between key actors: firms, households and governments in the EU and in the rest of the world.

2.2 Application of modelling framework for the evaluation

The **IA and CAO series presented forward-looking assessments** of health and environmental benefits and abatement costs under various emission reduction scenarios. However, there is also a back-casting element as GAINS yields outputs for historic years (such as 2005, the base year of the NECD, and 2015, that is closest to the start of the evaluation period in 2016). As such, outputs from GAINS and the linked models are useful to inform the development over the evaluation period.

In 2013, the Commission published an **Impact Assessment** (IA) alongside the proposal for the NECD. The IA presented an analysis of the costs and benefits of a range of options against a baseline. Under the baseline of 'no additional EU action', no new EU policies were envisaged. More specifically, the baseline was based on the assumptions set out in the following table.

Table 6 – NECD IA baseline assumptions (see Table 7 of the IA)

Regulatory area	Assumption
AAQ Directives	No change. Existing limit values, attainment dates, and other provisions, are maintained. Enforcement continues and is extended where appropriate.
NECD for 2020 - Directive 2001/81/EC	Reduction commitments for 2020 only in line with the 2012 amendment of the GP (met on the baseline trajectory).
EU source controls	No new EU source control measures other than relying on emission reductions yielded by current legislation, including resolution of the 'real world emissions' issue (relating to vehicle emissions) not later than 2017.
Member State source controls	All Member State actions required to reach compliance with AAQ Directives and NECD (Directive 2001/81/EC) continue as guided also by ongoing Time Extension Notification (TEN) conditions[160] and/or EU enforcement actions.
EU support measures	No new supporting measures other than ongoing revisions of TENs, targeted workshops supporting that process and availability of existing EU funds.

With respect to ERCs, the IA assessed policy objectives for 2020 and for 2025-30. For both time periods, the IA assessed the impacts of different levels of ambition, defined in

[159] Forastiere F., Spadaro J.V., Ancona C., et al. (2024) Choices of morbidity outcomes and concentration–response functions for health risk assessment of long-term exposure to air pollution. Environmental Epidemiology 8(4):p e314.

[160] Referring to postponement related to attainment deadlines for specific air pollutants under Directive 2008/5/EC.

terms of different levels of emission reduction achieved. The impacts were modelled using the GAINS integrated modelling system, simulating varying deployment levels of technical abatement measures available in 2012. To estimate the costs, the modelling selected the most cost-effective group of abatement measures to deliver the required gap closure objectives.

For 2020, the IA considered two options:

- 5A - Adopt new EU source control legislation to reduce air pollution;
- 5B - Amend the National Emission Ceilings Directive (Directive 2001/81/EC) so as to include stricter provisions compared to the recently agreed amendment of the Gothenburg Protocol.

For 2025-2030, the IA considered five options defining different levels of 'gap closure' for PM2.5 related to health impacts between the baseline and the Maximum Technically Feasible Reduction scenario (or MTFR): 25% gap closure (Option 6A), 50% (6B), 75% (6C), 100% (6D) and >100% (6E) of the gap closure.

The **CAO series** assesses the impacts and costs of different emission reduction scenarios. A list of selected scenarios most relevant for this evaluation are presented in the following table. As can be seen from the table, inclusion of the NECD in different scenarios has evolved over time, which has influenced the analysis and what conclusions can be drawn regarding the impacts of the NECD. Furthermore, each CAO developed an updated baseline, involving a detailed review of EU policies and the most recent Member State NAPCPs, to align as far as possible the starting point for the modelling with abatement measures taken up in practice. This includes half-day meetings with each Member State held by the Commission contractors supporting the CAO work to consult assumptions on national policies and data. Industry experts are also regularly consulted to inform the development of GAINS. IIASA also regularly validates the model outcomes, such as reported data on emissions as well as monitored atmospheric concentrations of air pollutants. Baseline updates also capture any pertinent changes in relevant policy (e.g. including energy and climate targets) and underlying activity projections.

Table 7 – Description of key scenarios included in CAO series

CAO	List of key modelled scenarios
CAO1 (completed in 2018)	**PRIMES 2016 REFERENCE activities projection** with the legislation already in place in 2014 (the 'pre-2014' legislation). with the new legislation adopted after 2014 (the 'post-2014' legislation). with full implementation of the technical emission control measures (MTFR). cost-effective achievement of the emission reduction requirements (ERRs). **CLIMATE AND ENERGY POLICY activities projection** with the new legislation adopted after 2014 (the 'post-2014' legislation). with full implementation of the technical emission control measures (MTFR). cost-effective achievement of the emission reduction requirements (ERRs).
CAO2 (completed in 2020)	**Baseline scenarios** CAO2 baseline – latest EU-wide legislation and already adopted national air pollution control measures. This also includes the 32% target for renewable energy and 32.5% for Energy Efficiency in 2030. NAPCP – as CAO2 baseline, plus additional measures (policies and measures selected for adoption of the NAPCPs). **The latest climate policy scenario** NAPCP scenario as above, plus Mix55 scenario from 2020 Commission proposal.

CAO	List of key modelled scenarios
CAO3 (completed in 2022)	**Baseline scenarios** Baseline - Green Deal, Fit for 55 climate and energy package, plus latest EU-wide legislation, including legislative proposals for IED update (as regards agriculture) and for Euro 7, and adopted national air pollution control measures. REPowerEU – baseline as above, plus alternative energy scenario reflecting for EU27 in response to the Ukraine war, including measures announced in May 2022[161].
CAO4 (completed in 2025)	**Baseline** – captures developments since CAO3 in EU climate and energy legislation (including reflecting latest political agreements on the legislative initiatives part of the "Fit for 55" package and REPowerEU initiative) and source-specific legislation (such as final revision of Euro 7 and IED), alongside developments in national air pollution control legislation and programmes (based on NAPCPs and discussions with Member States). **ERC** – cost-optimized scenario where the model forces all Member States to meet all their 2020-29 emission reduction commitments by 2020 and 2025, and 2030 ERCs by 2030.

Additional modelling work using the GAINS model was undertaken under Task 5 of the service request supporting the development of the CAO4. The aim was to provide additional insight to the role of policies and measures resulting from the implementation of the NECD versus other (national or EU level) source control policies. The analysis sought to address, and to the extent possible disentangle, the (i) effectiveness, (ii) efficiency, and (iii) coherence of various EU and national policies introduced and analysed since the implementation of the NECD. To address these questions, two types of analysis were performed:

(A) compares emissions and costs between 2005 and 2030, separating the effect of changes in emissions controls and of changes in the activity data. This separation provides insights into the extent to which the changes were driven by more stringent air pollution policy (including the NECD) relative to external factors which influence activity levels (this includes other policies, such as energy and climate policies, as well as exogenous factors, such as economic growth). The analysis under this Section is most relevant to evaluation questions 5 and 9.

(B) constructed counterfactual scenarios to explore specifically what the implications (emission reductions, costs) of the measures introduced between 2015 (just before the NECD) and the future years are. In the analysis, the CAO baseline scenarios are compared for each year 2020/2025/2030 with a corresponding counterfactual in which the emission controls stay at the 2015 levels. This comparison illustrates how much impact the deviation from the 2015 emission controls, i.e. the NECD and associated air pollution policy changes, had/will have over time.

Health benefits are estimated in the CAO series as well as the counterfactual calculations as follows.

- Adding an atmospheric chemistry modelling component to the emissions calculated in GAINS enables understanding of where pollution would likely end up after being emitted.
- GAINS and EMEP model calculate the extent to which the population is exposed to the different pollutants, by combining spatial concentration data with data on population.

[161] Commission Communication on the REPowerEU Plan (COM (2022) 230) and Commission Staff Working document on Implementing the REpowerEU action plan: investment needs, hydrogen accelerator and achieving the bio-methane targets (SWD (2022) 230).

- It is then analysed how this pollution is likely to affect the population (mortality and morbidity), based on a defined set of so-called concentration response functions combined with exposure data (done through the Alpha-RiskPoll model).
- The concentration response functions are taken from scientific literature, with the WHO playing an important role in reviewing evidence and moderating exchange amongst researchers to arrive at scientific consensus on functions to be employed. The 2021 WHO air quality guidelines have systematically reviewed the evidence and meta-analyses of quantitative effect estimates. Evidence linking exposure to air pollution to detrimental health impacts has continued to grow since, see Annex III 5.1.2.1.
- Finally, economic valuation (also done through the Alpha-RiskPoll model) implies applying monetary values to the estimated health impacts. These values are again derived from a range of scientific papers, depending on the health outcome, references for which are listed in past CAO reports[162].

2.3 Shortcomings and uncertainty of modelling approach

A key challenge for the analysis was that it is **not possible to assess precisely a cost attributable to the NECD alone**, as measures which deliver emissions reductions are driven by a range of interacting policy (of which NECD is one) and external factors. The NECD sits as part of the wider clean air policy package to deliver improved air quality across the EU. It complements the Ambient Air Quality Directives and captures one end of the source-receptor pathway which is central to the control of air pollution and its impacts in the EU. Furthermore, the achievement of the ERCs under the NECD is supported by a range of EU source-specific instruments, which impose specific requirements on individual sources of emissions, such as vehicle emissions standards ('Euro standards') and industrial Best Available Technique conclusions (BATc) implemented through the IED. The implementation of many abatement measures will be driven by the source-specific instruments but also contribute to meeting overall ERCs. Hence the separate pillars of the clean air policy act together to drive action to reduce emissions and improve air quality. Although it is not possible to assess the costs of the NECD directly, studies and further analysis conducted under this evaluation have explored the costs of meeting the ERCs set. These capture the costs of emissions controls implemented, which would at least partly be attributable to the NECD, but also to other influencing policies and factors, and hence provide the closest insight into the effects of the NECD.

The **IA and CAO series presented forward-looking assessments** of health and environmental benefits and abatement costs under various emission reduction scenarios, and as such do not present a backward-looking analysis of outturn data regarding what has occurred over the evaluation period. That said, and as explained in the previous section, there is also a back-casting element as GAINS yields outputs for historic years (such as 2005, the base year of the NEC Directive, and 2015, that is closest to the start of the evaluation period in 2016). As such, outputs from GAINS and the linked models are useful to inform the development over the evaluation period. To inform this exercise, each CAO involves a detailed review of EU policies and the most recent Member State NAPCPs, to align as far as possible the starting point for the modelling with abatement measures taken up in practice. However, this is not a perfect exercise as **consistent and complete information is not always available**, and the construction of the scenario in GAINS is

[162] The support study to CAO2 has a detailed list of references (Table 1.28). Support studies to subsequent Clean Air Outlooks add the latest references considered.

limited to deploying the techniques defined within the model. As such, there is likely to be some variation between the measures simulated as adopted and those taken up in practice. However, this modelling provides the best source of evidence to provide insight into the likely effects of the NECD, given evidence regarding the actual costs of policies and measures is extremely limited and not routinely recorded or reported.

The modelling has frequently **used 2030 as a reference year** for estimating costs and benefits, which is beyond the time period in scope of this evaluation (from adoption to 2025). In most cases, results are also provided for 2025, and while these are still projected estimates, the evidence base refers to it to illustrate the likely evolution of impacts over the evaluation period. Where this is not possible, the evidence base presents the analysis of impacts in 2030 as an illustration of the anticipated trend of impacts of the NECD (and of national air pollution control policies adopted in response to the NECD) over the evaluation period. Furthermore, additional analysis using the outputs of CAO4 has been undertaken to illustrate the costs of additional emissions controls implemented after the adoption of the NECD over the evaluation appraisal period.

The GAINS model used **does not consider the full potential of non-technical or local measures** which can also contribute to emissions reductions. This may lead to the modelling understating the costs of meeting ERCs.

Finally, there are several factors biasing the **modelling of the benefits towards under-estimation**:

- Not all health benefits are captured in the modelling. For instance, the effects of air pollution on mental health and other emerging impact pathways are not accounted for (even if there is growing evidence of those).
- Only the mortality related to long-term exposure to PM, NO_2 and O_3 is considered. Other pollutants and mortality due to short-term exposure are not considered.
- Results for mortality are corrected for overlaps between the different pollutants (i.e. by excluding mortality effects associated with exposure to NO_2). As an indicative estimate for the order of magnitude of the overlap, HRAPIE suggests an overlap of 33%. This number is, however, associated with a large uncertainty.
- Possible co-benefits associated with air quality measures in other policy areas (in particular transport and climate policies) are not accounted for, such as reduced GHG emissions, reduced noise or congestion, etc.

Although these limitations exist, the modelling undertaken by the IA and subsequent CAO series presents a key source of evidence providing insights into the costs and benefits of the NECD. The analysis is produced using a well-established and reviewed modelling system, and each modelling exercise is underpinned by a detailed review of EU policies and the most recent Member State NAPCPs, to align as far as possible the starting point for the modelling with abatement measures taken up in practice. As such, the IA and CAO series present a robust and reliable set of modelling outputs for use in the analysis under the evaluation. Throughout the different Clean Air Outlook reports, the modellers have consistently checked results for **sensitivity against key assumptions**. This involved:

- Performing analysis of how different factors (activity data change, introduction of additional policies) contributed to changes in emissions and costs (this is done by IIASA on a routine basis);

- Varying assumptions about the health outcomes included in the health impact assessment, depending on how established findings are;
- Using value of a life year (VOLY) vs value of statistical life (VSL) approach in health impact assessment.

3 Literature review

A comprehensive literature review was undertaken to identify relevant secondary sources of information and data. It drew on relevant literature and data from a variety of sources including the European Commission, the Member States and peer-reviewed literature. Sources were identified in various ways, including through targeted searches and identified by stakeholders. Information from the review was relevant for all aspects of the evaluation, including for the analysis of costs and benefits (in particular the IA and CAO series as identified in the preceding section).

Literature and data were primarily sourced in English, but targeted searches in other EU languages were conducted to bridge information gaps.

There were several shortcomings of the literature, in particular that key data and information is not well captured in published material. For example, evidence on administrative burdens associated to NECD obligations, and on the actual costs of the NECD, of policies and measures and of emissions controls are not routinely recorded or reported.

That said, where evidence and insight have been drawn from the literature, this has in the majority of cases been drawn from high-quality, robust studies which have undergone rigorous review and have been published by reputable sources (e.g. European Commission).

4 Consultation activities methods and evaluation

4.1 Summary of engagement activities

Stakeholder consultation activities, led by RPA, were undertaken horizontally across the evaluation, feeding into other aspects of the methodology, including the literature review and modelling exercises. This consisted of an initial Call for Evidence, a stakeholder workshop, an open public consultation, a technical targeted stakeholder consultation, and targeted engagement with competent authorities as well as with businesses, as summarised in more detail in the Consultation Synopsis report.

Between 15 February 2024 and 14 March 2024, the Commission conducted a **Call for Evidence** on the 'Have your say' portal. The objective was to provide stakeholders and the public with an opportunity to share their views on the functioning of the NECD. Feedback was provided by 53 participants. The respondents included three academic/research institutions, twenty-three EU citizens, one trade union, twelve NGOs, ten business associations, three other organisations, and one company/business.

The **open public consultation (OPC)** took place as a survey questionnaire that ran from 3 September 2024 to 24 November 2024 via the 'Have your say' portal. It intended to collect input from a broad range of stakeholders and the public on the NECD's implementation and effectiveness. 53 responses were received, and participants had the opportunity to provide supporting documentation. From the responses that were not requested to be kept anonymous, the greatest proportion of responses were from participants representing business associations, EU citizens, NGOs, and public authorities. One of the main limitations of the OPC lies in the generally low response rate, and the

particularly low participation from certain stakeholder groups. Some stakeholder groups such as academics, consumer organisations, trade unions, and environmental organisations were relatively underrepresented, while certain sectors and countries were not represented at all (for example Poland, Romania, Sweden, Greece, Bulgaria, Ireland, Lithuania, Slovenia, and Latvia). Respondents to public consultations are normally self-selected, with responses more likely to come from individuals or organisations who are already engaged, have strong opinions, or vested interests in the topic. This restricts the extent to which the results can be considered representative of the broader stakeholder landscape. Hence, the analysis of the results needs to be read with caution, taking into consideration the number of responses from each stakeholder group, which is provided in the analysis. A total of 11 position papers were submitted in response to the OPC. These were manually reviewed and analysed to extract key information.

The **targeted stakeholder consultation (TSC)** ran from 3 September 2024 to 26 November 2024. The targeted consultation questionnaire was distributed via email to 144 stakeholders who had registered for the stakeholder workshop and received 43 responses. The aim of the TSC was to allow targeted stakeholders to provide their views on the experience of the NECD, notably as regards its effectiveness, efficiency, relevance, coherence, and EU added value, and thus inform the evaluation process. As for the OPC**,** the TSC also received a low number of responses, with most responses from public authorities, industry associations and NGOs. Hence, the interpretation of the TSC results also requires caution, taking into consideration the number of responses from each stakeholder group, which is provided in the analysis. A total of 16 position papers were submitted in response to the TSC. These were also manually reviewed and analysed to extract key information.

Further written contributions outside the above-mentioned consultations activities were received from FAIRMODE and Bayerischer Landtag who sent contributions during the consultation period.

A hybrid **stakeholder workshop** was conducted on 14 October 2024 to discuss several topics relevant to the evaluation of the NECD. 144 stakeholders registered, 55 attending in person in Brussels and 89 participating remotely. Stakeholder groups represented included business associations, public authorities, Member State representatives, trade unions, research institutions, professionals, and NGOs. The aim of the stakeholder workshop was to gather initial views regarding whether the legislation has been successful in achieving its objectives and if the objectives are still relevant in view of changing circumstances.

Subsequently **targeted engagement of competent authorities** was undertaken through an additional survey that was sent to Member State authorities from 10 February 2025 to 28 February 2025. This aimed to address information gaps on costs and benefits, areas for simplification of the NECD, coherence and relevance with respect to agriculture, and the NECD's relevance to certain emission sources. The survey received 15 responses, with one respondent from each of the following countries: Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, the Netherlands, Portugal, Romania, the Slovak Republic, Spain, and Sweden. Bilateral follow-ups were conducted to clarify specific points raised in the feedback, ensuring a more comprehensive understanding of the responses. As part of this engagement, selected stakeholder interviews were conducted online between 26 February and 20 March 2025 with the aim of following up with specific Member States in response to the additional survey described above and other stakeholders:

- Four targeted interviews were conducted to get information on the costs and benefits, in particular administrative burden imposed by the NECD obligations. These interviews were conducted with the main aim of clarifying data already submitted, to ensure accuracy of interpretation. They also aimed to get more details on some of the answers provided in the additional survey, in particular around administrative burden and the use of data and information collected from businesses. Interviews were conducted virtually in March 2025, each lasting 1 hour, with representatives from four Member State competent authorities (Estonia, Denmark, Luxembourg and Portugal).

- Interviews with national inventory compilers and modellers were undertaken with a particular focus on the relevance of certain emission sources not included within compliance totals. Four interviews were conducted with national inventory compilers from the inventory teams in Denmark, Germany, France, and Croatia. Interviews were also conducted with an air pollution modeller from TNO (in the Netherlands) and an integrated assessment modeller from IIASA (Austria).

Another **targeted engagement of businesses** was undertaken through an additional survey that was sent to around 50 business representatives that had participated in prior consultation activities (OPC, TSC or stakeholder workshop) and which was open from 4 April 2025 to 25 April 2025. The purpose of this survey was to deepen the evidence and understanding on administrative burdens and abatement costs for businesses, including SMEs, related to the implementation of the NECD. By end of April, nine replies were received, with six of them providing additional information that has been integrated into the efficiency analysis. Answers mainly came from businesses or associations in the agriculture sector, and the limited reply meant it was not possible to significantly broaden information on costs for businesses.

4.2 Shortcomings of the stakeholder consultation

Multiple stakeholder engagement activities were undertaken to support the evaluation, engaging a wide range of stakeholders. However, there are limitations:

- **Relatively low response rate to the OPC**, and the particularly low participation from certain stakeholder groups. Some stakeholder groups such as academics, consumer organisations, trade unions, and environmental organisations were relatively underrepresented, while certain sectors and countries were not directly represented at all (for example Poland, Romania, Sweden, Greece, Bulgaria, Ireland, Lithuania, Slovenia, and Latvia, although it is noted that several responses identified themselves as EU-wide). The majority of responses to the OPC were from business associations (20 of 53 responses).

- **Relatively low response rate to the TSC**, with most responses from public authorities, industry associations and NGOs.

- **Respondents to public consultations are normally self-selected**, with responses more likely to come from individuals or organisations who are already engaged, have strong opinions, or vested interests in the topic. This restricts the extent to which the results can be considered representative of the broader stakeholder landscape.

Hence, although the evidence and opinion collected through the stakeholder engagement is useful for providing insights into specific issues (in particular from stakeholders who are often engaged in issues around air quality), interpretation of the OPC and TSC results also requires caution, and taking into consideration the number of responses from each stakeholder group should not be assumed to be representative of the broader stakeholder landscape.

No campaigns were identified in the consultation responses, although two OPC respondents provided very similar replies, and a number of stakeholders participated in the call for evidence, OPC and TSC. Eight respondents participated both in the OPC and TSC; of these, three also participated in the Call for Evidence.