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Update of the costs of not implementing EU environmental law

Written by Logika Group, RPA Europe and EMRC
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Report

Update of the costs of not implementing EU environmental law

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Environmental legislation, when implemented and enforced, will deliver improvements for environmental health, human health, and society and the economy more broadly. Where relevant legislation is not implemented as planned and targets are not met, such benefits are foregone. This study has estimated the costs (foregone benefits) of the lack of implementation of EU environmental law in the EU-27 Member States, building on two preceding European Commission studies (COWI et al. (2019), and COWI et al. (2011)).

The 'implementation gap' is defined as the difference between actual environmental status (based on the last historical year for which data is available) and the respective environmental target(s). The last historical year for which data is available varies depending on the policy area and specific target, but ranges from 2018 to modelled data for 2025. The implementation gap in this study covers eight environmental policy areas: air, noise, nature and biodiversity, water, waste, chemicals, industrial emissions and major accident hazards, and horizontal instruments. Climate and other policy areas were not included in the scope of this study. Furthermore, this study did not aim to ascertain why there is an implementation gap (e.g., lack of governance) because this is the role of individual policy evaluations and other reviews, such as the Environmental Implementation Review (EIR)[1]. Instead, the focus of this study was to assess the size of the implementation gap and its effect in terms of actual costs to society. The implementation gap was assessed quantitatively for all policy areas, except for chemicals and horizontal instruments where qualitative analysis was undertaken due to the nature of the targets set in those policy areas.

Notes on the approach

The focus of the study was on the implementation gap and costs to environmental targets defined in EU law. However, in some cases, relevant legislation does not define an explicit quantitative target – for example, the Environmental Noise Directive (END). Where legislation is in place, but measurable targets are not defined, the study looked to non-legislative, measurable targets (such as those contained in announcements and strategies – e.g. Zero Pollution Action Plan) to illustrate the implementation gap.

Although the eight policy areas were assessed separately, there are key interactions between them in terms of the environmental outcomes that might arise as a result. For example, action on industrial emissions inherently contributes to the achievement of air pollutant concentration targets. To produce a total gap cost across all policy areas the study has carefully considered and accounted for potential overlaps in a cross-cutting assessment.

In some policy areas (water, circular economy and waste, and industrial emissions and major accident hazards), legislation contains mechanisms for derogation or exemptions from environmental targets, which adds complexity when defining the implementation gap. The analysis has identified where derogations and exemptions apply and explored their potential impact on the implementation gap. However, to estimate the total cost, the analysis has focused on the gap not accounting for such derogations and exemptions (i.e. assuming they do not apply), in particular as many of the key derogations and exemptions for the cost assessment are due to expire over the next few years.

Headline results

The current study estimates **the total costs (foregone benefits) of the non-implementation of EU environmental law to be:**

[1] https://environment.ec.europa.eu/law-and-governance/environmental-implementation-review_en

- **€180 billion per year (2023 prices, range from €154 billion to 208 billion per year)** comparing the status of the environment in the last historical year for which data is available and **environmental targets which currently apply.**

- **This estimate increases to €325 billion per year (2023 prices, range from €294 billion to 408 billion per year)** when comparing the status of the environment in the last historical year for which data is available to **environment targets which will apply in the near future.**

In both estimations, the range stems from various uncertainties in the underlying methodology and approach to assessing the gap and quantifying the costs.

The estimate of the implementation gap cost has increased compared to the previous assessment in COWI et al. (2019), which estimated the gap cost at around €64 billion[2] (2023 prices, range €35 billion to 94 billion). However, the difference is not necessarily due to a deterioration in the environment (and in some cases the implementation gap has reduced relative to COWI et al. (2019), e.g. for clean air), but more so due to improvements in the approach to the analysis. The differences in approach (and their impact on the cost estimates) vary by policy area. Some changes have increased the implementation gap cost relative to COWI et al. (2019) and others have reduced it. Key differences include (alongside updated data on underlying environmental indicators):

- Consideration of new targets introduced since COWI et al (2019) – in particular, consideration in the nature & biodiversity area of targets introduced under the EU Biodiversity Strategy (BDS) 2030, Zero Pollution Action Plan target for noise, and Ecodesign under circular economy & waste.

- Consideration of targets not assessed in COWI et al. (2019) – in particular, 2030+ Emission Reduction Commitments under the National Emission reduction Commitment Directive.

- Expansion of the range of impacts captured – in particular, capturing an expanded set of health impact functions associated with exposure to air pollution, inclusion of waterbodies failing chemical status in water, and estimation of an implementation gap cost for marine (water).

- Use of new data and appraisal approaches where new targets are assessed – in particular to assess EU BDS and Invasive Alien Species Regulation targets under nature & biodiversity.

- Application of updated valuation of impacts – in particular, updated (higher) cost of health outcomes related to air and noise, changes in raw material and energy prices under circular economy and waste, and updated willingness-to-pay values under water.

The study results are summarised in Table E-1 below. Further detail on the comparison between the results of the present study and COWI et al. (2019) is captured in Appendix 1, although it was not possible to undertake a complete quantitative comparison to fully unpick the influence of all changes in approach.

Analysis by policy area

The EU Ambient Air Quality (AAQ) Directives and EU National Emissions reduction Commitments (NEC) Directive each contain quantitative, measurable targets against which an implementation gap can be assessed – source-specific and other air pollution legislation are not assessed directly to avoid double-counting. The analysis on air quality highlights that an implementation gap remains. In 2022, there were 788 instances where air pollutant concentrations were above relevant standards (AAQ Directives) at specific sites across all Member States (down from 1,502 in 2015). This leaves large numbers of EU citizens living in areas where concentrations of air pollution are above these standards (in particular for ozone and BaP). Furthermore, 10 Member States have

[2] COWI et al. (2019) reported total central estimate of €54.7bn (2018 prices), range from €29.7bn to €79.6bn. Estimates have been adjusted in the text from 2018 to 2023 prices for comparability to estimates from the present study.

not yet achieved emission reductions to meet all their ERCs (NEC Directive) for 2020-29. The combined ***implementation gap to current targets under the AAQ Directives and NEC Directive carries a cost between €3.5 billion to 4.6 billion per year. With respect to ERCs applying from 2030 (NEC Directive), the implementation gap for these emission targets alone is significantly larger, valued between €85 billion to 137 billion per year.***

These foregone benefits more than double where further, albeit less robust, impact pathways are included. Emissions of air pollutants will continue to fall and by 2030, reductions will be closer to 2030+ ERCs (NEC Directive), but compliance is not expected to be complete across all Member States and pollutants. The revised AAQ Directive has made air quality standards more ambitious (reflecting improved evidence that air pollution can have detrimental impacts on health at lower concentrations). This will increase, nominally, the number of people living in areas exceeding air quality standards from 2030. However, this does not yet account for additional action which will be taken to meet these more ambitious standards.

The EU Environmental Noise Directive (END) is the main EU law to identify ***noise pollution*** levels and act on them. The Directive does not provide quantitative targets hence the analysis also considers the ZPAP 2030 interim target to reduce "by 30% the share of people chronically disturbed by transport noise". A significant implementation gap remains – to meet the 2030 ZPAP targets, it is necessary to have reduced by then the exposure to harmful levels of road traffic noise for 26.6 million people, and to harmful levels of railway and airport noise for respectively 5.7 million and 1.1 million people. The ***cost for harmful levels of road transport noise alone is €20.0 billion per year*** (range from €12.9 billion to 27.1 billion per year) although this is considered an underestimate. Looking forward, the most recent research by the EEA and others indicates that ZPAP targets are unlikely to be achieved by 2030, and that it is possible that the implementation gap could even increase.

The EU Habitats and Birds Directives are central to the EU's ***nature and biodiversity policy***, forming the legal basis for the EU's nature protection network Natura 2000. In addition, the main long-term plan to protect nature and reverse the degradation of ecosystems in the EU is the EU Biodiversity Strategy (BDS) for 2030, from which 5 targets (1, 2, 5, 8 and 9) were analysed. The implementation gap for some is small: in the year 2021, protected areas covered 26% of EU land, close to the 30% target; also, in the period 2013-18 28% of species held 'good' conservation status, 2% off the 30% target. But for most, the gap is wider: bird and butterfly population indexes continued to deteriorate to 2022, and only 22.6 million trees have been planted versus an ambition for 3 billion additional trees. Furthermore, all Member States have reported the presence of multiple Invasive Alien Species (IAS) of Union concern. Although the data and assessment methods are more limited for this policy area, ***the cost analysis quantified three aspects: delays in protecting land costs between €11 billion – 30 billion per year; the decline in bird numbers carries a cost of €5 billion per year; and economic losses associated with IAS in EU27 could be around €46 billion per year***. Looking forward, based on historical trends some targets may be met by 2030, but for many gap closure is uncertain. That said, this does not capture the potential impact of the recently adopted Nature Restoration Regulation (NRR), which is expected to result in strengthened restoration efforts.

The **EU Water Framework Directive (WFD)** has established a framework for the protection of surface waterbodies and groundwater. Marine waters are addressed in the **Marine Strategy Framework Directive (MSFD)**. The overall target under WFD and MSFD is to achieve 'good' status for all waters, but even after both Directives have been in force for two decades, an implementation gap remains. ***For surface waters*** in 2021, only 30% of river length, 34% of lake area, 14% of transitional water area and 48% of coastal water area were classified to be in good or high ecological status. For chemical status in 2021, only 40% of river length, 19% of lake area, 29% of transitional water area and 33% of coastal water area were classified to be in good chemical status. Across both status dimensions, ***the combined central estimate of costs (foregone benefits) of not achieving 'good' status is €51.1 billion per year.*** Exemptions (in particular the delay until 2027 under Article 4(4) and less stringent objectives under Article 4(5)) have been applied widely by Member States, capturing the vast majority of waterbodies with status below 'good'. Taking account of exemptions, the central estimate of the remaining cost (foregone benefit) is €5.7 billion per year. ***For groundwaters***, in 2021 91% achieved 'good quantitative status' and 77% achieved 'good chemical status'. ***The gap for chemical status alone is estimated to cost €636 million per year*** (this estimate does not account for exemptions, and no estimate is made for quantitative status). Looking forward, the crucial date is 2027 when time limited exemptions under Article 4(4) expire (except for 'natural conditions') and hence all measures to achieve good status must be in place. Bringing the water bodies covered by Article 4(4) exemptions into 'good 'status could achieve benefits of around €38.6 billion per year for surface waters (this does not capture waterbodies with Article 4(5) exemptions). ***For marine waters***, there are still large areas where status has not yet been assessed. The Commission's MSFD evaluation estimates that 6.42% of the MSFD specific measures are fully implemented, and this study estimates a further 19.92% of other non-MFSD specific relevant measures may have been fully implemented. After accounting for both, this leaves ***an implementation gap of some €11.7 billion per year*** for marine waters. Although difficult to quantify precisely, it is important to note that there is likely to be some overlap between the foregone benefits estimated with respect to the WFD and the MSFD (noting the central estimate of total annual cost of non-implementation for coastal waters under WFD is €2.6bn per year). Across the ***whole water policy area, the total estimated foregone benefits of the current implementation gap are estimated to be €63.7 billion per year*** for all water bodies (range from €54.6 billion to €73.0 billion per year).

The **EU circular economy and waste management legislative framework** aims to protect human health and tackle the triple crisis of climate change, biodiversity loss and pollution. Since 2019, several of the EU's waste policies and laws have been reviewed and new legislation has either been adopted or proposed in line with goals of the European Green Deal and under its framework through the Circular Economy Action Plan. The analysis covers 11 separate pieces of legislation, of which eight set quantitative targets (with multiple targets under each). The implementation gap varies by target and between Members States. For some, the remaining gap is small, such as under the Batteries Directive (recycling efficiency target for different battery types) and End of Life of Vehicles Directive (reuse and recovery target). For other targets, the gap is larger, such as under the Landfill Directive (target to reduce the amount of municipal waste landfilled) and the Packaging and Packaging Waste Directive (recycling targets, in particular for plastic). The ***costs associated with not meeting targets which currently apply are estimated to be between €21 billion to 23 billion per year*** (including partial Ecodesign costs which only consider the energy efficiency parameter for a selection of relevant products). That said, ***the cost increases significantly when considering the gap to targets which will apply in the near future, to between €79 billion – 90 billion per year*** (including partial Ecodesign). Looking forward, the ZPAP contains four targets pertaining to waste (not assessed directly in this implementation gap analysis which instead focused on targets set in legislation), but recent studies suggest the EU is far from reaching these targets. Changes to the Waste Framework Directive, Packaging and Packaging Waste Directive and End of Life of Vehicles Directive have been proposed to drive further progress in closing the implementation gap.

The **EU chemicals acquis** seeks to protect human health and the environment, whilst enhancing the competitiveness of the EU chemical industry. Multiple pieces of legislation focus on managing risks from chemicals in specific sectors, product types and spheres (i.e. occupational, consumer, professional). The focus of this assessment is on the two most important pieces of horizontal chemicals legislation: the 'CLP' Regulation and the 'REACH' Regulation. ***A quantitative estimate of any implementation gap cost has not been possible for chemicals*** given that the REACH and CLP regulations do not have specific environmental protection or improvement targets. Overall, the ***CLP Regulation was considered effective in a 2019 fitness check*** with many aspects of its implementation operating efficiently, ***but some implementation challenges were identified.*** A revised CLP regulation has been in force since December 2024 and is expected to address any substantive implementation gaps. The 2018 REACH Review concluded that ***the REACH regulation is working as intended and has delivered significant benefits, but some elements and processes are not working as efficiently as they could***, including the Authorisation process. The efficiency and speed of the process has proved more resource intensive – and slower – than anticipated prior to implementation for several reasons, potentially creating a gap in the level of protection for human health and the environment. The number of REACH Restrictions adopted has not met original, albeit overly optimistic, expectations but there has been a shift in the nature of Restrictions toward groups of substances with multiple uses, with a corresponding increase in human health and environmental benefits anticipated. For example, the current PFAS Restriction process is ongoing and absorbing significant resources to prepare opinions and finalise, however, further empirical research should examine actual ex-post benefits of adopted Restrictions. ***Evidence also suggests an enforcement implementation gap by national authorities***, with trends improving in some Member States but worsening in others. Looking forward, a proposed targeted revision to REACH is expected in 2025 which may encompass changes to several processes that have the potential to accelerate the rate at which benefits are realised.

The **Industrial Emissions Directive (IED) and Seveso III Directive** regulate respectively ***industrial emissions and major accident hazards*** (other legislation has not been assessed to avoid double counting). ***The IED does not set specific targets to be met***, instead requiring installations to use best available techniques (BAT) and to operate within activity thresholds specified in their permit (emission limit values), which in turn must be based on relevant BAT Conclusions (BATC) and Associated Emission Levels (AELs). Hence assessing the implementation gap with respect to the IED is challenging, and for this study, the main analysis explores the impacts under stricter permit requirements – as such it does not strictly assess non-compliance but illustrates the benefits of greater ambition. Several reports found that Member States mainly set emission limit values in the least stringent (i.e. upper end) of the BAT-AEL ranges, and that the number of derogations granted has increased over time. ***Setting emission limit values at the upper BAT-AEL range and derogations are both compliant with the Directive but carry a cost (foregone benefit) of between €27 to 98 billion per year in 2025*** (based on modelled emissions for 2025). Looking forward, the IED 2.0 contains new provisions which require permits to be set at the strictest achievable level, and as such this gap should be expected to decline. ***The Seveso III Directive*** establishes requirements for the prevention and remediation of major accidents involving dangerous substances, which can be considered qualitatively. Reports highlight an ***implementation gap where a small but significant number of installations did not have an external emergency plan (EEP), with many more not showing evidence of testing and review. Furthermore, major accidents continue to occur***, with recent reports recording 42 industrial incidents over the period 2022 to 2023. Such accidents can have significant associated costs, in terms of human health (fatalities and casualties), damage to buildings, etc.

Horizontal instruments are legislative tools that aim to improve the overall environmental governance framework by creating systems to improve policy implementation and compliance across sectors. This captures a wide range of legislation, including the Environmental Liability Directive (ELD), the Environmental Crime Directive (ECD) and the Industrial Emissions Portal Regulation (IEPR). Horizontal instruments do not define specific targets but contribute indirectly to the achievement of environmental targets within various policy areas. While some Member States have successfully applied the ELD, others have struggled due to narrower interpretation of certain ELD provisions, resulting in smaller scopes for their national legislations and less stringent measures for remediating water and biodiversity damages. This has left an ***implementation (and enforcement) gap under ELD***, which has resulted in complementary and compensatory remediation not always being achieved. There have been significant disparities in implementation and enforcement of the ECD among Member States, including: inconsistent application and interpretation of the Directive, varying resources dedicated to enforcement, and fragmented data collection. This again has left a ***clear implementation (and enforcement) gap for ECD***. While the European Environment Agency (EEA) and Member State competent authorities have comprehensive procedures to check and verify reported data, resources dedicated to verifying and validating data reported to the E-PRTR/IEPR vary among Member States. This may lead to inconsistent data for some pollutants and/or industrial activities and varying accuracy of data across Member States. It has ***not been possible to estimate a cost as the impact of horizontal instruments*** is often indirect and preventive, supporting compliance and enforcement regarding sector-specific goals.

Table E-1: Analysis for each policy area and assessment of total implementation gap cost. Notes: Rows coloured blue show the alternative assessment against future targets for particular policy areas where this is applicable (i.e. where there are different targets that currently apply and will apply in the future). Accordingly, numbers in white cells were counted in the current gap, and in blue cells in the future gap totals at the bottom of the table.

Policy area *(year of data used for assessment)*	Targets	Annual implementation gap cost (€, 2023 prices)	Forward look
Air *(2022 data)*	AAQ Directives (standards applying until 2029) and NEC Directive 2020-29 ERCs	€3.5 billion (range up to €4.6 billion)	Implementation gap to 2030+ ERCs anticipated to fall as emission reductions continue. More ambitious air quality standards will increase the number of people living in areas or exceedance (although this does not capture additional action which will be put in place to work towards these new targets).
	NEC Directive 2030+ ERCs	€85 billion (range up to €137 billion)	
Noise *(2017 data)*	ZPAP 2030 target	€20 billion (range from €12.9 billion to 27.1 billion)	Most recent evidence suggest it is unlikely that the 2030 ZPAP target will be achieved, and the implementation gap could even increase.
Nature & biodiversity *(data varies from 2018 to 2024 depending on target)*	EU Biodiversity Strategy 2030 targets	€72 billion across targets assessed (range from €62 billion to 81 billion)	Based on historical trends some targets may be met by 2030, but for many, it is uncertain whether ambitions will be achieved based on current trends. That said, this does not capture the potential impact of the recently adopted NRR, which expected to result in strengthened restoration efforts.
Water *(2021 data for surface and ground water bodies; 2018 data for marine)*	Target under WFD and MSFD to achieve 'good' status for all waters	€63.7 billion for all water bodies (range from €54.6 billion to 73.0 billion)	To note, time limited exemptions under WFD Article 4(4) expire in 2027 and hence all measures to achieve good status must be in place by then. Attaining 'good 'status of surface waterbodies (rivers, lakes, transitional and coastal waters) covered by Article 4(4) exemptions could achieve benefits of around €38.6 billion per year. The study has not estimated the equivalent foregone benefits for groundwater bodies.
Circular economy and waste *(data varies from 2019 to 2022 depending on target)*	Targets under several policies that currently apply	€20.6 billion (range up to €22.6 billion)	The new Batteries Regulation, new Waste Shipment Regulation and Single Use Plastics Directive have only recently been adopted – the analysis captures the full gap to their targets but if successful these policies will reduce the gap. In addition, proposed changes to the Waste Framework Directive, Packaging and Packaging Waste Directive and End of Life of Vehicles Directive have been proposed to drive further progress in closing the implementation gap.
	Targets under several policies that will apply in the future (e.g. 2030, 2035)	€79 billion (range up to €90 billion)	
Chemicals	N/a – Legislation does not have specific and quantifiable environmental protection or improvement targets.	Not quantified. CLP Regulation considered effective, but some implementation challenges were identified in a 2019 fitness check. The REACH Regulation is working as intended and has delivered significant	The revised CLP regulation, in force since December 2024, is expected to address any substantive implementation gaps. A proposal for a targeted revision of REACH is expected in 2025. Such revisions may encompass changes to several processes. Collectively these changes

Policy area *(year of data used for assessment)*	Targets	Annual implementation gap cost (€, 2023 prices)	Forward look
		benefits, but some elements and processes are not working as efficiently as they could, potentially creating a gap in the level of protection for human health and the environment.	have the potential to accelerate the rate at which benefits are realised, perhaps significantly
Industrial emissions and major accident hazards *(modelled 2025 data)*	Stricter permit requirements under IED(greater ambition) – Seveso III does not set quantitative targets	€27 billion (range up to €98 billion)	The IED 2.0 contains new provisions which require permits to be set at the strictest achievable level. This will drive emissions reductions which will capture these available benefits, as industrial sites will be required to take action to meet stricter permit requirements.
Horizontal	N/a - Horizontal instruments do not define specific targets but contribute indirectly to the achievement of environmental targets within various policy areas	Not quantified. For ELD and ECD, analysis highlights a clear implementation (and enforcement) gap, which has resulted in complementary and compensatory remediation not always being achieved (under ELD), and financial, ecological, and social impacts of unaddressed environmental crimes (related to ECD).	New guidelines and training on environmental damage, the new Environmental Crime Directive, adopted on 11 April 2024, and new IEPR should all work to reduce gaps in implementation and their associated costs.
TOTAL COST	*Air targets to 2029 and current circular economy & waste targets, plus noise, nature & biodiversity and water*	**€180 billion (range from €154 billion to 208 billion)**	Most significant costs are in nature & biodiversity and water areas, hence implementation gap likely to reduce to 2030 as implementation of NRR begins to work towards targets in the EU BDS 2030, and expiry of WFD Article 4(4) exemptions pushes a greater attainment of 'good'.
	Air targets from 2030 and future circular economy & waste targets, plus noise, nature & biodiversity and water	**€325 billion (range from €294 billion to 408 billion)**	Most significant costs are in: nature & biodiversity, water, air and circular economy & waste. Implementation gap likely to reduce to 2030 as further air pollutant emission reductions are anticipated and new legislation and changes to existing policies in circular economy & waste drive further progress in closing the implementation gap.

1 Introduction

Environmental legislation, when implemented and enforced, will deliver improvements for environmental health, human health, and for society and the economy more broadly. Where environmental legislation is not implemented as planned and targets are not met such benefits are foregone. In 2019, the European Commission published a study[3] (this study will be referred to from here as 'COWI et al (2019)') which estimated the costs (foregone benefits) for the EU of not achieving environmental targets across seven environmental policy areas: (i) air and noise; (ii) nature and biodiversity; (iii) water; (iv) waste; (v) chemicals; (vi) industrial emissions and major accident hazards; and (vii) horizontal instruments. This followed a previous study with the same objective conducted in 2011 (COWI et al. (2011))[4].

This report builds on these preceding studies and updates the estimates of the costs (foregone benefits) of the lack of implementation of EU environmental law in the EU-27 Member States. In this report, air and noise are split into two separate sections resulting in analysis across eight policy areas. The starting point for this study are the approaches used in COWI et al (2019) to facilitate comparison between the two sets of results, but this study also includes several improvements across different elements of the approach. These improvements aim to address weaknesses in the COWI et al. (2019) study and to reflect scientific and analytical advances in the underlying evidence base, data and appraisal methods since it was published. Furthermore, there have been significant developments in the environmental acquis since COWI et al. (2019), in particular reflecting the multiple developments stemming from the EU Green Deal and publication of the 8th Environmental Action Program, which are captured in this study.

The 'implementation gap' is defined as the difference between the actual environmental status and the respective environmental target(s). It is not within the scope of this study to ascertain why there is an implementation gap (e.g., lack of governance) because this is the role of individual policy evaluations and has already been covered by other reviews, such as the Environmental Implementation Review[5] (EIR). Instead, the focus of the present study is on how significant this implementation gap is and what effect it has. The analysis follows three key steps:

1. Update of the policy scope to reflect legislative developments;
2. Define and assess the implementation gap; and
3. Monetise the costs associated with the implementation gap.

The focus of the study is on the implementation gap and costs to environmental targets defined in EU law. The assessment aimed to produce quantitative estimates of the implementation gap and costs where possible. However, in some cases, relevant legislation does not define an explicit quantitative target which can be used as a benchmark – for example, the Environmental Noise Directive (END). In other cases, there may be no clear target – for example, in the case of the chemicals acquis. Furthermore, since 2019 there have been a range of announcements and strategies, which although do not constitute EU Law, have defined explicit quantitative targets in one or more of the seven policy areas in scope of this study, for example, the Zero Pollution Action Plan and the EU Biodiversity Strategy 2030. This study adopted the following approach to address this challenge:

- Where legislation is in place with clear quantitative targets (i.e. for air, water, waste, and industrial emissions), this legislation was the basis for the assessment.

[3] https://op.europa.eu/en/publication-detail/-/publication/2c05c9e6-59aa-11e9-a8ed-01aa75ed71a1
[4] https://op.europa.eu/en/publication-detail/-/publication/c1ea3ac1-ed7f-4abb-a06b-41b8f515991c/language-en/format-PDF/source-search
[5] https://environment.ec.europa.eu/law-and-governance/environmental-implementation-review_en

- Where legislation is in place, but measurable targets are not defined, the study looked to non-legislative, measurable targets to help to illustrate the implementation gap (i.e. for noise and nature & biodiversity).
- Where quantification was not possible, the rationale and limitations are explained, and qualitative indicators and descriptions were instead used to illustrate the implementation gap and costs where appropriate (i.e. for chemicals and horizontal instruments).

Although the eight policy areas are somewhat distinct, there are key interactions between them in terms of the environmental outcomes that might arise as a result. For example, action on industrial emissions inherently contributes to the achievement of air pollutant concentration targets, and achievement of air pollution targets contributes to effects on nature and biodiversity. The study ultimately aggregates the impacts across all policy areas into a total cost of non-implementation, and as such an important consideration was the potential for overlaps in the assessment. To address this, first the study has assessed the implementation gap costs separately in each policy area to produce as complete an assessment as possible for each area. Next, interdependencies and links between the policy areas were mapped forming a clear representation of the interactions between the policy areas and environmental outcomes. Finally, taking into account the map of interdependencies and the typology of costs, adjustments were applied to the costs for individual policy areas where necessary to mitigate the risk of overlap such that they can be aggregated into a total cost estimate.

In some policy areas legislation contains mechanisms for derogation or exemptions from environmental targets. This is the case for Water (related to the Water Framework Directive), Industrial Emissions and Major Accident Hazards (related to the Industrial Emissions Directive), and Circular Economy and Waste (several policies, including the Waste Framework Directive). In the cases of Water and Circular Economy and Waste, the analysis has identified where derogations and exemptions apply and assessed their potential impact on the implementation gap. For Industrial Emissions and Major Accident Hazards, the analysis explores the application of derogations in detail but given the approach to estimating the cost, an adjustment or comparison with and without derogations is not relevant. For the overall cost, the analysis has ultimately focused on the gap excluding consideration of these derogations and exemptions (in particular because many are due to expire over the next few years).

The majority of the remainder of the report is split into separate chapters with the assessment under each of the 8 policy areas. Each section follows the same common structure:

- outline of relevant EU environmental policies and legislation, including the most recent developments
- overview of the targets set by these sectoral directives and regulations
- assessment of the implementation gap, defined as the difference between the target and the actual environmental state (since the target has not been met) using the most recent data available
- estimate of the cost of the implementation gap, evaluating the impact on human health and the environment due to the unmet targets and monetizing this impact (all costs are presented in 2023 prices)
- forward look assessment, depicting how the implementation gap may evolve to 2030. Where significant policy proposals remain under consideration (i.e. where proposals have not yet been adopted, or where they have been adopted but the transposition window has not yet closed), these are considered as part of the 'forward-looking' element of the assessment.

A final section presents the cross-cutting analysis and brings together the conclusions of the study. Finally, the Appendices include: a comparison of the results to the preceding COWI et al. (2019) study, and additional detail on the methodology, data used in the analysis, and the description of additional pieces of legislation for each policy area.

2 Air

- Analysis focuses on the AAQ Directives and NEC Directive. Quantitative targets for concentrations of pollutants in ambient air (i.e. air quality standards) are set in the AAQ Directives and for reduction of emissions in the NEC Directive specified in Emission Reduction Commitments (ERCs) for various air pollutants. Source-specific and other legislation are not assessed directly to avoid double-counting of costs.
- In 2022, there were 788 instances where air pollutant concentrations were above the relevant standard across all Member States (reduced from 1,502 in 2015). Pollutants which had the largest number of locations where concentrations were above the standard were: ozone (491), BaP (207) and NO_2 (44). The proportion of urban and total populations exposed to air pollution levels above the standards has fallen to relatively low levels for many pollutants, but in 2022 16.6% of all EU residents were exposed to ozone and 11.9% to BaP concentrations above EU target values.
- 17 of 27 Member States are already meeting their 2020-29 ERCs in 2022. Of the rest, 7 Member States did not meet their target for one pollutant, and 3 Member States for two or more pollutants. The pollutant for which the greatest number of Member States did not meet their emissions reduction target was ammonia. In 69% of cases where an implementation gap remains for any pollutant, this gap is less than 10%. There is a wider compliance gap for ERCs set for 2030 onwards.
- The combined implementation gap cost to targets applying from 2020 (AAQ Directives air quality standards and NEC Directive 2020-29 ERCs) is estimated to range from €3.5 billion to 4.6 billion (or €9.0 billion to 10.0 billion under a high sensitivity where further impact pathways are included). With respect to targets applying from 2030 (NEC Directive 2030+ ERCs), the implementation gap is significantly larger, valued between €85 billion to 137 billion (or €267 billion to 312 billion including additional pathways).
- Going forward, it is anticipated that emissions of air pollutants will continue to decline and air quality will continue to improve. By 2030, emission reductions will be closer to 2030+ ERCs (relative to today), but compliance will not be complete across all Member States and pollutants – in particular for ammonia only 6 Member States could comply with 2030+ ERCs. More ambitious air quality standards to be attained from 2030 (reflecting improved evidence that air pollution can have detrimental impacts on health at lower concentrations) will increase the number of people living in areas exceeding air quality standards, but this does not yet account for additional action which will be taken to meet these more ambitious standards.

2.1 EU environmental policy and law

There are three key components of the EU's Clean Air Policy: the revised Ambient Air Quality Directive (or "AAQ Directive", Directive 2024/2881, which *inter alia* merged two previous Directives – Directive 2008/50/EC and Directive 2004/107/EC into one), the National Emissions Reduction Commitments Directive (NEC Directive, 2016/2284/EU), and a cohort of so-called 'source-specific' legislation. The revised AAQ Directive (and the two previous Directives) establish ambient air quality objectives to reduce harmful effects on human health and the environment, defined in terms of standards for concentrations of specific air pollutants to be met. They also describe the methods of assessing ambient air quality in Member States and requirements to remedy breaches of air quality standards and promotes transparency and cooperation between Member States. The NEC Directive sets national emission reduction commitments (ERCs) for the emissions of five pollutants (SO_2, NOx, non-methane volatile organic compounds (NMVOCs), NH_3 and $PM_{2.5}$). In addition, the NEC Directive requires Member States to produce national air pollution control programmes (NAPCPs) which set out how Member States intend to reach their reduction commitments, and air pollutant emission inventories and projections. The Directive also aims to enhance co-operation between different governance levels, recognising that action at different scales may be required to meet the air quality guidelines at national, regional, and local levels.

In addition to the AAQ Directive and NEC Directive, the EU has also put in place a range of 'source-specific' pieces of legislation aiming to tackle emission of pollutants to air from key sources, including from: road transport, non-road mobile machinery (NRMM), maritime transport, agriculture, energy and industrial sources, paint, and domestic heating. Source-specific legislation has not been assessed separately as part of the present study to avoid the risk of double counting of the costs of non-implementation.

The European Green Deal, adopted in 2019[6], introduced a set of policy initiatives with the overarching aim of making the EU climate neutral and environmentally sustainable by 2050. This included initiatives to further enhance the EU air quality legislation to avoid, prevent or reduce the harmful effects of air pollution on human health and the environment. The EU Action Plan 'Towards Zero Pollution for Air, Water and Soil' (also referred to as the 'Zero Pollution Action Plan' or 'ZPAP') was adopted by the Commission in 2021, with the aim to reduce air, water and soil pollution levels so that they are no longer considered harmful to health and natural ecosystems by 2050. As called for by the European Green Deal, a proposal for a revised AAQ Directive was adopted by the Commission in October 2022 and agreed by the co-legislators in 2024 and aligns European air quality standards more closely with the recommendations of the World Health Organisation (WHO)[7]. As a result, air quality standards for many pollutants have been tightened, in particular for $PM_{2.5}$ and NO_2.

2.2 Environmental target

The AAQ Directives and the NEC Directive each contain quantitative, measurable targets against which an implementation gap can be assessed. Information on pollutant-specific targets stipulated within key legislation and Member State-specific information where relevant are presented in the following subsections.

AAQD 2008/50/EC and AAQD 2004/107/EC

Pollutant-specific limits are detailed in Appendices VII, XI, XIII and XIV of Directive 2008/50/EC (and in Annex I of Directive (EU) 2024/2881, for particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides (NO_2), sulphur dioxides (SO_2), benzene, carbon monoxide, lead and ozone (O_3)). In some cases, multiple standards are defined for the same pollutant but over different time periods. Furthermore, standards to protect human health are specified in different ways, in terms of time-bound concentrations and as average exposure indicators.

There are also targets for the protection of vegetation under concentration limits of O_3, NOx and SO_2. Long-term objectives for O_3 exposure for both the protection of human health and vegetation are set out in Appendix VII part C. However, these did not yet have a defined date by which the long-term objective should be met. The standards that are the focus of the study are included in the following table. Note that Directive (EU) 2024/2881 sets long-term objectives for O_3 to be attained by 2050.

Directive 2004/107/EC sets target values for other pollutants not within the scope of Directive 2008/50/EC, namely arsenic, cadmium, nickel and benzo(a)pyrene (BaP). These target values are laid out in Annex I of this Directive – Directive (EU) 2024/2881 confirms and updates these air quality standards. In zones or agglomerations where these values are exceeded, Member States must specify the sources contributing.

[6] https://commission.europa.eu/publications/communication-european-green-deal_en
[7] See the latest WHO Air Quality Guidelines, published September 2021. Available at: https://iris.who.int/handle/10665/345334.

Table 2-1: Air quality standards for concentrations of pollutants for the protection of human health as per Directives 2008/50/EC and 2004/107/EC

Pollutant	Averaging period	Health protection concentration value and exceedances permitted per year	Date by which limit/ target value is to be met
Sulphur Dioxide (SO_2)	One day (24 hrs)	125 µg/m³, not to be exceeded more than 3 times in any calendar year	1 January 2005
Nitrogen dioxide	One year	40 µg/m³	1 January 2010
Particulate matter (PM_{10})	One year	40 µg/m³	1 January 2005
	One day (24 hrs)	50 µg/m³, not to be exceeded more than 35 times per calendar year	1 January 2005
Particulate matter ($PM_{2.5}$)	One year	25 µg/m³ (Stage 1)	Target value: 1 January 2010 Limit value: 1 January 2015
	One year	20 µg/m³ (Stage 2)	1 January 2020[8]
Lead (Pb)	1 year	0.5 mg/m³	Limit value to be met as of 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m3 limit value applied from 1.1.2005 to 31.12.2009)
Carbon monoxide (CO)	Maximum daily 8 hour mean	10 mg/m³ not to be exceeded on more than 25 days per calendar year averaged over three years	1 January 2005
Benzene	1 year	5 µg/m³	1 January 2010
Ozone (O_3)	Maximum daily 8 hour mean	120 µg/m³ not to be exceeded on more than 25 days averaged over 3 years.	1 January 2010
Arsenic (As)	Calendar year	6 ng/m³	31 December 2012
Cadmium (Cd)	Calendar year	5 ng/m³	31 December 2012
Nickel (Ni)	Calendar year	20 ng/m³	31 December 2012
Polycyclic Aromatic Hydrocarbons (PAH)	Calendar year	1 ng/m³ (expressed as concentration of Benzo(a)pyrene[9] or BaP)	31 December 2012

NEC Directive (EU) 2016/2284

The NEC Directive stipulates national emission reduction commitments (ERCs) per Member State. The reduction commitments are expressed as percentages relative to 2005 emission levels and are defined for two time periods: 2020-2029 and 2030 onwards (Table 2-2). The reduction commitments defined for 2020 to 2029 imply that the reduction stipulated must be met in 2020, and in every year after. Member States should display a

[8] Stage 2 limit value is not included in the implementation gap analysis as it is not a legally binding target. However, it is referred to in the cost analysis to illustrate the impact of tighter standards.
[9] Benzo(a)pyrene is measured as a marker of the carcinogenic risk of polycyclic aromatic hydrocarbons in ambient air.

continuing, linear reduction over the 2020-29 period to avoid the need for a steep step-down in 2030, or if not explain why in their NAPCPs.

Table 2-2: Member State reduction commitments for all pollutants compared with 2005 levels (for any year from 2020 to 2029 and 2030).

Member State	SO_2 reduction		NOx reduction		NMVOC reduction		NH_3 reduction		$PM_{2.5}$ reduction	
	2020-29	2030	2020-29	2030	2020-29	2030	2020-29	2030	2020-29	2030
Austria	26%	41%	37%	69%	21%	36%	1%	12%	20%	46%
Belgium	43%	66%	41%	59%	21%	35%	2%	13%	20%	39%
Bulgaria	78%	88%	41%	58%	21%	42%	3%	12%	20%	41%
Croatia	55%	83%	31%	57%	34%	48%	1%	25%	18%	55%
Cyprus	83%	93%	44%	55%	45%	50%	10%	20%	46%	70%
Czech Republic	45%	66%	35%	64%	18%	50%	7%	22%	17%	60%
Denmark	35%	59%	56%	68%	35%	37%	24%	24%	33%	55%
Estonia	32%	68%	18%	30%	10%	28%	1%	1%	15%	41%
Finland	30%	34%	35%	47%	35%	48%	20%	20%	30%	34%
France	55%	77%	43%	69%	43%	52%	4%	13%	27%	57%
Germany	21%	58%	13%	65%	13%	28%	5%	29%	26%	43%
Greece	74%	88%	54%	55%	54%	62%	7%	10%	35%	50%
Hungary	46%	73%	34%	66 %	30%	58%	10%	32%	13%	55%
Ireland	65%	85%	49%	69%	25%	32%	1%	5%	18%	41%
Italy	35%	71%	40%	65%	35%	46%	5%	16%	10%	40%
Latvia	8%	46%	32%	34%	27%	38%	1%	1%	16%	43%
Lithuania	55%	60%	48%	51%	32%	47%	10%	10%	20%	36%
Luxembourg	34%	50%	43%	83%	29%	42%	1%	22%	15%	40%
Malta	77%	95%	42%	79%	23%	27%	4%	24%	25%	50%
Netherlands	28%	53%	45%	61%	8%	15%	13%	21%	37%	45%
Poland	59%	70%	30%	39%	25%	26%	1%	17%	16%	58%
Portugal	63%	83%	36%	63%	18%	38%	7%	15%	15%	53%
Romania	77%	88%	45%	60%	25%	45%	13%	25%	28%	58%
Slovakia	57%	82%	36%	50%	18%	32%	15%	30%	36%	49%
Slovenia	63%	92%	39%	65%	23%	53%	1%	15%	25%	60%
Spain	67%	88%	41%	62%	22%	39%	3%	16%	15%	50%
Sweden	22%	22%	36%	66%	25%	36%	15%	17%	19%	19%

2.3 Implementation gap

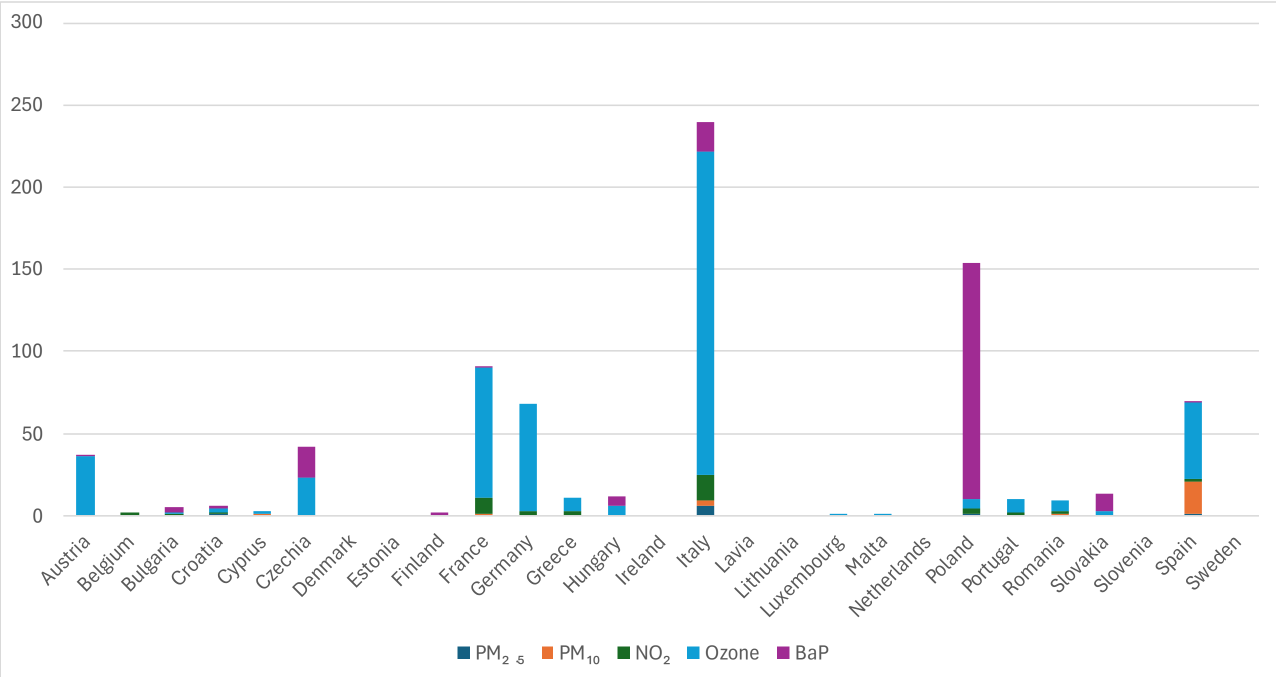
2.3.1 Analysis

There are multiple targets associated with air quality, covering concentrations (AAQ Directives) and emissions of (NEC Directive) air pollutants. The following analysis uses data to assess the implementation gap relative to these targets. For the AAQ Directives this includes analysis of sampling points where concentrations are above limit or target values, total population exposure counts and urban population exposure counts. For the NEC Directive, this analysis focuses on 2022 emissions inventory data compared to the emission reduction commitments per Member State.

AAQ Directives implementation gap

The total ***number of instances (based on number of sampling points) where air pollutant concentrations are above the applicable limit or target value*** for key pollutants across Member States are displayed in the figure below (using the latest available validated data for 2022[10]). Table A2-10-3 splitting this data by pollutant and Member State for 2022 is presented in Appendix 2. For $PM_{2.5}$, PM_{10} and SO_2 Member States can discount the contribution of natural sources (and winter road sanding/salting under specific circumstances) to the total concentrations for compliance assessments but contributions from these sources are not excluded from this analysis.

Figure 2-1: Number of sampling points where concentrations of key pollutants are above limit or target values, split by Member State in 2022[11, 12]



Overall, there were a total of 788 instances where the concentration of an air pollutant was above the applicable limit or target value across all Member States in 2022. The pollutants which had the largest number of locations where concentrations were above the standard were: the target values for ozone (491) and BaP

[10] Provisional data for 2023 is available, but this analysis uses the most recent set of validated data from 2022.
[11] EEA, 2024. AQ eReporting – Annual Statistics. Available at: https://www.eea.europa.eu/en/analysis/maps-and-charts/air-quality-statistics-dashboards.
[12] The EU standards assessed in this figure the annual limit values for $PM_{2.5}$, PM_{10}, NO_2, Lead, Benzene, Arsenic, Cadmium, Nickel and Polycyclic Aromatic Hydrocarbons, the 24-hour limit value for SO_2 and the maximum daily 8 hour mean or CO and Ozone.

(207), and the limit value for NO_2 (44). Four pollutants (SO_2, lead, carbon monoxide and benzene) did not have any recorded instances of concentrations above relevant standards in 2022, and Cadmium recorded only one (hence these pollutants are not captured in Figure 2-1). Arsenic and nickel also had very few instances where concentrations were above the relevant target values (6 and 4 respectively, and hence these are also not presented in the figure above).

Across Member States, concentrations of at least one air pollutant were above the relevant limit or target value for at least one sampling location in 19 different Member States. The Member States with the most instances of concentrations above relevant standards were: Italy, Poland and France (241, 156 and 92 respectively). In terms of numbers of different pollutants for which this was the case, Italy recorded locations where concentrations were above the relevant standard for 6 different pollutants, followed by Poland, France and Spain (5 different pollutants each).

Since 2015 (reference year for analysis in COWI et al. (2019)), the number of instances where concentrations of a pollutant (not including ozone)[13] was above the limit or target value reduced from 740 in 2015 to 297 in 2022 across all Member States. A comparison by Member State is presented in the Figure 2-2 below, and in summary (and in each case not including ozone):

- Three Member States recorded a higher number of instances than in 2015: from 8 extra counts for Czechia, 5 extra counts for Slovakia and 2 in Romania.
- Six Member States (Cyprus, Finland, Ireland, Latvia, Malta and Slovenia) recorded the same number of instances in 2022 compared to 2015.
- 18 Member States have recorded fewer instances in 2022 than 2015, with the largest reductions in Germany (150 fewer), Italy (119 fewer) and Poland (58 fewer).

Figure 2-3 and Figure 2-4 show the trend in number of sampling points where concentrations of a pollutant are above the relevant standard, for different pollutants, across all Member States between 2015 and 2022. For all pollutants (except nickel), the number of sampling points where concentrations are above the relevant standard in 2022 is lower than in 2015.

Data to track progress against air quality standards is measured at specific points (sampling locations), however it is exposure to these concentrations which drive human and environmental health impacts. The EEA reports that at the EU-27 level in 2022, less than 1% of the ***urban population were exposed to concentrations*** of $PM_{2.5}$ and NO_2 above EU air quality standards, whereas 9% were exposed to PM_{10} concentrations (daily limit value) and 19% to ozone concentrations above air quality standards (Figure 2-5). The percentage of EU urban population exposed to air pollution concentrations above quality standards has generally decreased to 2022, compared to 2015 (Figure 2 5).

[13] Ozone is not included in the comparison as exceedance for ozone depends much more on meteorological conditions in a given year relative to other pollutants, which challenges comparison between 2015 and 2022.

Figure 2-2: Number of instances (based on sampling points) where concentrations are above relevant limit or target values (all pollutants except ozone) by Member States in 2022 compared to 2015[14, 15]

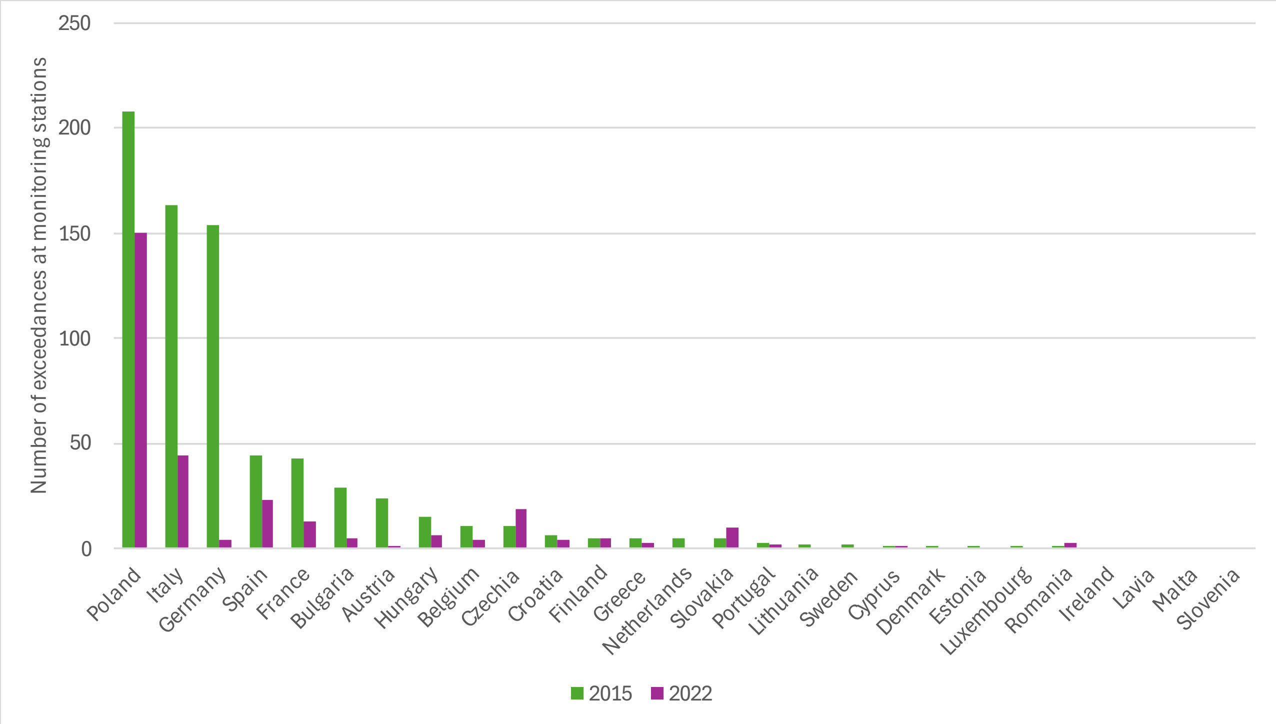
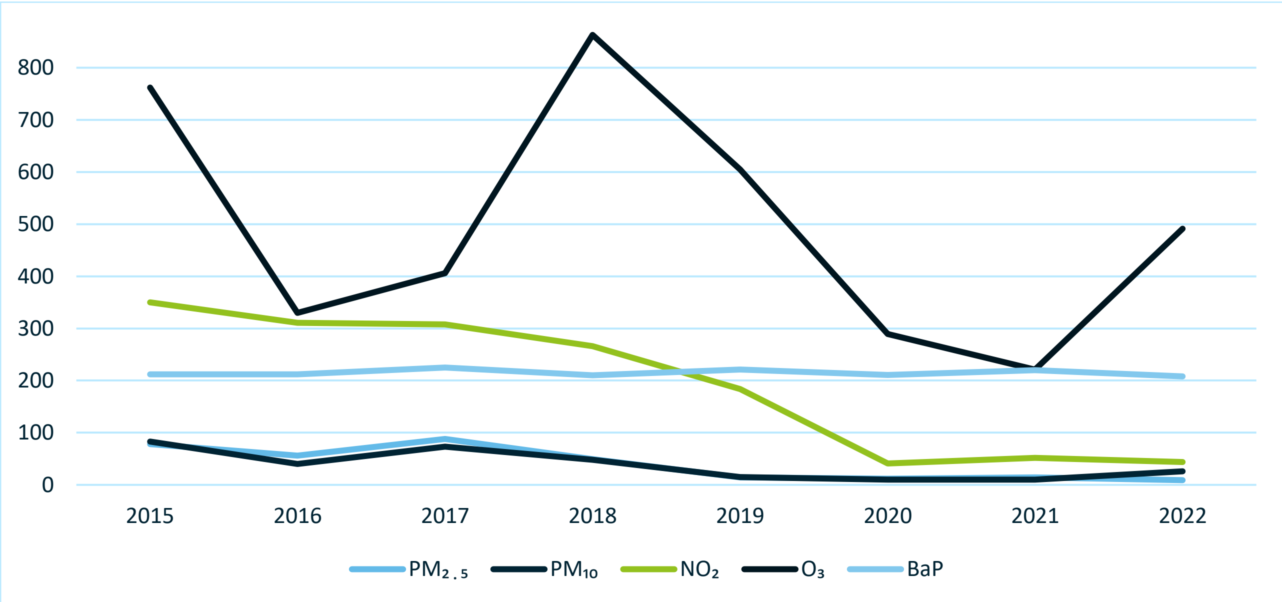


Figure 2-3: Number of recorded sampling points where concentrations are above relevant limit or target values for selected air pollutants, EU-27 (2015-2022)[14, 15]



[14] EEA, 2024. AQ eReporting – Annual Statistics. Available at: https://www.eea.europa.eu/en/analysis/maps-and-charts/air-quality-statistics-dashboards.

[15] The EU standards assessed in this figure the annual limit values for PM2.5, PM10, NO2, Lead, Benzene, Arsenic, Cadmium, Nickel and Polycyclic Aromatic Hydrocarbons, the 24-hour limit value for SO2 and the maximum daily 8 hour mean or CO and Ozone.

Figure 2-4: Number of recorded sampling points where concentrations are above relevant limit or target values for selected air pollutants, EU-27 (2015-2022)[14, 15]

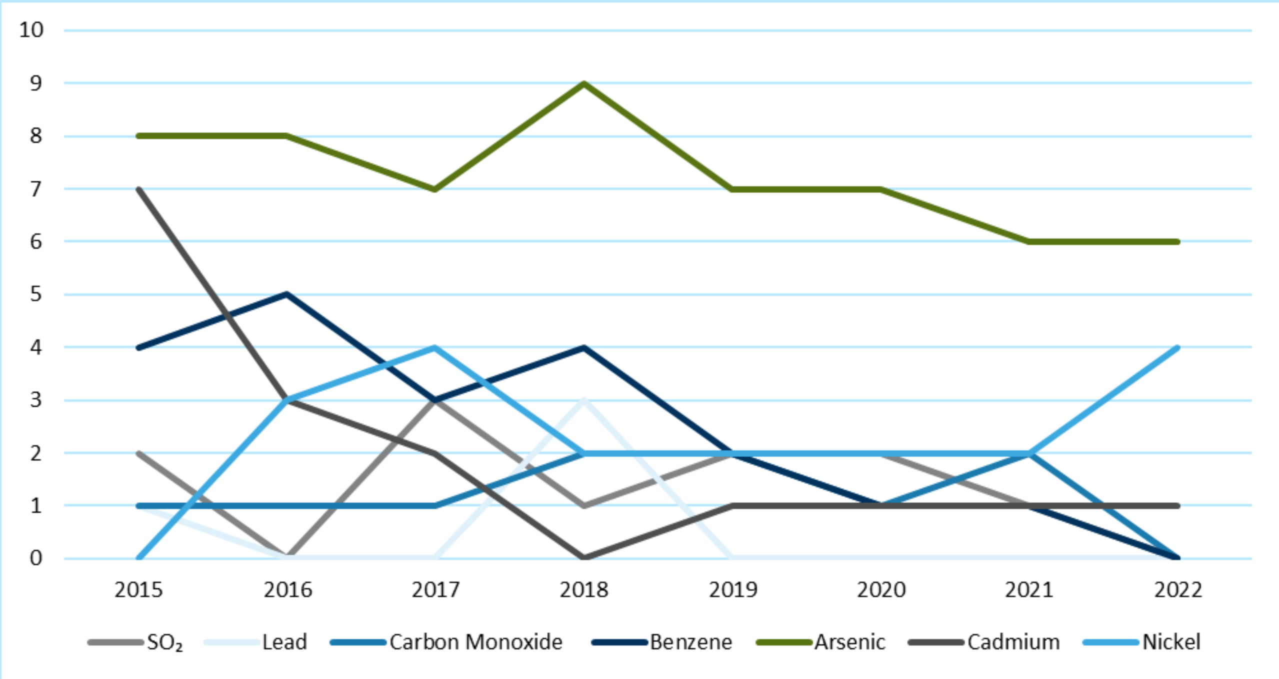
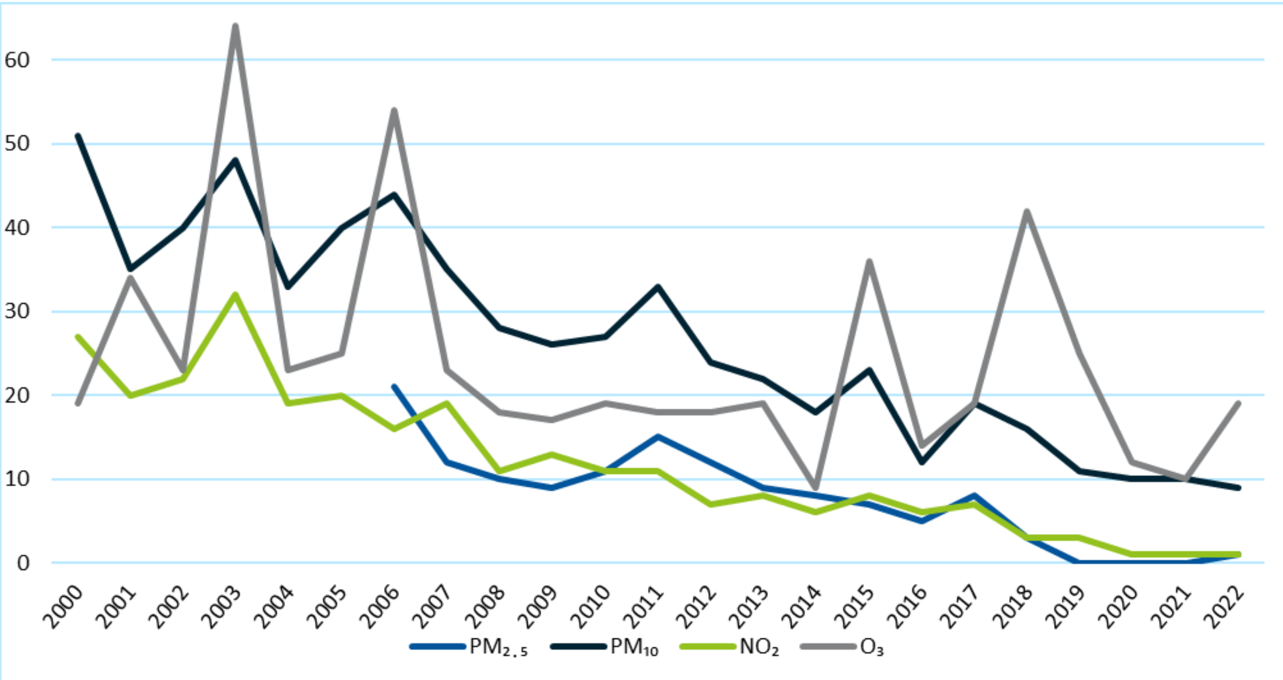


Figure 2-5: Percentage of urban population exposed to air pollutant concentrations above relevant limit or target values for selected air pollutants, EU-27[16], [17], [18]



Note: PM_{10} based on daily average metric

[16] EEA, 2024. Exceedance of air quality standards in Europe. Available at: https://www.eea.europa.eu/en/analysis/indicators/exceedance-of-air-quality-standards

The EEA reports that more than 70% of EU citizens live in urban areas[19], meaning a majority of those exposed to poor air quality are likely to reside in these areas. Data is also available to consider ***total population exposure*** at both the EU-27 level and disaggregated by Member State[20]. Table 2-3 shows the total exposed population at the EU-27 level for individual pollutants in 2022. As for urban population, the proportion of all EU27 citizens exposed to pollutant concentrations above standards for PM_{10}, $PM_{2.5}$ and NO_2 is very small, however a significant number of people were exposed to levels of ozone and BaP above their relevant standard in 2022.

Table 2-3: Total population living in areas with concentrations above standards for particular pollutants (EU27) (2022)

Pollutant	Total exposed EU27 population (%)	Population equivalent
PM_{10} (annual average)	0.2%	740,000
$PM_{2.5}$	0.2%	790,000
O_3	16.6%	72,700,000
NO_2	0.2%	1,040,000
BaP	11.9%	52,600,000

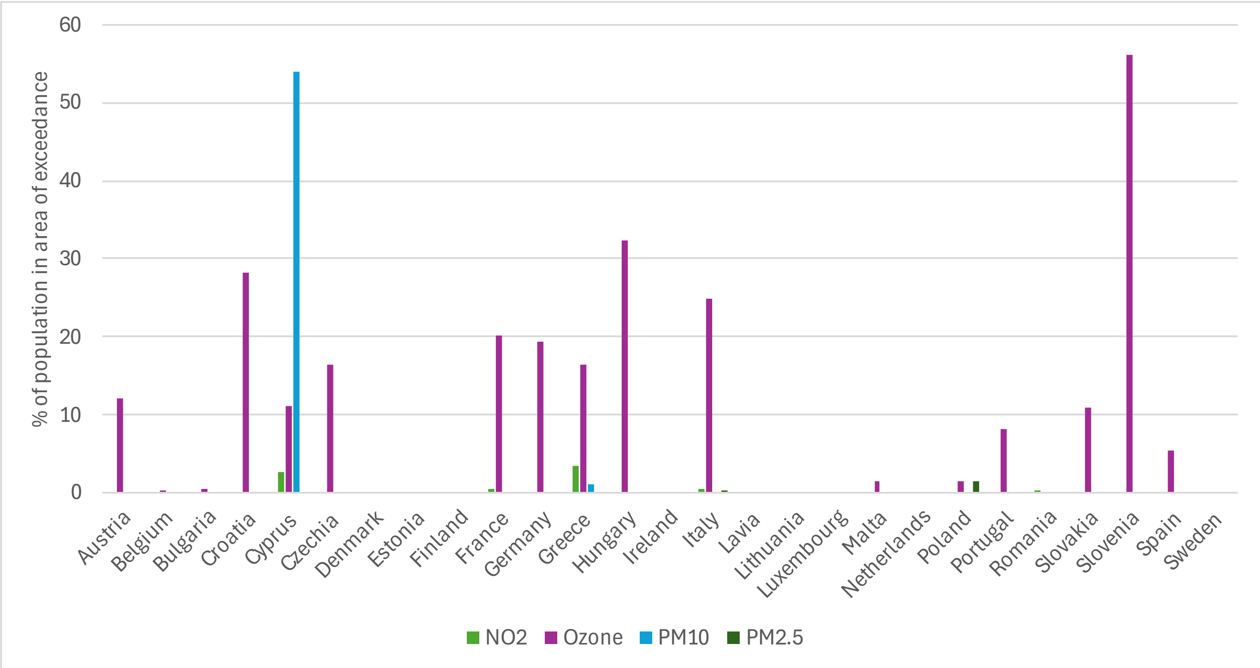
Figure 2-6 presents the proportion of population living in areas with pollutant concentrations above air quality standards by each Member State for four key pollutants (also presented in Table A2-10-5 in Appendix 2). As of 2022:

- 9 Member States did not have any population exposed to air pollution levels above EU air quality standards for four key pollutants
- For the 18 Member States with populations exposed to air pollutant concentrations above standards for the four selected pollutants:
  - 17 Member States have populations that are exposed to ozone levels above the target value, with Slovenia having the greatest population exposed at 56.1%.
  - Five Member States had populations exposed above the limit value for NO_2, and two Member States had population exposed above limit values for $PM_{2.5}$ and PM_{10}.

[17] The values for PM_{10} shown on this graph represent the population exposed to *daily concentrations exceeding 50µg/m³ for more than 35 days per year*. This figure does not include emission data for SO_2. This is because in all years between 2010 and 2022, less than 0.1% of the urban population were exposed to exceedances of the pollutant (with a maximum of 2% in 2004).
[18] The EU standards assessed in this figure are : annual limit value for $PM_{2.5}$ and NO_2, the daily value for PM_{10}, the target value threshold for O_3 for the protection of human health.
[19] Data extracted in October 2022. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Urban-rural_Europe_-_introduction
[20] Horálek, J. et al. (2024). ETC HE Report 2024/4: Air quality maps of EEA member and cooperating countries for 2022. PM10, PM2.5, O3, NO2, NOx and BaP spatial estimates and their uncertainties. Eionet Portal. Available at: https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-reports/etc-he-report-2024-4-air-quality-maps-of-eea-member-and-cooperating-countries-for-2022-pm10-pm2-5-o3-no2-nox-and-bap-spatial-estimates-and-their-uncertainties

For BaP, assessing this regionally[21], most exposure to concentrations above the target value were in South-Eastern Europe (without Türkiye) and in Central Europe. Western Europe (excluding the UK) did not have any population exposed to concentrations above the target value.

Figure 2-6: Percentage of total population exposed to air pollutant concentrations above relevant limit or target values for selected air pollutants (2022)



NEC Directive implementation gap

Figure 2-7 shows that emissions of all pollutants covered by ERCs in the NEC Directive have decreased since 2005 at the EU-27 level. The sharpest decreases have been experienced for SO_2 and NOx, with the smallest reduction being in ammonia emissions. Since 2016 (reference years used for COWI et al. (2019)) emissions of all pollutants have reduced to 2022, although this progress has not in all circumstances been linear (see also Table A2-10-7 and Table A2-10-8 in the Appendix 2).

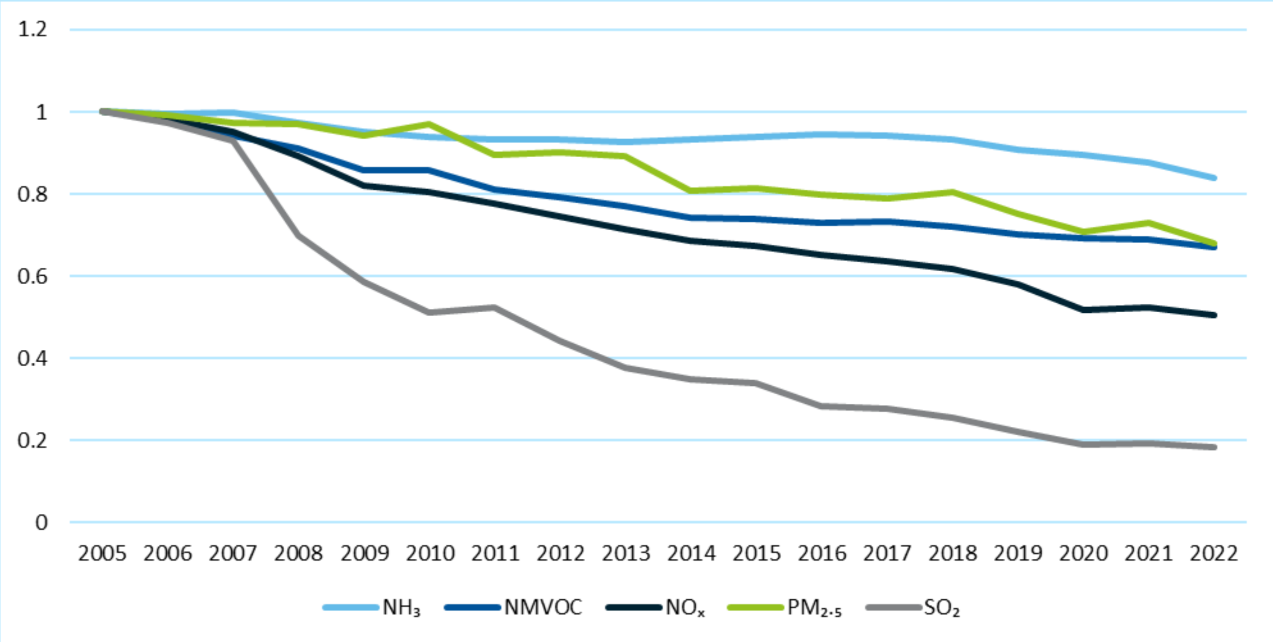
However, emission reductions in some cases have fallen short of the objectives set[22]. Figure 2-8 shows how close Member States are to ERCs stipulated for 2020-29 based on 2022 emissions data. Overall:

- 17 of 27 Member States in 2022 are already meeting their NEC Directive ERCs for 2020-2029 relative to 2005 values for all pollutants. All other Member States did not meet their ERCs for at least one pollutant.
- Seven Member States did not meet their ERCs for one pollutant (Austria, Bulgaria, Cyprus, Ireland, Latvia, Portugal and Sweden).

[21] Exposure data for BaP is not available on a Member State level. Country groupings are as follows: Western Europe refers to Belgium, France north of 45 degrees, Ireland, Luxembourg, Netherlands; Central Europe refers to Austria, Czechia, Germany, Hungary, Liechtenstein, Poland, Slovakia, Slovenia, Switzerland; and South-Eastern Europe refers to Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, North Macedonia, Romania, Serbia including Kosovo under the UN Security Council Resolution 1244/99.
[22] See Aether (2024), 'Final horizontal review report - Review of National Air Pollutant Emission Inventory Data 2024 under Directive 2016/2284': https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/8c979d9e-7c23-4b30-ba1e-4c9a58e3e754/details?download=true. Note: the compliance dashboard in the horizontal review report takes into account the flexibilities when specifying distance to ERC.

- Two Member States (Hungary and Romania) did not meet their ERCs for two pollutants and one Member State (Lithuania) has not met their ERCs for three.

Figure 2-7: Trends in pollutants (relative to base year 2005, EU-27 level)[23]

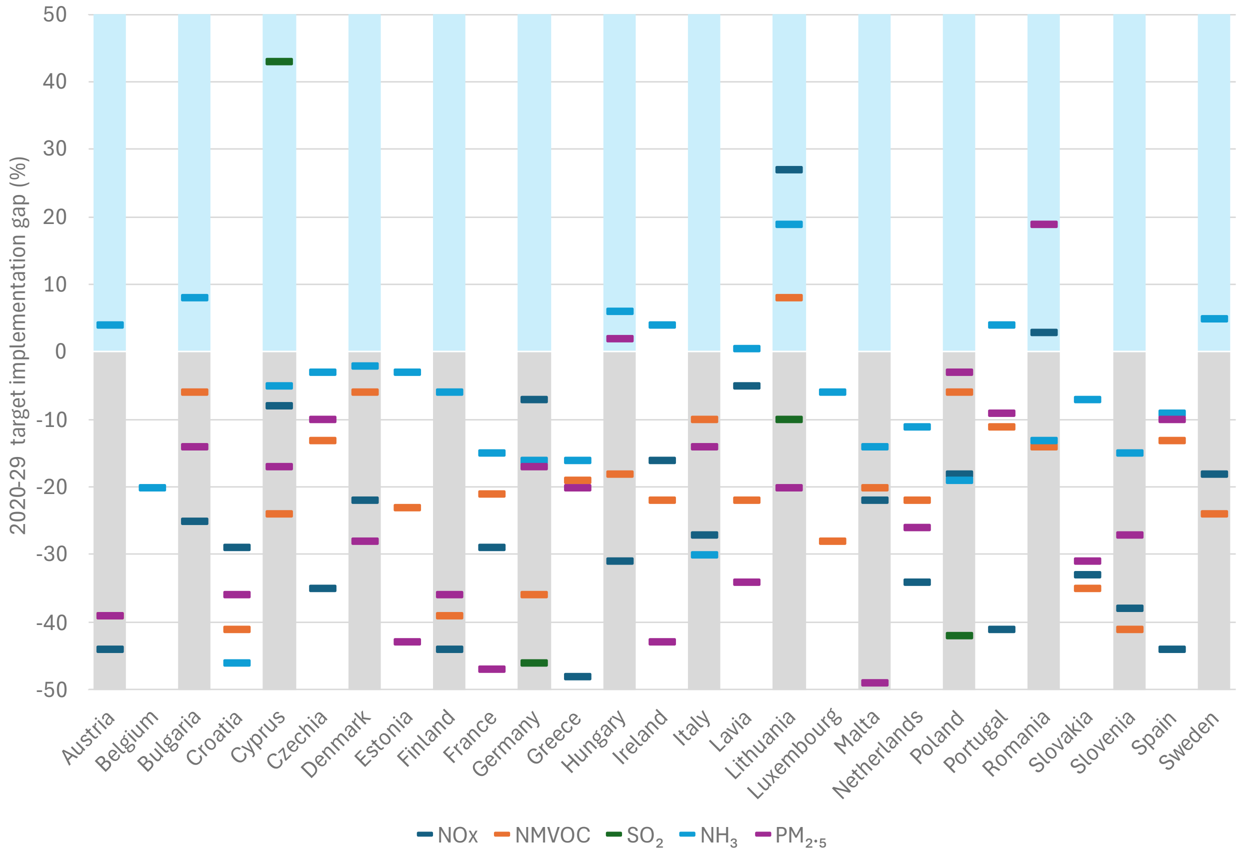


The pollutant for which the greatest number of Member States exceeded their ERCs was ammonia (8 Member States). Indeed, compared to 2005 levels, emissions of ammonia have increased for 4 Member States.

Figure 2-8 also displays the distance to the ERC for each Member State with respect to each pollutant. Across all pollutants and Member States, there are 14 exceedances. In 10 cases the gap to target is less than 10%. Of these instances, 5 had a gap of 5% or less. Of the 8 Member States not reaching their ERC for ammonia, 7 had a gap of less than 10%. For NO_x, 1 of the 2 Member States not reaching ERCs need to reduce emissions by less than 10%. For both ammonia and NO_x, Lithuania is the only Member State that needs to reduce emissions by more than 10% relative to 2005 levels (19% and 27% respectively). Cyprus's SO_2 emissions represent the greatest implementation gap associated with the NEC Directive 2020-2029 ERCs, for which a 43% reduction is needed.

[23] EEA, 2024. Air pollution in Europe: 2024 reporting status under the National Emission reduction Commitments Directive. Available at: https://www.eea.europa.eu/publications/national-emission-reduction-commitments-directive-2024

Figure 2-8: NECD pollutant emissions and implementation gaps (based on 2022 emissions, relative to 2020-2029 ERCs)[24]



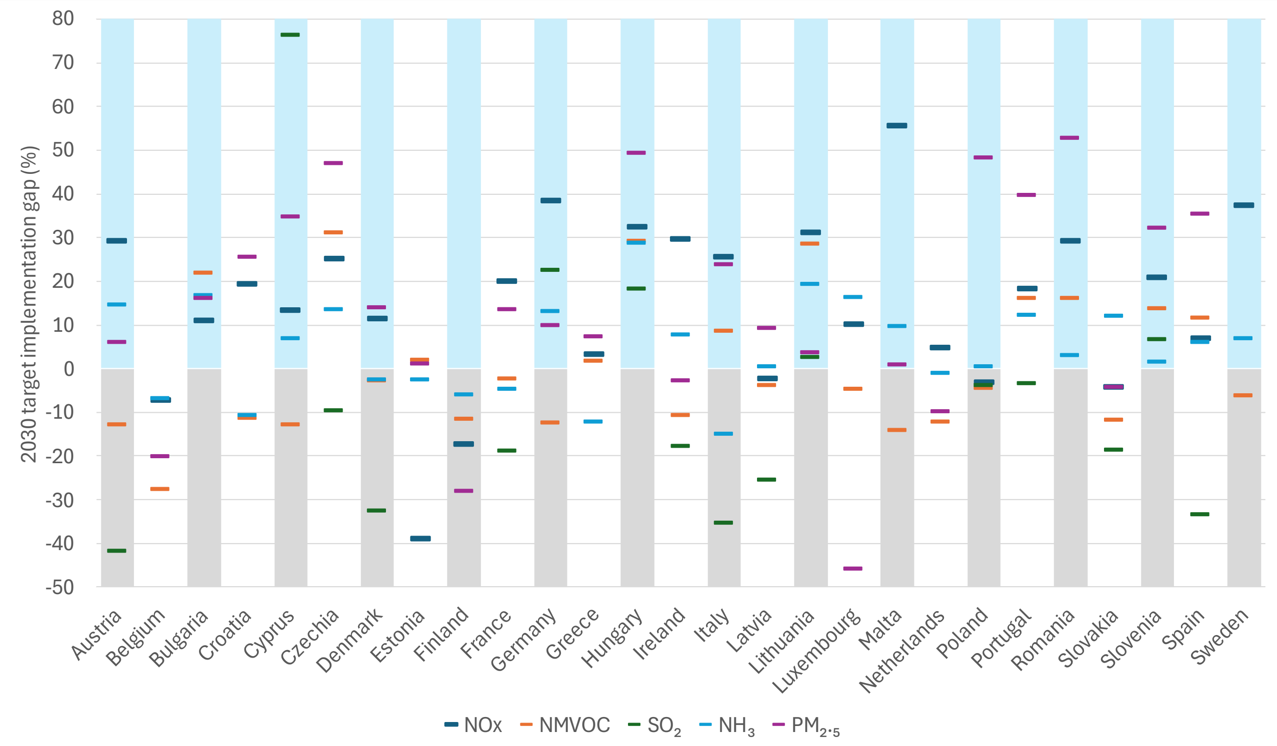
Note: minimum on y-axis has been set to -50% to ensure clarity in the chart. Some Member States achieved even more significant reductions against pollutant targets in 2020-29, which are not shown on the chart[25].

Figure 2-9 presents the implementation gap relative to the 2030 NEC Directive ERCs. It shows that all Member States (except for Belgium and Finland) are not currently compliant with the 2030 ERCs for at least one pollutant, based on the most recent 2022 emission inventories, reported in 2024. Three Member States are not currently meeting 2030 ERCs for any pollutants (Hungary, Lithuania and Slovenia). The most significant reductions needed to reach 2030 targets are in NO_x emissions, with 21 Member States currently non-compliant. This is followed by $PM_{2.5}$ with 20 Member States, NH_3 with 18 Member States, NMVOC with 11 Member States and SO_2 with 5 Member States. The pollutant for which the most significant reductions are needed is $PM_{2.5}$, with 8 Member States (Cyprus, Czechia, Hungary, Poland, Portugal, Romania, Slovenia and Spain) needing to reduce by over 30% relative to 2005 levels to reach their respective ERCs.

[24] See: Aether (2024): FINAL HORIZONTAL REVIEW REPORT - Review of National Air Pollutant Emission Inventory Data 2024 under Directive 2016/2284 (NEC Directive); https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/8c979d9e-7c23-4b30-ba1e-4c9a58e3e754/details?download=true

[25] The pollutants and Member States not shown on the graph are: (i) Belgium, Estonia and Luxembourg for NO_x; (ii) Belgium for NMVOC; (iii) all Member States except Cyprus, Germany, Lithuania and Poland for SO_2 and (iv) Belgium and Luxembourg for $PM_{2.5}$. No Member State achieved beyond a -50% reductions for NH_3.

Figure 2-9: NECD pollutant emissions and implementation gaps (based on 2022 emissions, relative to 2030+ ERCs)



Note: minimum on y-axis has been set to -50% to ensure clarity in the chart. Some Member States have achieved even more significant reductions against 2030+ ERCs, which are not shown on the chart[26].

2.3.2 Limitations and uncertainties of the analysis

The data used for the analysis of whole population exposure to air pollution in exceedances of standards are taken from the ETC HE Report 2024/4[27]. Generally, an assessment of exposure carries a greater level of uncertainty as it inherently captures additional assumptions regarding the placement of population, usually based on where people reside. Data reported for BaP are not as granular as other pollutants and the map created for BaP is labelled as experimental due to differences in methodology. The authors state that these differences mean that the map for BaP does not yet meet the same accuracy standards as the maps for the other pollutants. There is also no split by Member State for BaP, instead, estimates are grouped together into Northern, Western, Central, Southern and South-Eastern Europe and by EU-27.

[26] The pollutants and Member States not shown on the graph are: (i) Belgium, Bulgaria, Croatia, Estonia, Finland, Greece, Luxembourg, Malta, Netherlands, Romania, Sweden for SO_2; and (ii) Sweden for $PM_{2.5}$.
[27] Horálek, J. et al. (2024). Available at: https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-reports/etc-he-report-2024-4-air-quality-maps-of-eea-member-and-cooperating-countries-for-2022-pm10-pm2-5-o3-no2-nox-and-bap-spatial-estimates-and-their-uncertainties

All data informing the analysis of the implementation gap regarding the NEC Directive are derived from the reviewed air pollutant emission inventory data reported in 2024[28]. These data are available for each Member State for NH_3, NMVOC, NOx, $PM_{2.5}$ and SO_2 and are reported annually by Member States under Directive 2016/2284. In the 2022 data (reported in 2024), the compliance dashboard in the horizontal review report takes into account the flexibilities when specifying distance to ERC.

2.4 Implementation gap cost

2.4.1 Analysis

Assessment of health impacts of exposure to harmful levels air pollution has been undertaken in many studies at EU and Member State level using well established methodologies (a recent example is Medina et al (2025), who estimate a monetised health and wellbeing impact of reducing levels of $PM_{2.5}$ and NO_2 to anthropogenic thresholds in France)[29]. Analysis is carried out in two parts. The first quantifies the damage associated with concentrations of air pollution above limit values for $PM_{2.5}$, PM_{10} and NO_2 and target values for ozone, and the second, below for the NECD.

AAQ Directive standards

Damage for $PM_{2.5}$, PM_{10} and NO_2 is calculated as the product of:

- Population weighted mean concentration in excess of the annual mean limit value for each pollutant
- The population affected by concentrations above the annual mean limit value
- Damage cost per person per unit pollutant exposure. These damage costs have been quantified using the latest version of the ALPHA-Riskpoll model (ARP), and as such are fully consistent with the assumptions used for benefits assessment in Clean Air Outlook 4 (CAO4)[30].

Given that the areas affected by annual mean concentrations above the limit values for these pollutants are small, it is considered here that action to meet the requirements of the Directive would be localised, and that benefits to surrounding populations would be small. The calculated cost of inaction here is therefore restricted to the population experiencing concentrations above the limit values. Two sensitivities, also explored in the recent analysis for CAO4, have been investigated:

1. Valuation of mortality using the value of a life year (VOLY) or the value of statistical life (VSL) for both PM and NO_2
2. For $PM_{2.5}$ and PM_{10}, inclusion of sensitivity functions for dementia and diabetes, recognising the higher uncertainty associated with these effects (Forastiere et al, 2024 [31]).

The method used for ozone is different to that for the other pollutants given: (a) the form of the target is different, relating to the number of daily exceedances of the standard (120 $\mu g.m^{-3}$), rather than exceedance of an annual mean concentration, and (b) exceedances of target values are linked to ozone being a secondary pollutant, formed from reactions involving NOx and VOCs. These reactions are weather dependent and generate ozone

[28] https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/08a061a3-20c5-40c6-a537-49927eb22fc2/details?download=true
[29] https://www.santepubliquefrance.fr/presse/2025/asthme-accident-vasculaire-cerebral-diabete-quels-impacts-de-la-pollution-de-l-air-ambiant-sur-la-sante-et-quel-impact-economique
[30] IIASA (2025) Support to the development of the fourth Clean Air Outlook. Under European Commission Framework FRA/C.3/ ENV/2021/OP/0017; https://op.europa.eu/en/publication-detail/-/publication/4d746ab1-f7de-11ef-b7db-01aa75ed71a1/language-en
[31] Forastiere 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, August 2024. | DOI: 10.1097/EE9.0000000000000314.

for some distance from the source of emissions. The timing of exceedances at any location will be variable and difficult to predict. To estimate the costs for ozone, EEA data were obtained showing the 93.15%ile of annual mean daily 8-hour-peak concentrations[32]. The highest value was selected from data from the monitoring stations in each country in each year from 2018 to 2022 to account for inter-annual variability in ozone concentrations, and the percentage reduction needed to bring this down to the limit was calculated. Assuming that compliance would require action across affected countries, costs of inaction accrue to the whole population, not only those in areas where the limit is exceeded. The required percentage reduction in concentration (mean SOMO35 covering the years 2018 to 2022) was therefore multiplied by the national population and by unit damage costs, again calculated using the ARP model. For ozone, only the VOLY was applied for mortality valuation, reflecting uncertainties in interpretation of ozone mortality outputs.

Input data for the assessment of non-compliance with air quality limit values are provided in Table A2-10-10 (see Appendix 2) showing the population in areas of exceedance defined by concentration ranges[33]. The table also indicates the national average SOMO35 reduction required to meet the ozone target as described above, calculated as a 5-year average (2018 to 2022) in recognition of the inter-annual variability in ozone concentrations. Table A2-10-11 (see Appendix 2) shows damage costs per person per year per µg.m^{-3} for $PM_{2.5}$ and NO_2, and per person per year per ppb.hour for O_3. Resulting damage costs by pollutant and limit value are shown in Table 2-4. The largest damage estimates are for O_3, with little difference between PM_{10}, $PM_{2.5}$ and NO_2 for which quantified ranges overlap. The countries with the highest damage are Italy (mainly ozone), Cyprus (mainly PM_{10}), Germany (O_3), Greece (mainly NO_2), Poland (mainly $PM_{2.5}$) and Spain (O_3).

Total damage by country and overall is shown in Table 2-5. The following approach was used to avoid double counting when combining estimates across pollutants. Following practice elsewhere (e.g. CAO4) it is assumed that ozone impacts are independent of damage from $PM_{2.5}$ and NO_2:

- For Cyprus, where concentrations were above limit values for PM_{10} and NO_2, results for the pollutant giving the higher result (PM_{10}) were used. The impact on results is trivial, with the NO_2 effects being less than 1% of the estimates for PM_{10}.

- For Greece, where again concentrations were above limit values for PM_{10} and NO_2, results for the pollutant giving the higher result (NO_2) were used. NO_2 impacts were roughly twice those of PM_{10}, so omissions of the latter could make a significant contribution to underestimation of damage at least at the national level.

- For Italy, where concentrations were above limit values for $PM_{2.5}$ and NO_2, results for the pollutant giving the higher result ($PM_{2.5}$) were used. Effects on the national total are small given the dominance of O_3 in this case.

No other countries observed concentrations above the relevant standard for more than one pollutant.

Note the estimates made here are different to the health damages caused by air pollution as estimated in Clean Air Outlook 4[34], which estimated the total burden associated with exposure to all concentrations of air pollution from 2030 onwards, rather than the gap between current exposure and air quality targets.

[32] Which corresponds to the 25th highest daily 8-hour maximum concentration.
[33] Population in areas of exceedance taken from the following link. Concentrations to which this population are exposed are derived from data at this link and underlying concentration maps. https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-reports/etc-he-report-2024-4-air-quality-maps-of-eea-member-and-cooperating-countries-for-2022-pm10-pm2-5-o3-no2-nox-and-bap-spatial-estimates-and-their-uncertainties
[34] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025DC0064&qid=1741360484886

Table 2-4: Damage costs from concentrations above air quality standards in 2022 for $PM_{2.5}$, PM_{10} and NO_2, and for ozone averaged values 2018 to 2022. €million/year, 2023 prices. Ranges reflect sensitivity to inclusion impact pathways. Includes only countries where population were exposed to concentrations above at least one standard

	$PM_{2.5}$		PM_{10}		NO_2		O_3
	VOLY	VSL	VOLY	VSL	VOLY	VSL	VOLY
Austria							13
Belgium							4.4
Bulgaria							4.0
Croatia							7.1
Cyprus			95 to 158	219 to 282	0.19	0.53	0.87
Czechia							13
France					0.32	1.2	112
Germany							192
Greece			15 to 27	55 to 66	31	148	34
Hungary							18
Italy	7.0 to 14	25 to 32			2.1	9.7	473
Luxembourg							0.42
Malta							0.32
Netherlands							2.8
Poland	27 to 40	88 to 101					26
Portugal							13
Romania					0.27	1.2	13
Slovakia							4.3
Slovenia							4.6
Spain							82
Totals	**34 to 54**	**113 to 134**	**110 to 185**	**273 to 348**	**34**	**161**	**1,023**

Table 2-5: Total damage from concentrations above air quality standards in 2022, €million, 2023 prices. Ranges within cells show sensitivity to inclusion of dementia and diabetes for countries where concentrations are above PM limit values (only Cyprus, Italy and Poland). Single estimates without range indicate that exceedance only applies for ozone, for which dementia and diabetes effects are not quantified and mortality is valued using only the VOLY. Includes only countries showing population exposed to concentrations above air quality standards for at least one pollutant.

	VOLY	VSL
Austria	13	
Belgium	4.4	
Bulgaria	4.0	
Croatia	7.1	
Cyprus	96 to 159	220 to 283
Czechia	13	
France	113	114
Germany	192	
Greece	65	182
Hungary	18	
Italy	480 to 487	498 to 505
Luxembourg	0.42	
Malta	0.32	
Netherlands	2.8	
Poland	53 to 66	114 to 128
Portugal	13	
Romania	14	15
Slovakia	4.3	
Slovenia	4.6	
Spain	86	
Totals	**1,182 to 1,265**	**1,504 to 1,587**

NEC Directive ERCs 2020-29

The second part of the analysis quantifies damage associated with not reaching ERCs under the NECD. In this case, damage is calculated as the product of excess emissions and the damage cost per tonne of pollutant. The same sensitivities were explored as for the concentration-based analysis. Damage costs per tonne of pollutant were calculated adjusting those reported by EEA (2023)[35] with updated assumptions from the CAO4 analysis.

[35] EEA (2023) Estimating the external costs of industrial air pollution: Trends 2012-2021. Technical note on the methodology and additional results from the EEA briefing 24/2023.

Input data for the assessment are provided in Table A2-10-12 (see Appendix 2), showing emissions in excess of limits and in Table A2-10-13 (see Appendix 2) showing damage cost per ktonne emission for cases where ERCs are not reached has been identified. Methods account for the following impacts of each emitted pollutant:

- NOx: Health impacts from exposure to NO_2, secondary $PM_{2.5}$ and O_3, materials damage from acid deposition, damage to crops and forests from O_3 exposure, damage to ecosystems from nitrogen deposition.
- NMVOC: Health impacts from exposure to secondary $PM_{2.5}$ and O_3, damage to crops and forests from O_3 exposure.
- SO_2: Health impacts from exposure to secondary $PM_{2.5}$, materials damage from acid deposition.
- NH_3: Health impacts from exposure to secondary $PM_{2.5}$, damage to ecosystems from nitrogen deposition.
- $PM_{2.5}$: Health impacts from exposure to primary $PM_{2.5}$.

Results are shown in Table 2-6. As for analysis of the AAQ Directive, sensitivity is shown to methods for mortality valuation (VOLY and VSL) and to inclusion of functions for $PM_{2.5}$ and dementia and diabetes (included for 'High' estimates but not 'Low'), given the higher uncertainty associated with functions for these two effects (Forastiere et al, 2024).

Table 2-6. Damage estimates for gap to 2022-2029 for NECD limits (€ million/year) aggregated across pollutants. Only countries with excess emissions above ERCs are shown.

	Low VOLY	High VOLY	Low VSL	High VSL
Austria	80	130	234	284
Bulgaria	109	158	321	357
Cyprus	43	70	55	70
Hungary	197	296	644	732
Ireland	43	62	123	149
Latvia	0	1	1	2
Lithuania	162	214	598	641
Portugal	25	45	80	99
Romania	1,650	2,402	5,433	6,115
Sweden	24	42	72	92
Totals	**2,333**	**3,422**	**7,560**	**8,540**

The largest damage estimates for individual pollutants are associated with: Romania: $PM_{2.5}$, Hungary: $PM_{2.5}$ and NH_3, Lithuania: NOx and NH_3, and Austria, Bulgaria, Ireland and Portugal: NH_3.

https://www.eea.europa.eu/publications/the-cost-to-health-and-the/technical-note_estimating-the-external-costs/view.

Combined estimates of damage for 'current' targets

To provide an overall estimate of the costs of non-compliance with the AAQ Directive and NEC Directive limits for 2022, it is considered appropriate here to combine results for the two from Table 2-5 and Table 2-6. In the event that there was widespread occurrence of population exposed to concentrations above relevant air quality standards and emissions which do not reach ERCs, there would be a risk of significant double counting. However, it is concluded that this risk is small, given that only 6 countries (Austria, Bulgaria, Cyprus, Hungary, Portugal and Romania) are estimated to have an implementation gap against both Directives. Also, because of some of the patterns in the results (e.g. Bulgaria does not reach the NECD ERC for NH_3, but only has modelled population exposed to concentrations above the AAQ Directive target value for ozone), clear potential for double counting was identified only for Cyprus and Romania. To eliminate the possibility of significant double counting only results for the legislation with the greater damage estimate are used (NEC Directive for Romania, AAQ Directive for Cyprus). Results are shown in Table 2-7.

Concentrations above air quality standards and/or emissions above ERCs have been identified in 24 Member States, with the only exceptions being Denmark, Estonia and Finland. The most significant contributions to damage come from:

- Romania, where emission reductions of $PM_{2.5}$ and NO_2 do not reach ERCs.
- Hungary, where emission reductions of the NH_3 and $PM_{2.5}$ do not reach ERCs.
- Lithuania, where emission reductions of the NOx and NH_3 do not reach ERCs.
- Italy, through concentrations above the O_3 target value.

Table 2-7 Combined damage estimates for implementation gap with the AAQ Directives and NEC Directive ERCs for 2020-29 in 2022. € million, price year 2023.

	Low VOLY	High VOLY	Low VSL	High VSL
Austria	93	143	247	297
Belgium	4.4	4.4	4.4	4.4
Bulgaria	113	162	325	361
Croatia	7.1	7.1	7.1	7.1
Cyprus	96	159	220	283
Czechia	13	13	13	13
France	112	113	112	113
Germany	192	192	192	192
Greece	65	65	182	182
Hungary	215	314	662	750
Ireland	43	62	123	149
Italy	480	487	498	505
Latvia	0.4	0.7	1.3	1.5
Lithuania	162	214	598	641
Luxembourg	0.42	0.42	0.42	0.42
Malta	0.32	0.32	0.32	0.32
Netherlands	2.8	2.8	2.8	2.8
Poland	53	66	114	127
Portugal	38	58	94	113
Romania	1,650	2,402	5,433	6,115
Slovakia	4.3	4.3	4.3	4.3
Slovenia	4.6	4.6	4.6	4.6
Spain	86	86	86	86
Sweden	24	42	72	92
Totals	**3,459**	**4,606**	**8,996**	**10,045**

NEC Directive ERCs 2030+

Similar analysis has been carried out comparing emissions in 2022[36] to those achieved under the ERCs applying from 2030 onwards (Table A2-10-14 – see Appendix 2), and calculating the associated damage. Many more countries are included than for the period 2022-29, 25 out of 27 countries (only Belgium and Finland not being included given emissions levels in 2022 already meet 2030+ targets) compared to 10 countries for the earlier

[36] 2022 emissions are taken from Aether (2024), Final horizontal review report - Review of National Air Pollutant Emission Inventory Data 2024 under Directive 2016/2284'.

period. Damage is calculated as before, combining the emissions in Table A2-10-14 with the unit damage costs per ktonnes of emission shown in Table A2-10-13. The results are shown in Table 2-8.

Table 2-8: Damage estimates for gap for 2030+ for NECD limits (€ million/year) aggregated across pollutants. Only countries with excess emissions are shown (only Belgium and Finland are not shown).

	Low VOLY	High VOLY	Low VSL	High VSL	% of total
Austria	1,766	2,628	5,499	6,368	2.0%
Bulgaria	766	1,081	2,419	2,656	0.9%
Croatia	766	1,178	2,561	2,915	0.9%
Cyprus	90	143	114	144	0.1%
Czechia	4,787	7,142	13,863	15,939	5.2%
Denmark	221	298	662	735	0.2%
Estonia	1.7	2.6	4.0	4.6	0.0%
France	6,913	10,276	20,988	24,174	7.8%
Germany	20,835	35,021	67,077	78,924	25.2%
Greece	307	477	1,151	1,310	0.4%
Hungary	3,330	4,818	11,221	12,563	4.0%
Ireland	392	523	1,109	1,284	0.4%
Italy	13,794	25,499	46,234	56,648	17.8%
Latvia	62	98	212	242	0.1%
Lithuania	201	269	735	791	0.2%
Luxembourg	72	99	184	215	0.1%
Malta	25	26	22	24	0.0%
Netherlands	366	485	1,176	1,294	0.4%
Poland	17,291	26,032	48,246	55,643	18.4%
Portugal	2,095	3,685	7,063	8,498	2.7%
Romania	5,611	7,960	18,723	20,847	6.6%
Slovakia	95	134	298	339	0.1%
Slovenia	444	696	1,673	1,971	0.6%
Spain	4,623	7,405	14,251	17,020	5.4%
Sweden	442	564	1,442	1,581	0.5%
Total	**85,296**	**136,540**	**266,926**	**312,132**	**100%**

The results indicate a substantial increase in damage, relative to the figures shown in Table 2-6 (a range of €85 to 312 billion/year compared to €2.3 to 8.5 billion/year).

Table 2-8 shows that three countries (Germany, Italy and Poland) each account for more than 10% of estimated damage, noting that, unsurprisingly, there is correlation between country size and the absolute magnitude of damage. Although this presents the gap to the 2030+ ERCs based on emissions as of 2022, the implementation gap in 2030 (when the ERCs will apply) is anticipated to look very different. As explored further in the Forward Looking Assessment section below, emissions are likely to continue to fall, reducing the implementation gap. Hence the cost presented in this section overstates what the gap is expected to be in 2030, presenting a pessimistic scenario where there are no further changes. Given the extent of Member States having not yet reached their ERCs applying from 2030 onwards, it is concluded that there is scope for a significant level of double counting if damages associated with concentrations above air quality standards are combined with those associated with emissions where 2030+ ERCs are not reached. On that basis, with respect to 'future' targets, only data related to the NEC Directive are presented.

2.4.2 Limitations and uncertainties of the analysis

The following are considered to be the most important uncertainties associated with the quantification of health impacts and values for current performance relative to the AAQD and NECD:

- Approach to valuation of mortality, which has been addressed through sensitivity analysis
- Inclusion of impacts given a lower confidence rating in the EMAPEC study of WHO (dementia and diabetes), again addressed through sensitivity analysis
- Treatment of ozone impacts, given varying conclusions from epidemiological research regarding appropriate ozone metrics and mortality functions impacts (Kasdagli et al, 2024)[37]. A conservative approach has been taken here, likely biased to underestimation of impacts, perhaps significantly.

2.5 Forward looking assessment

Pollutant emissions are anticipated to continue to fall at the EU level due to current and future policies including the revised AAQ Directive targets. Work undertaken for the service contract 'Clean Air Outlook 4'[38] projected the trend for future emissions under a baseline assuming no further regulatory action. These projections are produced using the GAINS model[39] which is updated periodically reflecting latest policy and evidence, and are shown in Figure 2-10.

[37] Kasdagli, M. et al (2024) Long-Term Exposure to Nitrogen Dioxide and Ozone and Mortality: Update of the WHO Air Quality Guidelines Systematic Review and Meta-Analysis, International Journal of Public Health, DOI=10.3389/ijph.2024.1607676.
[38] See: https://op.europa.eu/en/publication-detail/-/publication/4d746ab1-f7de-11ef-b7db-01aa75ed71a1/language-en
[39] See https://gains.iiasa.ac.at/models/ for further information on the GAINS model.

Figure 2-10: Projected trend in emissions for pollutants in scope of the NEC Directive in 2020, 2025 and 2030 (from CAO4[40])

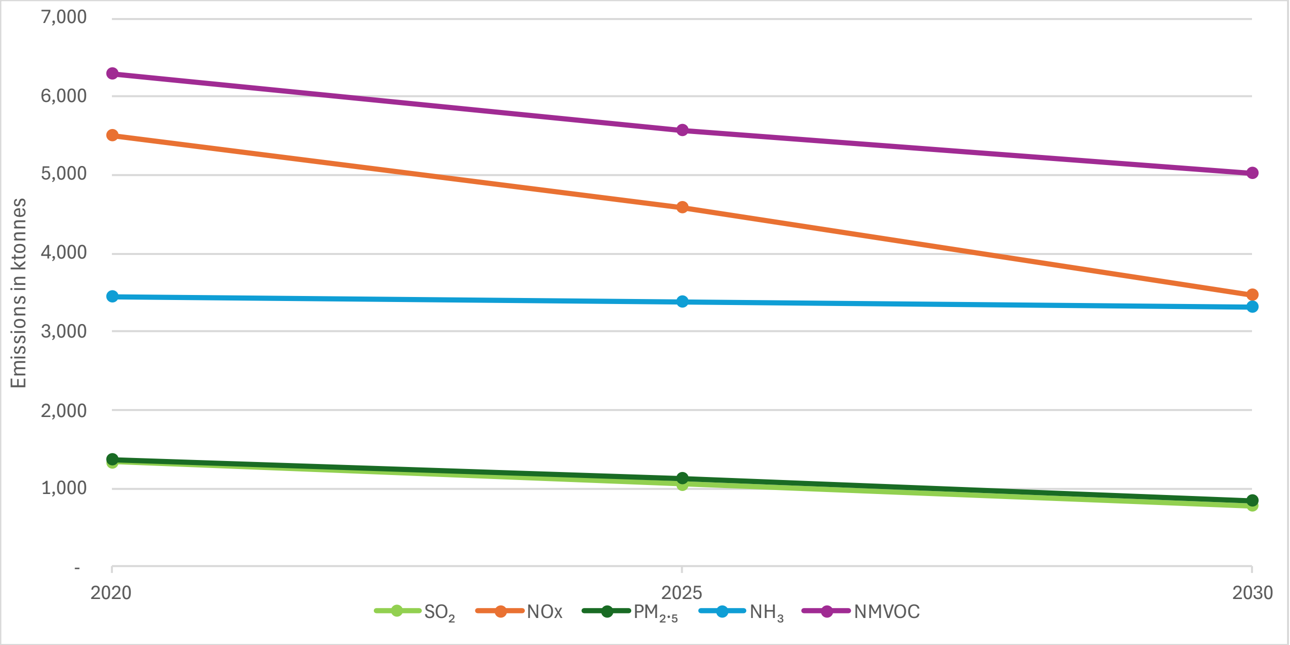


Figure 2-11 presents emissions forecasted under CAO4 in 2030 relative to the NEC Directive 2030+ ERCs. These data suggest that compliance prospects with the 2030+ ERCs improve when considering projected emissions rather than using emissions inventories data for relative to 2022 (see Figure 2-9). Although based on projected data, several countries risk having emissions above their ERCs, however the additional reduction effort needed to meet the NEC Directive commitments is generally less. More specifically, for:

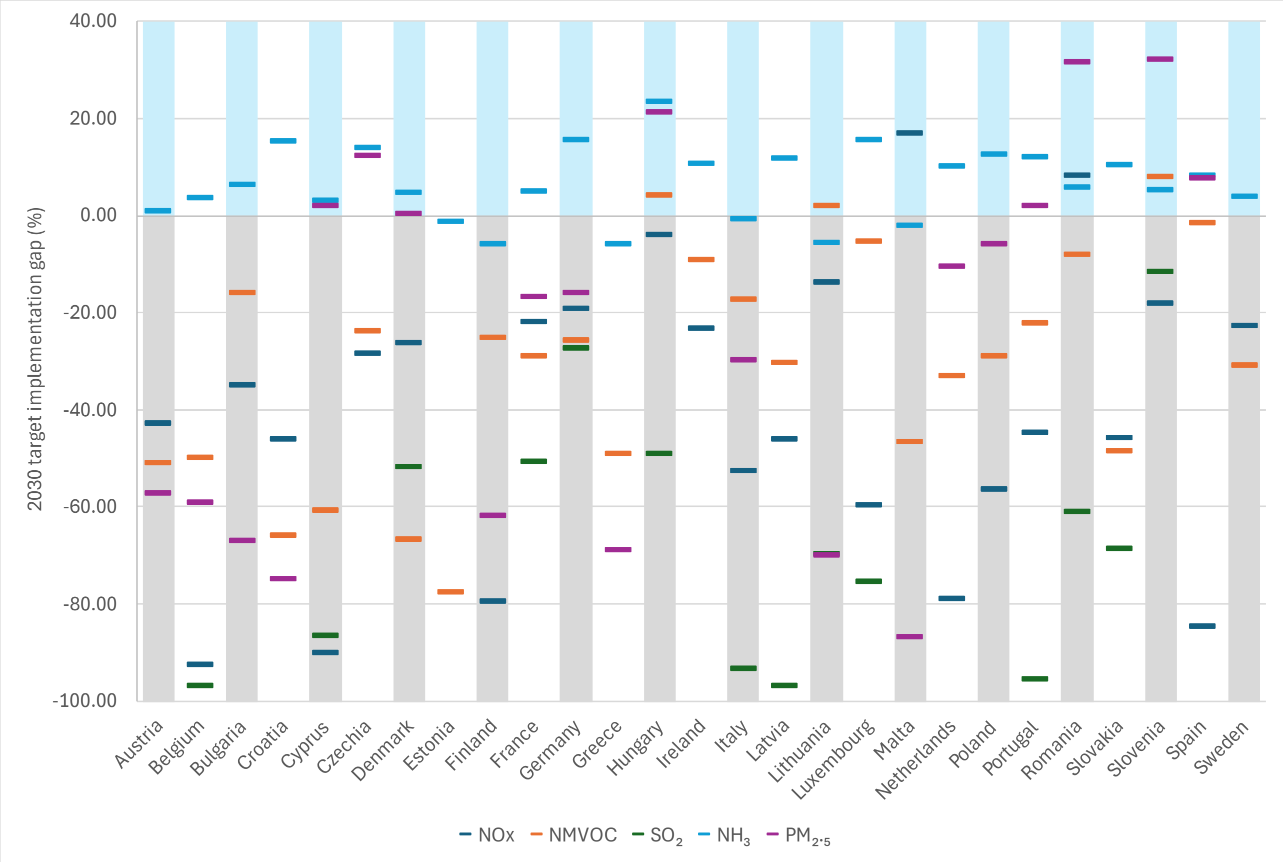
- SO_2: the Baseline projections indicate that all countries will achieve ERCs in 2030 and beyond.
- NOx: emissions of two countries were estimated above the ERCs for 2030 (Malta and Romania).
- $PM_{2.5}$: Nearly a third of Member States (8 in total) are projected to have emissions which do not reach ERCs in 2030.
- NH_3: most Member States are estimated to be have emission which do not reach ERCs in 2030, under baseline assumptions, with the exception of Estonia, Finland, Greece, Italy, Lithuania and Malta.
- NMVOC: Finally, there are 3 identified potential Member States which fail to meet 2030 targets for NMVOC (Hungary, Lithuania and Slovenia).

Member States with expected emissions that reach ERCs for all 5 pollutant are Estonia, Finland, Greece and Italy. 15 Member States are expected to be compliant with 4 of 5 pollutants, and 5 compliant with 3. 3 Member States (Hungary, Romania and Slovenia) are projected to be compliant with 2 pollutants.

The greatest cases of implementation gap (i.e. where distance from projected emissions to the target ERC are greatest) exists in the case of Hungary for NH_3 emissions, followed by Romania and Slovenia for $PM_{2.5}$. Several of the other instances of emissions above the $PM_{2.5}$ ERC are very small according to GAINS calculations, i.e., Cyprus, Denmark, Portugal, within 1% of ERCs. For NH_3, the pollutant for which the most Member States are expected to have emissions which do not reach the ERC, 7 Member States are anticipated to be within 5% of the target, but 9 Member States are anticipated to be more than 10% away from their respective ERC.

[40] https://environment.ec.europa.eu/document/21a9e24e-6af3-41de-abe9-ee884748013c_en

Figure 2-11 NECD pollutant emissions and implementation gaps (projected 2030 emissions based on modelling under CAO4 versus 2030+ ERCs))[41]



Further reductions in the emissions of air pollutants will also lead to reductions in air pollutant concentrations and the achievement of quality standards. As explored above, significant progress has been against the standards agreed in 2004 and 2008 which apply until the end of 2029. Evidence around the impacts of air pollution on health and the environment continues to evolve, with increasing evidence of detrimental impacts on health at lower levels of pollution than those defined in the air quality standards for 2020. The EU's ambient air quality standards have recently been revised to more closely align with the latest WHO guidelines[42]. The most significant revisions with expected impacts on human health are the reductions in the air quality standards for NO_2 and $PM_{2.5}$, with the annual average limit value for NO_2 reducing from 40 µg/m³ to 20 µg/m³, and for $PM_{2.5}$ from 25 µg/m³ to 10 µg/m³. These revised standards agreed in 2024 will increase the implementation gap from 2030 onwards.

Figure 2-12 and Figure 2-13 presents the number of people anticipated to be exposed to different levels of air pollution under the CAO4 baseline scenario in 2030. This data is only available for two pollutants: $PM_{2.5}$ and NO_2.

[41] Note: minimum on y-axis has been set to -50% to ensure clarity in the chart. Some Member States are anticipated to achieve even more significant reductions against pollutant targets in 2030, which are not shown on the chart.
[42] https://environment.ec.europa.eu/topics/air/air-quality/revision-ambient-air-quality-directives_en

Figure 2-12: Exposure to $PM_{2.5}$ in 2030 under a baseline scenario

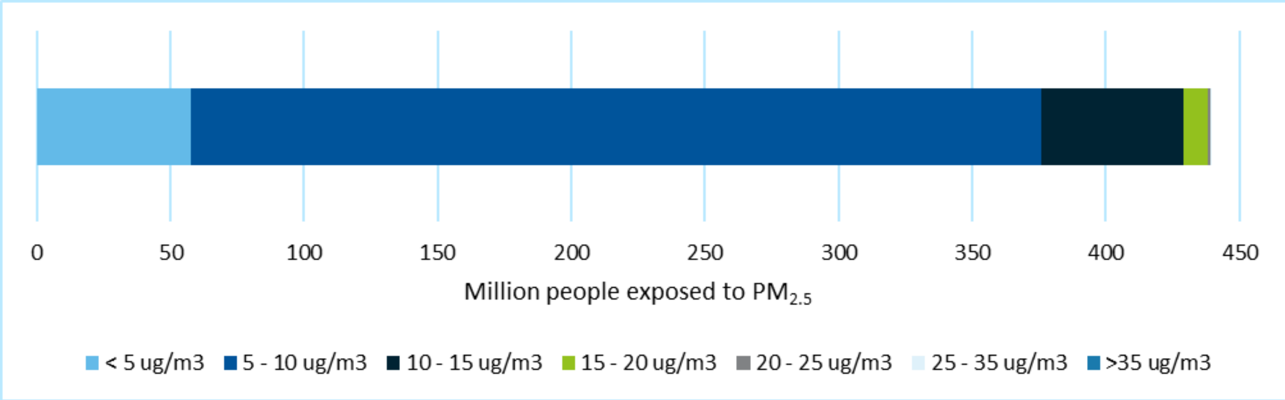
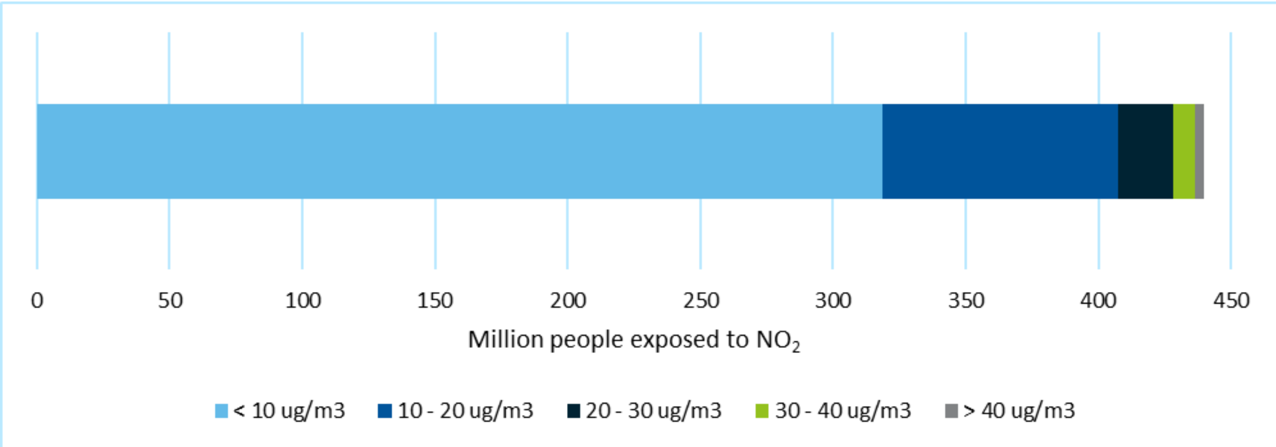


Figure 2-13: Exposure to NO_2 in 2030 under a baseline scenario



Under the baseline scenario in 2030, the population exposed to levels of $PM_{2.5}$ above the 25 µg/m³ limit value is around 300,000, equating to 0.07% in 2030. Relative to the revised $PM_{2.5}$ limit value of 10 µg/m³ (which applies as of 2030, unless a postponement of the attainment deadline is applied), the number exposed above the standard increases to 63.5 million, equating to around 14.5% of the EU27 population.

Relative to the limit value of 40 µg/m³ for NO_2, CAO4 models that in 2030 around 1% of the EU public (or 3.77 million people) will be exposed to levels of pollution above this limit value. This percentage increases to 7% (or 32.4 million people) for the revised NO_2 limit value of 20 µg/m³ (which will apply as of 2030).

The CAO modelling also suggests that even if the implementation gap to 2030 emissions targets under the NEC Directive is closed, the revision of air quality standards to more ambitious levels will increase the gap post the year 2030. CAO4 also modelled a scenario where 2030+ ERCs were met. Under this scenario, 55.5 million and 29.8 million people would be exposed to levels of air pollution above the revised standards for $PM_{2.5}$ and NO_2 respectively (relative to 63.5 million and 32.4 million under the baseline scenario).

It is important to note that these estimates may be an overestimation of the implementation gap, as it is expected that the revised AAQ Directive will accelerate ambition and effort to further improve air quality (and therefore reduce concentrations) in order to meet the new standards. The CAO4 baseline scenario does not capture any further policy ambition beyond the current acquis. Indeed a recent report from the Joint Research Council (JRC) "Delivering the EU Green Deal. Progress towards targets"[43] by the Joint Research Centre (JRC) provided an estimation of some implementation gaps in achieving climate and environmental policy targets.

[43] https://publications.jrc.ec.europa.eu/repository/handle/JRC140372

According to the report, for 35% of zero pollution targets progress is on track and for 30% of targets progress should accelerate. It noted that progress has been achieved in reducing air pollution, resulting in a significant drop in related deaths and that the recently adopted revised AAQ Directive is expected to shrink the area of EU ecosystems threatened by air pollution by 25% by 2030 compared to 2005.

2.6 Lessons learnt and recommendations

The analysis of the implementation gap is undertaken against defined and measurable quantitative targets, using robust and complete data. Where available, further modelling of the exposure of people to different levels of air pollutant concentrations may help deepen the assessment of the implementation gap against all air pollutant standards.

For the estimation of costs, two recommendations are made for improving the analysis, both relating to the health functions used:

1. Undertake further analysis of ozone-mortality data to derive a robust response function for long-term exposures. It is understood that this may be covered under the HRAPIE2 study currently being led by WHO.

2. Undertake further research to understand the potential for double counting when combining response functions for different pollutants derived from epidemiological research.

It was concluded that for analysis of 2022 conditions, exceedances of the NEC and AAQ Directives could be added. With reasonable precautions, taking account of the pattern of exceedances within and between countries, taken it was concluded that the potential for double counting was small. The same conclusion was not reached for the analysis of NEC Directive 2030+ ERCs, where much broader exceedances were observed and monetised, risking greater overlap with those of the AAQ Directive standards.

3. Noise

- Analysis focuses on the Environmental Noise Directive (END). The Directive does not set quantitative targets to be achieved but the ZPAP announced a 2030 interim target to reduce "by 30% the share of people chronically disturbed by transportation noise".
- The analysis uses data from the third round of END noise mapping (based on the 2016 situation and reported to the European Commission in 2017). Fourth round data (based on the noise mapping of the 2021 situation and reported to the Commission in 2022) are starting to become available but contain a number of limitations and uncertainties so have not been used for the analysis of the implementation gap. Despite the fact the END round three data are more than 7 years old, they can still provide a reliable estimate of the current noise situation as wider evidence suggests the number of people exposed to noise is likely to be in line with today, if not increased.
- In order to meet the 2030 ZPAP targets (assuming for illustration that this applies equally to each transport noise source): 26.6 million people will need to reduce their exposure levels below the END reporting thresholds to road traffic noise to levels below 55 dB Lden, 5.7 million people to railways noise and 1.1 million to airport noise.
- The estimated implementation gap cost for road transport noise alone is €20.0 billion per year (sensitivity range from €12.9 billion to 27.1 billion per year, again driven by uncertainty in the estimation of health effects). This understates the total implementation gap for noise, as it does not account for health impacts associated with railways, airports and other sources (which have not been added to those for road transport to avoid double counting).
- Looking forward, the outcomes of the most recent research and publications on noise trends indicate that it is unlikely that the ZPAP will be achieved by 2030, and that the implementation gap could even increase.

3.1 EU environmental policy and law

The Environmental Noise Directive (Directive EC/49/2002) (or 'END') is the main EU law to identify noise pollution levels and act on them. The Directive aims to establish a common EU approach to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise[44]. The Directive does not include a common noise reduction objective nor noise limits. It focuses on four action areas:

- determining exposure to environmental noise and assessing its health effects at single dwelling level;
- ensuring that information on environmental noise and its effects is made available to the public;
- preventing and reducing environmental noise;
- preserving environmental noise quality in areas where it is good.

The Directive requires EU countries to prepare and publish noise maps and noise management action plans every 5 years (i.e., in each reporting round of the END) for:

- agglomerations with more than 100,000 inhabitants;
- major noise sources: major roads (more than 3 million vehicles a year); major railways (more than 30,000 trains a year); and major airports (more than 50,000 take-offs and landings a year, including small aircrafts and helicopters);

[44] END Art.1(1)

When developing noise management action plans, national authorities must consult the concerned public. The Directive does not set limit or target values for environmental noise, nor does it prescribe the measures to be included in the action plans. This is for the Member State competent authorities to decide. Member States are to report to the European Commission the results of the strategic noise mapping as estimated total number of dwellings and population exposed to environmental noise. The reporting thresholds are set from 55 dB L_{den} and 50 dB L_{night}.

3.2 Environmental target

The Directive does not provide quantitative targets to be achieved through its implementation. Instead, it leaves Member States to address priorities which may be identified by exceedances of any relevant limit value, or by other criteria chosen by the Member States[45].

In 2021, the European Commission published the Zero Pollution Action Plan (ZPAP) which included a 2050 vision alongside 2030 interim targets set to speed up noise emission reduction. For noise, the ZPAP included a target to reduce "by 30% the share of people chronically disturbed by transport noise"[46]. Whilst it is not the END legislative objective, this target presents a benchmark for the implementation gap for noise in lieu of a legislative target. This study adopted the following interpretations and assumptions to facilitate the analysis:

- The reduction is considered with respect to 2017 which corresponds to the year of the data reporting obligations under the third round of END.
- By "people chronologically disturbed by transport noise", it is interpreted that this concerns the population exposed to the END reporting thresholds. Such an assumption is aligned with other similar assessments carried out by the EEA in relation to health impacts of exposure to noise from transport which can also provide comparability between the different works carried out by the European Commission[47].
- The ZPAP target is meant to be achieved at European Union level rather than setting a target for each individual Member State. As such the analysis of the implementation gap and cost is only presented at EU level and not split by Member State.
- The ZPAP target is referred generically to transport noise, rather than setting a target for each source specifically. However, for this analysis, each of the transport noise sources referenced in the END (i.e. road, railway and airports) has been considered individually as it is uncertain in practice how the target will be achieved between sources. Furthermore, the same person can be exposed to multiple noise sources at the same time and the data as currently reported to the European Commission do not allow this kind of considerations. Dose-effect relations for harmful effects induced by the exposure to environmental noise are also different for each transportation source[48] with multiple sources interacting that can create further chronic disturbance. It is therefore deemed that if the number of people exposed to each individual noise source were to be added together, it would provide a misrepresentation of the total population exposed to transport noise and consequently the number of people that would need to have reduced their exposure levels to meet the ZPAP target[49]. Hence for the present analysis, although assessed separately for illustration, the implementation gap for the individual noise sources are not added together. In this way the harmful effects deriving from the

[45] END Art.8(1,2,3)
[46] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0400&qid=1623311742827
[47] https://www.eea.europa.eu/en/analysis/indicators/health-impacts-of-exposure-to-1?activeAccordion=ecdb3bcf-bbe9-4978-b5cf-0b136399d9f8
[48] https://eur-lex.europa.eu/eli/dir/2020/367/oj
[49] EU 367/2020 Appendix 2 III (3): The exposure of the population shall be assessed independently for each noise source and harmful effect. Where the same people are simultaneously exposed to different noise sources, the harmful effects may -in general- not be cumulated. However, those effects may be compared to assess the relative importance of each noise.

exposure to each noise source can be quantified and monetised to provide the associated costs. As the ZPAP refers specifically to transport noise, population exposed to industrial noise sources has not been considered in the analysis.

3.3 Implementation gap

3.3.1 Analysis

The 2030 interim target to reduce "by 30% the share of people chronically disturbed by transport noise" is considered against the total number of people exposed to noise in 2017 (i.e. the year of third round of END reporting obligations), with the difference presenting the implementation gap. The analysis of the data of the third round of the END[50] shows for each noise source that (see Figure 3-1):

- 88.6 million people are exposed to road traffic noise levels greater than 55 dB L_{den}, of which 61.2 million to levels greater than 50 dB L_{night};
- 19.1 million people are exposed to railway noise levels greater than 55 dB L_{den}, of which 16.2 million people to levels greater than 55dB L_{night}; and
- 3.6 million people are exposed to airport noise of which 2.1 million also during the night-time period.

These figures take into account both the number of people exposed to noise as reported by the Member States under the third round of END and "gap filling" data generated by the EEA[51] for those Member States, agglomerations and major noise source which data are yet to be submitted to the European Commission.

As the total population within the 55 dB L_{den} noise exposure levels is inclusive of the population exposed to 50 dB L_{night}, for the purpose of the implementation gap assessment, the calculation of the 30% reduction in population exposed to the END reporting thresholds only considers the L_{den} exposures to avoid any double counting of the population in setting the 2030 noise target.

In order to meet the 2030 ZPAP targets: 26.6 million people will need to have reduced their exposure levels to road traffic noise to levels below 55 dB L_{den}, 5.7 million people to railways noise and 1.1 million to airport noise (Figure 3-2) (noting again that this is illustrative given the ZPAP target does not specifically require a 30% reduction for those chronically disturbed by each source but overall, and meeting the overall target in practice could result in a greater or less than 30% reduction for each individual source).

[50] END 16 April 2024 data harvest https://sdi.eea.europa.eu/data/6390fc31-0c20-45bf-b866-417a1755098b
[51] Data generated by EEA and ETC/HE provided by EEA for the study

Figure 3-1: Total population exposed to transport noise in 2017 for each noise source

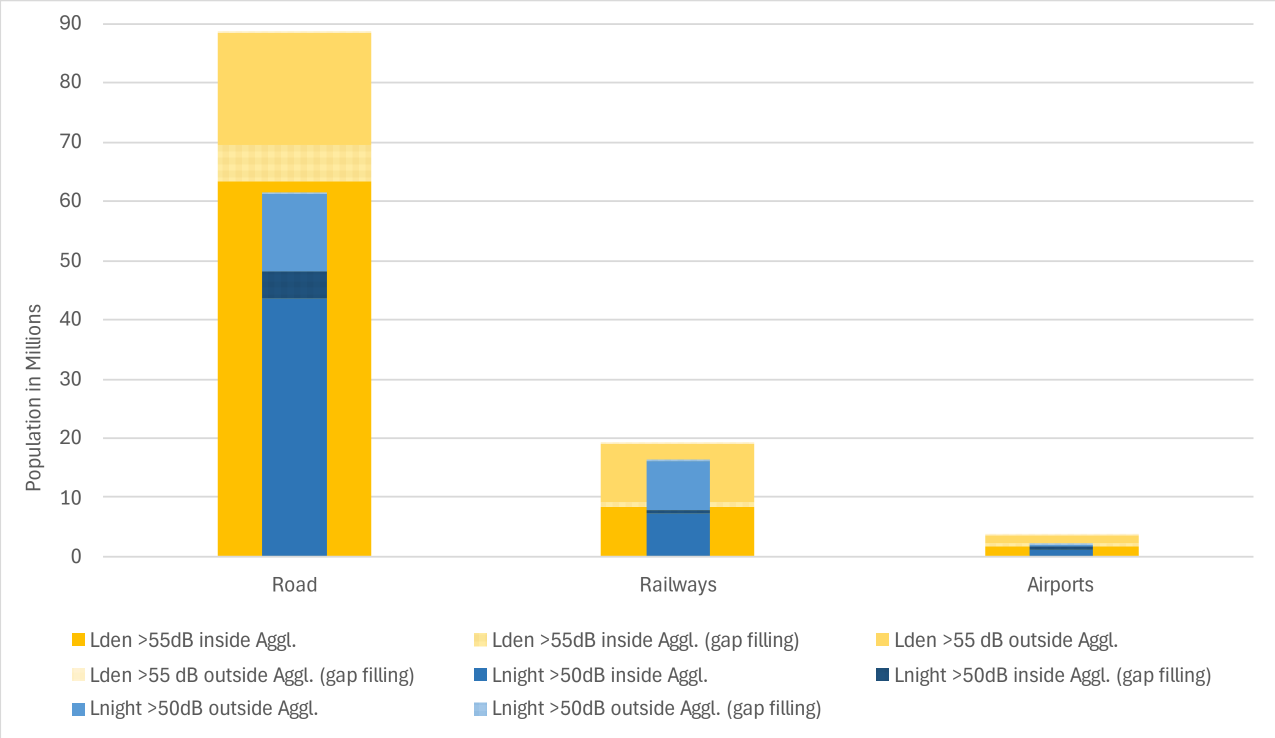


Figure 3-2: Implementation gap assessment for each noise source against the ZPAP targets

3.3.2 Limitations and uncertainties of the analysis

For the purpose of this assessment, the study team has obtained the most up-to-date dataset of both the third and fourth rounds of END reported data from the EEA[52].

The study reviewed the data reported under the END fourth round in 2022 to understand if it could be used to provide a more current basis for the implementation gap assessment with respect to the 2030 ZPAP target. However, through review the following limitations and uncertainties were identified:

- There is a general lower reporting ratio for agglomerations or major noise sources data compared to the previous END round 3 (see Figure A2-10-2 and Figure A2-10-3 in Appendix 2).
- The available data under the END fourth round are likely to be affected by the effects of Covid pandemic: the 2022 END data, which are based on the results of the strategic noise mapping of 2021 operations are likely to be highly influenced by the Covid travel restrictions. For instance, the observed reduction in the population exposed to airport noise in round four data can be mainly attributable to the fewer operations occurred in 2021 due to the Covid restrictions, being in some instances more than 60% less than compared to pre-pandemic period and relative to post-pandemic data in 2023[53], rather than as a result of a noise management strategy.
- The total number of agglomerations and major noise sources with reporting obligations have also declined in 2022 compared to 2017, presenting a different total population sample for the analysis of the noise exposures and comparison against the ZPAP noise target (see Figure A2-10-4 and Figure A2-10-5 in Appendix 2).
- Moreover, for the fourth round of END, countries needed to assess exposure to noise using the same calculation method, CNOSSOS-EU, whereas under the third round, Member States could use their own method. The different noise assessment methods used between the third and the fourth round of END therefore pose comparability issues between the two datasets. Recent research suggest that population exposure statistics calculated under the CNOSSOS-EU method may more accurately reflect the real noise exposure situation than previously reported estimates of population exposure statistics calculated using other methods, with higher levels of population exposure resulting from using CNOSSOS-EU[54,55]. However, it is difficult to quantify what differences the CNOSSOS-EU methodology resulted in terms of total population exposures across the EU considering that assessment methodologies would vary across Member States.

Due to the limitations and the uncertainties that have been identified with the data reported in 2022 under the fourth round of the END, the study team determined that data reported in 2017 under the END round three represented a more reliable and complete dataset to be used for the implementation gap assessment, as presented in the preceding section.

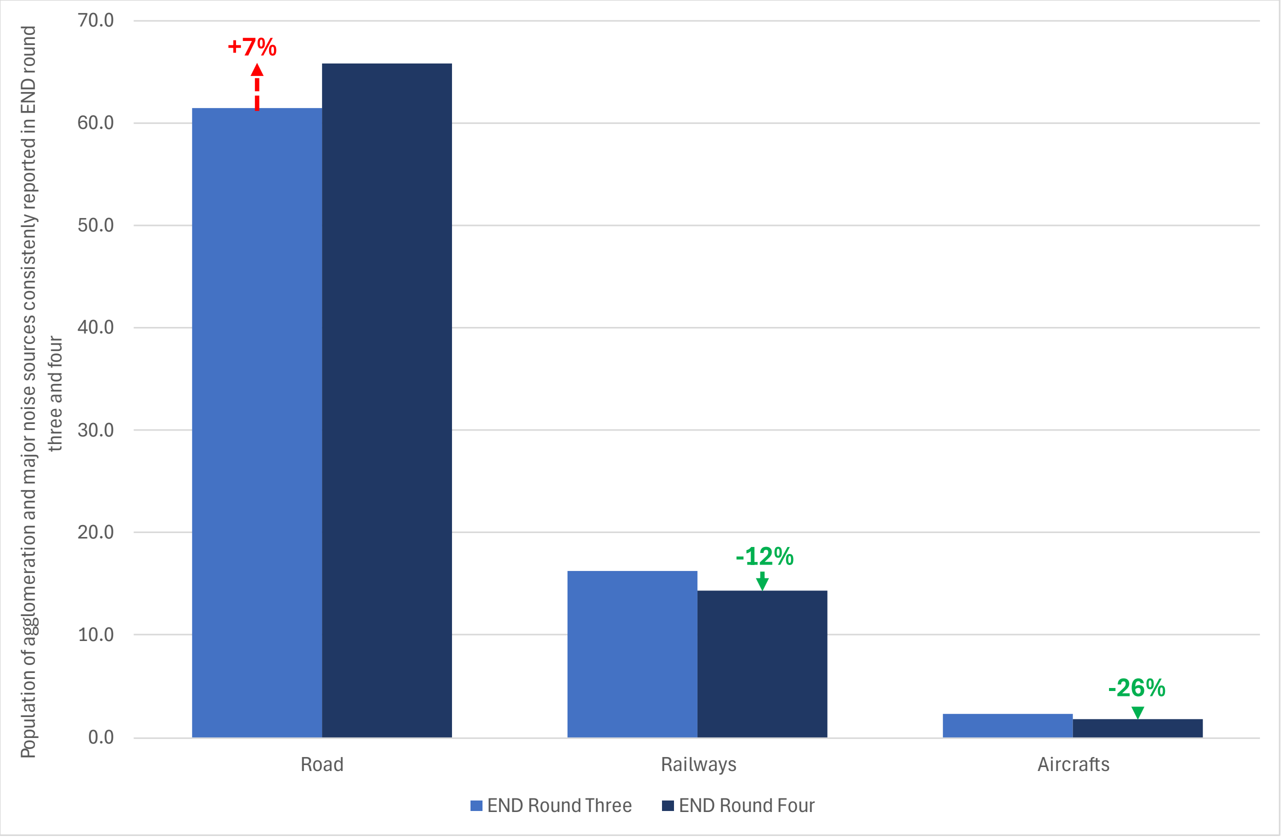
Despite the limitations and uncertainties identified in the collected data for both the third and fourth round of the END, the study team carried out an illustrative analysis of the change in noise exposure between the two rounds. This considered only the agglomerations or the major noise sources for which noise exposure data have been consistently reported to the European Commission in both round three and round four of the END (Figure A2-10-8). Based on the available data, the analysis shows that between 2017 and 2022 in selected agglomerations:

[52] END 16 April 2024 data harvest https://sdi.eea.europa.eu/data/6390fc31-0c20-45bf-b866-417a1755098b .
[53] https://www.eurocontrol.int/publication/eurocontrol-european-aviation-overview-archive-2023
[54] Jon-Paul Faulkner, Enda Murphy, Road traffic noise modelling and population exposure estimation using CNOSSOS-EU: Insights from Ireland, Applied Acoustics, Volume 192, 2022,
[55] Arnaud Kok1, Mark Bakermans, Sander Buitelaar, NOISE MAPPING 2021: HOW TO COMPARE RESULTS TO PREVIOUS ROUNDS?, Forum Acusticum 2023

- an increase of 7% is observed in the population exposed to road traffic noise levels greater than 55 dB L_{den}.
- population exposed to railways and airport noise levels greater than 55 dB L_{den} have seen a reduction of 12% and 26% respectively (Figure 3-3).

Should such trend continue in the future years, the ZPAP noise targets would be met for railways and airport noise sources, whilst for road traffic noise might be expected a further increment in population exposed to noise greater than 55 dB L_{den} (Figure 3-3).

Figure 3-3: Change in noise exposure between 2017 and 2022, based on agglomerations and major noise sources for which noise exposure data have been consistently reported between END third and fourth rounds



However, the study team has acknowledged that the trend derived from the END available data could be somewhat misleading as being highly influenced by the limitations and uncertainties of the 2022 data discussed in this section. Recent research has in fact identified different trends for road, rail and airport noise than the ones derived utilising the END fourth round data (which are discussed in the Forward Looking Assessment section).

Considering these research and publications, it can also be deduced that even if the END round three data are based on data from more than 7 years ago, they can still provide a reliable representation of the current noise situation. In fact, now that the transport operations returned or in some instances exceeded their pre-Covid levels, the number of people exposed to noise is likely to be comparable with the pre-pandemic scenarios, if not increased. This consolidates the decision of the study team to use the END round three dataset for the implementation gap assessment.

Under the third round of the END, there is still a number of agglomerations and major noise sources for which data have not yet reported to the European Commission (see Figure A2-10-6 and Figure A2-10-7 in Appendix 2). For these cases, the study relied on gap filling data which have been produced and made available for the study by EEA and ETC/HE[56] and have been used to provide a more complete assessment of the implementation gap. It is important to note that being the gap filling data based on previous END rounds or EU averages, this can overestimate or underestimate the number of people effectively exposed to noise.

Generally, independently from the END rounds, there is also a high uncertainty of the census data used by Member States to quantify the population exposed to noise. In some instances, the population data used were dated, which could have led to an underestimation of the number of people actually exposed to noise. Moreover, a further source of uncertainty is driven by Member States approaches to END related assessment of the population within agglomerations. This has been highlighted also in other studies, where in some instances different approaches have been taken to quantify the number of people exposed to the same source whether this was considering within the agglomeration or in the major noise source assessments[57].

Considering all uncertainty and limitations identified, the use of the END round three dataset is preferable to using round four, but it might result in an underestimation of the total population exposed to noise and consequently of the implementation gap assessment.

3.4 Implementation gap cost

3.4.1 Analysis

Long-term exposure to environmental noise has been associated with a range of detrimental physical and mental health impacts. Health issues related to these exposures include: annoyance, sleep disturbance, cardiovascular issues (ischemic heart disease) and premature death. Exposure has also been associated with cognitive impairment in children as their ability to learn is affected.

The data reported under the END on the population exposure can therefore be used for the purposes of the assessment of harmful effects generated by each noise source[58]. The harmful effects deriving from the exposition to each noise source can be monetised and used for the assessment of the implementation gap costs.

The EEA[59] has assessed the health burden associated with environmental noise as presented in the table below. This analysis uses the data reported by Member States in their END round three reporting which contains several gaps as noted above. Updated estimates of the number of people highly annoyed or highly sleep disturbed are included in the table below for comparison, based on the third round of END and the “gap filling” data generated by the EEA[60] for those Member States, agglomerations and major noise source which data are yet to be submitted to the European Commission.

The most prevalent health impacts associated with excessive levels of noise are annoyance and sleep disturbance, with the highest impacts associated with exposure to noise from road transport. The implementation gap to the zero-pollution objective results in negative health outcomes for EU citizens which would otherwise be avoided. More specifically, failure to achieve the zero pollution target results in (assuming for illustration that the 30% reduction target applies equally to each source, which is not specified in the ZPAP):

[56] Data generated by EEA and ETC/HE provided by EEA for the study
[57] https://op.europa.eu/en/publication-detail/-/publication/67225cf1-2d8c-11ed-975d-01aa75ed71a1/language-en
[58] EU 367/2020 Appendix 2 III (3): The exposure of the population shall be assessed independently for each noise source and harmful effect. Where the same people are simultaneously exposed to different noise sources, the harmful effects may -in general- not be cumulated. However, those effects may be compared to assess the relative importance of each noise.
[59] https://www.eea.europa.eu/en/analysis/maps-and-charts/additional-information-on-health-impacts?activeTab=570bee2d-1316-48cf-adde-4b640f92119b
[60] Data generated by EEA and ETC/HE provided by EEA for the study

- 4.8m citizens suffering from high annoyance from road transport noise, with a further 1.1m and 0.4m from railway and airport respectively;
- Sleep deprivation affecting 1.2m citizens from road transport noise, with a further 0.6m and 140,000 from railway and airport respectively;
- 10,100 additional cases of ischemic heart disease (IHD) each year from road transport noise, with a further 1,700 and 200 from railway and airport noise respectively;
- 2,700 premature deaths each year from road transport noise, with a further 450 and 60 from railway and airport respectively;
- Additional cases of cognitive impairment amongst children who have their learning interrupted.

Table 3-1: Key health impacts associated with exposure to unhealthy levels of noise based on END thresholds (number of people, EU27 in 2017)

	Noise source	**Highly Annoyed**		**Highly Sleep Disturbed**		**IHD**	**Premature Mortality**	**Cognitive impairment**
Source		*Round 3*	*Gap filling*	*Round 3*	*Gap filling*	*Round 3*	*Round 3*	*Round 3*
TOTAL effect	Road transport	14,400,000	16,100,000	3,700,000	4,090,000	33,600	8,900	-
	Railway	3,100,000	3,690,000	1,600,000	1,900,000	5,600	1,500	-
	Airport	900,000	1,180,000	200,000	474,000	600	200	9,600
Implementation gap	*Road transport*	*4,320,000*	*4,830,000*	*1,110,000*	*1,227,000*	*10,080*	*2,670*	
	Railway	*930,000*	*1,107,000*	*480,000*	*570,000*	*1,680*	*450*	
	Airport	*270,000*	*354,000*	*60,000*	*142,200*	*180*	*60*	*2,900*

Furthermore, these effects are likely to be underestimates, with evidence of detrimental health outcomes even below the END thresholds[61].

These health impacts can be expressed in terms of Disability-adjusted life years (DALYs), where one DALY is equivalent to a year of healthy life lost either through death, morbidity or both. The following table presents the implementation gap expressed in terms of DALYs and a monetised cost. DALY estimates present an aggregate across the underlying health impacts, using data from the EEA analysis from Round 3 data and the 'gap filling' data for annoyance and sleep disturbance. To estimate the implementation gap cost, the same Value-of-life-year (VOLY) is used as applied to health effects associated with exposure to air pollution for consistency in the analysis across areas.

[61] See for example, https://www.who.int/europe/publications/i/item/9789289053563

Table 3-2: DALYS and cost associated with implementation gap (€ million, 2023 prices)

	Noise source	DALY – central	DALY – Low	DALY – High	Cost (€ million) - Central	Cost (€ million) – Low	Cost (€ million) - High
Implementation gap	*Road transport*	161,000	105,000	217,000	20,000	12,900	27,100
	Railway	47,100	26,600	67,600	5,880	3,310	8,460
	Airport	12,100	6,650	17,600	1,520	832	2,220

The health impacts associated with each noise source are not aggregated together to avoid the risk of double counting – as noted above, one person can be affected by excessive exposure to more than one noise source.

The noise source with the greatest impact is road transport. Assuming to meet the ZPAP target there must be a 30% reduction in those exposed to excessive road transport noise (noting that the ZPAP target is not specific to particular noise sources), the implementation gap leads to an estimated 161,000 DALYs each year (based on 2017 data, with a sensitivity range of 105,000 to 217,000 based driven by uncertainty in the estimation of health effects[62]). The **estimated implementation gap cost for road transport noise alone is €20.0 billion per year** (sensitivity range from €12.9 billion to 27.1 billion per year, again driven by uncertainty in the estimation of health effects. This is an underestimate of the total implementation gap with respect to noise as it does not account for the health impacts associated with noise from railways and airports.

3.4.2 Limitations and uncertainties of the analysis

The estimation of the implementation gap cost has several caveats and limitations. It is important to note that there is uncertainty associated with each step of the process to calculate health effects associated with exposure to noise pollution, including around the: dose-response function, robustness of baseline health data, mapping of exposure, the disability weight applied and the valuation of health endpoints. This is somewhat reflected in the sensitivity range assessed here.

The above estimates only capture a sub-set of the health impacts linked to exposure to environmental noise, focusing on those for which quantitative relationships exist which can be used in appraisal and where the evidence is most robust. However, exposure to noise is associated with a wider range of health effects, including cognitive impairment in children, hearing impairment and tinnitus, adverse birth outcomes and metabolic outcomes. It is also important to consider that END does not comprehensively cover all urban areas, roads, railways and airports across Europe. Hence the above estimates could be considered somewhat an underestimate.

The above analysis adopts a simplified approach to estimating the impacts of the implementation gap, and the effects where an individual is no longer exposed to excess noise. As it is not clear who may benefit where the implementation gap is closed, the gap cost is calculated based on the average exposure and health impacts associated with this. The actual impact in practice may differ depending on an individual's current level of exposure, existing health and socio-economic factors.

In addition, the analysis assumes the implementation gap applies equally to each noise source. However, the zero-pollution target is not defined with respect to specific sources, but relates to the overall exposure to noise.

[62] This is driven by an uncertainty range around the disability weights used to estimate the effects of annoyance and sleep disturbance.

The approaches to assess health impacts vary by source, hence where the gap is expressed differently (e.g. where it is assumed the gap is greater or less for a particular source), then the associated gap cost could vary.

3.5 Forward looking assessment

Due to the uncertainties and limitations that have been identified in the reported data under the fourth round of END, the study did not use the 2022 END dataset to assess the implementation gap. Furthermore, the data has not been used to provide a quantitative trend or forward-looking assessment as it could misrepresent the ongoing trend of the change in noise exposure (although a demonstrative trend analysis is presented in section 3.3.2 for illustration only).

A recent report from the JRC "Delivering the EU Green Deal. Progress towards targets"[63] provided an estimation of some implementation gaps in achieving climate and environmental policy targets. According to the report, for 35% of zero pollution targets progress is on track and for 30% of targets progress should accelerate. However, in the noise area progress was reported to be slower, noting that noise levels are not expected to decrease by more than 19% by 2030.

Recent publications from the EEA and the European Commission have identified that the average number of people exposed to harmful levels of noise has remained stable[64] or increased[65] since the implementation of the END. Furthermore, these reports suggest there is no prospect of achieving a 30% decrease in the number of people chronically disturbed by transport noise by 2030, even assuming the implementation of a substantial number of noise mitigation measures[66]. These conclusions are also evident when looking at individual major noise sources:

- Under a conservative scenario[67], the EEA has assessed that population exposed to ***road transport*** noise could increase by 4% outside urban areas if no additional measures are implemented[68].

- Despite noise levels being reduced through ***railway*** innovation and mitigation measures being implemented, evidence shows that there has been a potential increase in the number of people affected by railway noise[69] with a predicted increment between 4% up to 36% in population exposure[70].

- Around major ***airports***, the EEA's most recent predictions are that population exposed to aircraft noise could decline by 37% under a conservative scenario[67] by 2030. However, in contrast other studies such as the ICAO's 2022 Environmental Report suggests that the population exposed to airport noise is expected to either stabilise or increase in the coming years[71].

Therefore, the outcomes of the most recent publications on noise trends indicate that it is unlikely that the ZPAP will be achieved by 2030, and that is possible that the implementation gap could even increase.

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63 https://publications.jrc.ec.europa.eu/repository/handle/JRC140372
64 https://www.eea.europa.eu/publications/environmental-noise-in-europe
65 https://op.europa.eu/en/publication-detail/-/publication/67225cf1-2d8c-11ed-975d-01aa75ed71a1/language-en
66 https://www.eea.europa.eu/en/analysis/publications/sustainability-of-europes-mobility-systems/transport-noise
67 Scenario considering the implementation of current regulation and a small increase of mitigation measures following current trends
68 https://www.eea.europa.eu/publications/outlook-to-2030
69 UIC SUSTAINABILITY, Nuisance and Health Impacts of Railway Noise, Noise and Vibration Technical Advice (NOVITÀ) Project, September 2022
70 https://www.eea.europa.eu/publications/outlook-to-2030/outlook-to-2030-can-the/#case-studies
71 Gregg G. Fleming, Ivan de Lépinay, Roger Schaufele - ICAO's 2022 Environmental Report – Chapter 1 Aviation & Environmental Outlooks - Environmental Trends in Aviation to 2050 - https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2022/ENVReport2022_Art7.pdf

3.6 Lessons learnt and recommendations

Considering the uncertainties and limitations with the round four END dataset, the data that will be submitted under the next END round in 2027 representative of the 2026 situation will provide a clearer description of trends in noise when compared to third round and against the ZPAP target. From the fourth round of END, countries have to assess exposure to noise using the same calculation method, CNOSSOS-EU, whereas under the third round, Member States could use their own method, which has resulted in inconsistent approaches to the assessment of population exposure to noise around the European Union. From the fifth END round, although assessments across Member States will be uniform providing consistent dataset, there will still be comparability issues to the target set by the ZPAP which is based on round three data and a different assessment methodology. Ideally, to provide in future a direct comparison against the ZPAP target, the scenario reported under the END round three should be re-assessed using the CNOSSOS-EU methodology to reduce the uncertainties derived from the different assessment methodology that were adopted.

Providing results and macro trends in the number of people exposed to noise levels against a general non-legislative target (as has been performed in this study) does not fully explain the changes in noise across the European Union. These could be described instead by a more detailed count or proportion of agglomerations and major noise sources that have seen an increase or decrease in the population exposure or harmful in the application of the END, besides providing a general overview against the ZPAP target.

Also the latest research and publications advise that the risk of developing negative health effects caused by the long-term exposure to noise start to occur below the END thresholds. The WHO[72] indicates that adverse health effects are associated with these noise levels: equal and greater than 53 dB Lden and 45 dB Lnight for road traffic, 54 dB Lden and 44 dB Lnight for railways, and 45 dB Lden and 40 dB Lnight for airports. However, to date, levels from these lower thresholds are not reported under the END and therefore the costs associated with the adverse health effects at these lower levels cannot be considered to date.

[72] World Health Organization 2018 – Environmental Noise Guidelines for the European Region

4. Nature and biodiversity

- The analysis considered 5 BDS targets to be achieved by 2030, namely targets 1, 2, 5, 8 and 9. These targets were selected as they have indicators developed to measure against the targets. The implementation gap for some is small: by 2021 protected areas covered 26% of EU land, close to the 30% target; also, between 2013-18 28% of species held 'good' conservation status, 2% off the 30% target. For most, the gap is wider: bird and butterfly population indexes continued to deteriorate to 2022, and only 22.6 million trees have been planted versus an ambition for 3 billion additional trees. All Member States have reported the presence of multiple IAS of Union concern.
- The conservation status of habitats under the EU Habitats Directive within the EU between the years 2013-2018 show that 36% are in bad condition, 45% are in poor condition, 15% are in good condition and 5% of habitat condition is unknown. The conservation status of species under the EU Habitats Directive between the years 2013-2018 shows 28% of species in good condition, 42% in poor condition and 21% in bad condition. Overall, 10% of species condition is classed as unknown which is more than double that of habitats. The gaps to reaching at least 30% of favourable conservation status for habitats and species under the EU Habitats Directive (target 4 EU BDS 2020) are 15% and 2%, respectively.
- The cost analysis quantified three aspects, noting that given the approaches and data available the estimation is somewhat illustrative: The potential loss in ecosystem service benefits due to not implementing protecting 30% of land in the EU by 2030 is estimated at between **€11 billion - 30 billion per year (low to median estimate)**; applying Bioval values to the decline in bird numbers produces a potential economic cost of around **€5 billion per year**; and economic losses associated with IAS in EU27 could be around **€46 billion per year**.
- Looking forward, based on historical trends some targets may be met by 2030, but for many, it is uncertain whether ambitions will be achieved based on current trends. That said, this does not capture the potential impact of the recently adopted Nature Restoration Regulation (NRR), which is expected to result in strengthened restoration efforts.

4.1 EU environmental policy and law

The Habitats and Birds Directives are central to the EU's nature and biodiversity policy, forming the legal basis for the EU's nature protection network Natura 2000. As summarised in Table 4-1, these Directives aim to protect specific habitats and species by creating the Natura 2000 network – this consists of the special areas of conservation designated pursuant to the Habitats Directive and the special protection areas pursuant to the Birds Directive. Both Directives also established a system of strict species protection within and outside the Natura 2000 sites.

In addition to the above-mentioned legislation, the main long-term plan to protect nature and reverse the degradation of ecosystems in the EU is the EU Biodiversity Strategy for 2030. This aims to put nature on a path to recovery by 2030, for the benefit of people and the planet. It focuses on ecosystem restoration, protection of pollinators (EU Pollinators Initiative), sustainable agriculture, and mainstreaming biodiversity into various sectors.

One of the main targets of the Strategy was to adopt a legally binding instrument to restore degraded ecosystems in the EU. This goal materialised with the adoption in August 2024 of the Nature Restoration Regulation (NRR). The Nature Restoration Regulation is the first EU-wide, comprehensive law of its kind, which sets binding targets to restore degraded ecosystems, particularly those with the most potential to capture and store carbon, as well as to prevent and reduce the impact of natural disasters.

In addition, the Invasive Alien Species (IAS) Regulation aims to prevent and minimise the adverse impact on biodiversity from the introduction and spread of invasive alien species in the Union.

Altogether, the EU has several strategies aimed at preserving and enhancing biodiversity across the European Union. The key strategies include:

- **EU Forest Strategy for 2030:** The EU Forest Strategy for 2030 focuses on preserving and enhancing forests within the European Union by protecting and restoring EU forests. With focus on the importance of primary and old-growth forests, Sustainable Forest Management, Climate Adaptation and Resilience and an EU Forest Governance Framework.

- **EU Pollinators Initiative:** This is the first ever EU framework to tackle the decline of wild pollinators setting a commitment to reverse the decline of wild pollinators by 2030. The main objectives are to improve knowledge of pollinator decline (causes and consequences), improve pollinator conservation and tackle the causes of their decline, mobilise society and promote strategic planning and cooperation at all levels.

4.2 Environmental target

The Habitats and Bird Directives do not define quantitative targets against which progress can be measured. Instead, the targets set in the EU Biodiversity Strategy (EU BDS) for 2030 have been used to define and measure the implementation gap (in particular as indicators are available from the EU Biodiversity Strategy Dashboard[73] (BSD) to measure against these targets). Of the 16 targets identified in the EU BSD, 5 are referred to in this assessment which are measured against 10 indicators. Not all the targets outlined in the EU BSD have corresponding indicators defined at this point and hence cannot be included in this assessment. Table 4-1 shows all the targets assessed in this study and the indicators used.

Information from the latest State of nature in the EU report (2013-2018)[74] has also been used in the analysis to look at the conservation status of species and habitats. Although not an indicator on the EU BDS, the data can be used to measure progress against target 4.

The IAS regulation also does not contain measurable targets. However, the BDS includes a measurable target: *Target 12: There is a 50% reduction in the number of Red List species threatened by invasive alien species'*. Despite this, there is currently no indicator to measure progress against this target. That said, capturing information on the Regulation's effectiveness to date is important, as IAS are a major threat to native plants and animals in Europe and one of the five primary causes of biodiversity loss[75]. Therefore, this study includes an analysis of data identifying the presence of IAS in Member States to illustrate the gap.

[73] https://dopa.jrc.ec.europa.eu/kcbd/EUBDS2030-dashboard/?version=1#EU%20NATURE%20RESTORATION%20PLAN
[74] https://www.eea.europa.eu/publications/state-of-nature-in-the-eu-2020
[75] https://environment.ec.europa.eu/topics/nature-and-biodiversity/invasive-alien-species_en

Table 4-1: List of EU BDS targets and the corresponding indicators used in the analysis taken from the EU Biodiversity Strategy Dashboard

BDS Targets	BDS Indicators/unit (notes on indicators)
1 - Legally protect a minimum of 30% of the EU's land area and a minimum of 30% of the EU's sea area and integrate ecological corridors, as part of a true Trans-European Nature Network	Terrestrial protected area coverage (includes Natura 2000 terrestrial protected area coverage and nationally designated terrestrial protected area coverage) (%)
	Marine protected area coverage (includes Natura 2000 marine protected area coverage and nationally designated marine protected area coverage) (%)
4 – Legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment by 2030, significant areas of degraded and carbon rich ecosystems are restored. Habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.	Here the 'Common bird index by type of species' is used as this is a published indicator from the BDS. However, the recently adopted Nature Restoration Regulation has a list of biodiversity indicators for different ecosystems outlined in the Appendices[76]. EU countries are expected to submit National Restoration Plans to the Commission within two years of the Regulation coming into force (so by mid-2026), showing how they will deliver on the targets. Therefore, there will be different indicators available in 2026 which can then be used to measure a implementation gap.
5 – The decline of pollinators is reversed	Grassland butterfly index (this will be replaced by a pollinator indicator once the monitoring under the NRR is implemented).
8 – At least 25% of agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased	Area under organic farming (%)
9 – Three billion additional trees are planted in the EU, in full respect of ecological principles	Number of trees planted in the EU as part of the 3 Billion Trees Pledge (number of trees planted)

4.3 Implementation gap

4.3.1 Analysis

Previous studies have undertaken analyses relevant to the implementation gap. For example, the evaluation of the EU Biodiversity Strategy to 2020[77] published in 2022 found that none of the six targets of the Strategy were fully achieved. According to the report, progress towards the headline target to '*halt and reverse the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and help to avert global biodiversity loss*' was limited, as indicated by various sources. Firstly, data on the status of EU habitats and species (also referenced under Target 4 below) showed that the majority were in poor or bad condition, and many Natura 2000 sites continued to suffer from anthropogenic pressures and fragmentation. Findings from the EU ecosystem assessment revealed that the impacts of climate change on ecosystems were increasing, and Invasive Alien Species of Union concern were observed across all ecosystem types.

In the remainder of this section, each of the EU BDS 2030 targets are analysed using the latest available data.

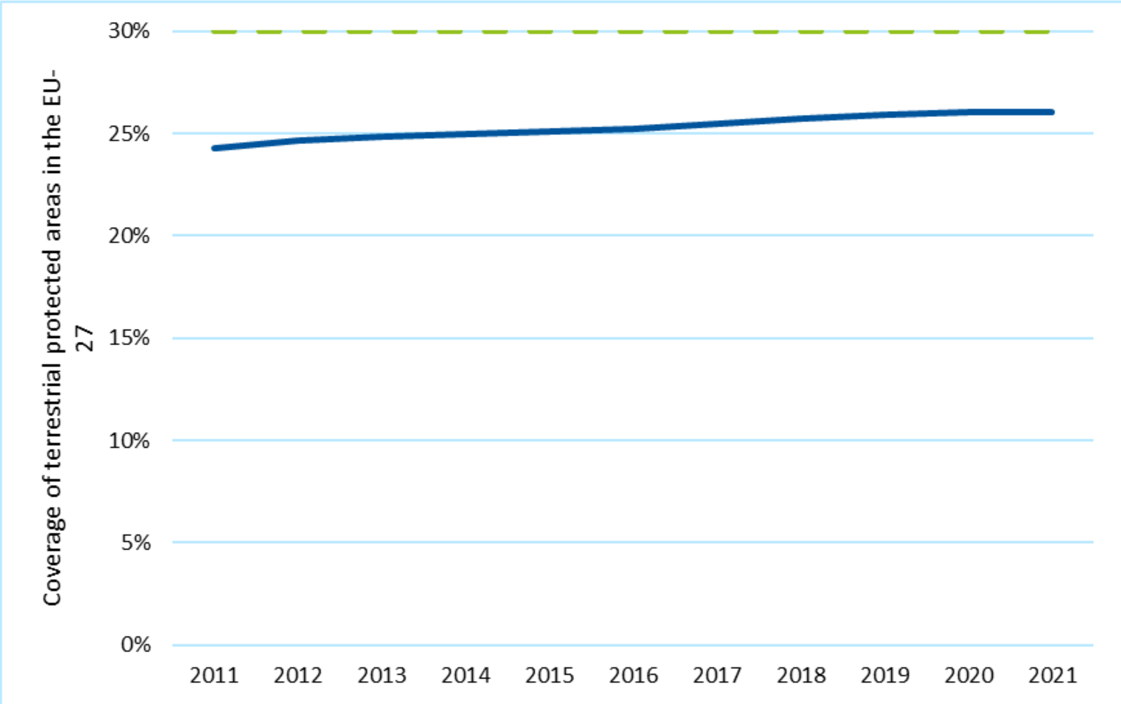
[76] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1991&qid=1722240349976
[77] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1832-Evaluation-of-the-EU-Biodiversity-Strategy-to-2020_en

A recent JRC report "Delivering the EU Green Deal. Progress towards targets"[78] provided an estimation of some implementation gaps in achieving climate and environmental policy targets. In the report targets contained in the Nature Restoration Law and other communications were assessed. According to the report, progress on only 6% of targets (2 out of 33 targets identified) is on track, progress on 27% of targets needs to be accelerated and trends related to 20% of targets needs to be reversed entirely.

Target 1: Legally protect a minimum of 30% of the EU's land area and a minimum of 30% of the EU's sea area, and integrate ecological corridors, as part of a true Trans-European Nature Network.

Terrestrial protected areas are highly diverse areas of land that benefit species and ecosystems. The designation of protected areas plays an important role in halting biodiversity decline. The EEA reports that by the end of 2021, protected areas covered 26% of EU land (1.08 million km²) (Figure 4-1). This consisted of Natura 2000 sites (18.6%) and other national designations (7.4%)[79]. The remaining area of land required to be protected to meet the 30% target is around 0.16 million km².

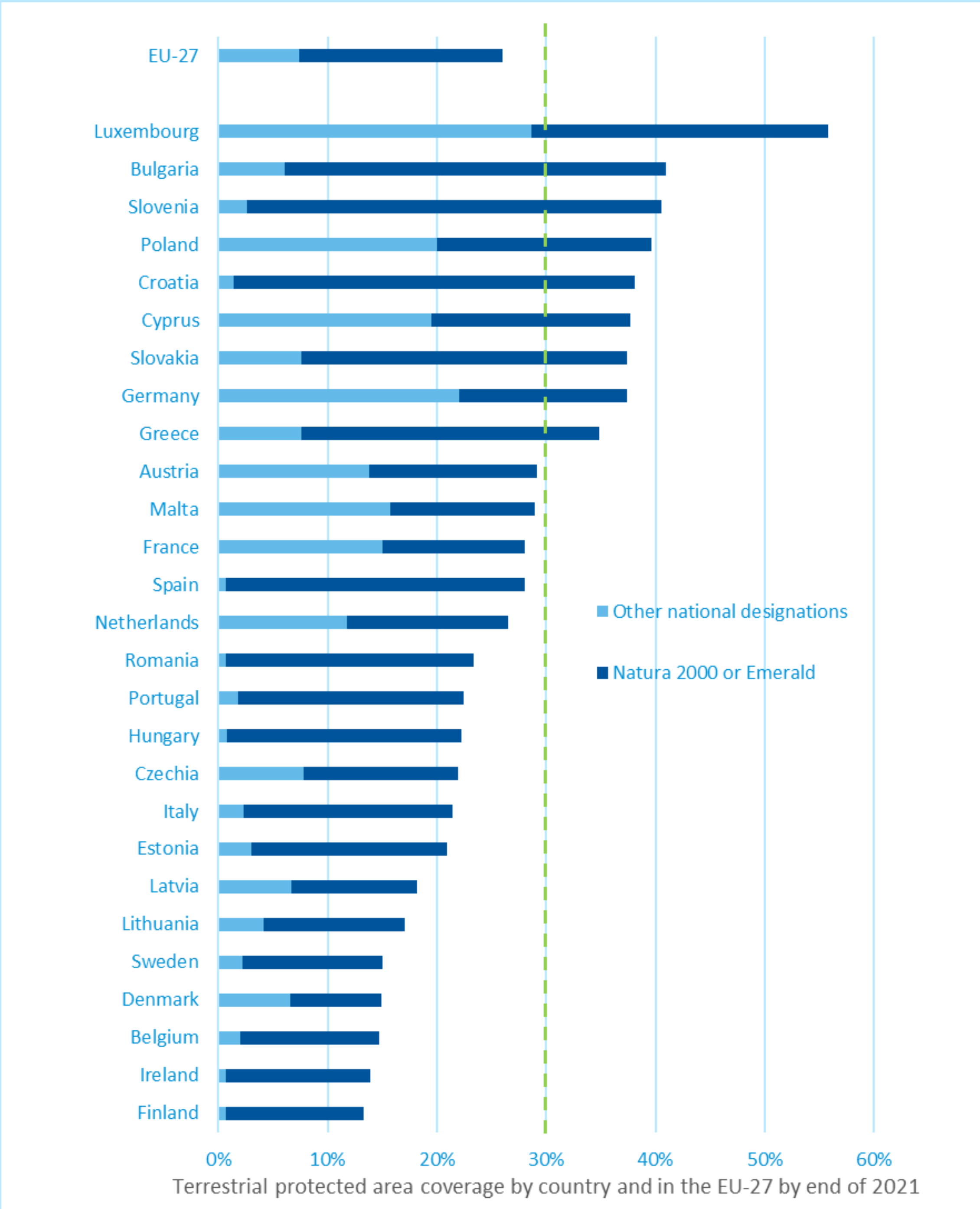
Figure 4-1: Percentage EU land covered by Terrestrial Protected Areas in EU-27 from 2011 to 2021



Coverage of protected areas within EU Member States varies greatly. According to the EEA, by the end of 2021, nine Member States (Bulgaria, Croatia, Cyprus, Germany, Greece, Luxembourg, Poland, Slovakia, and Slovenia) had achieved the target of protecting 30% of their land area (Figure 4-2).

[78] https://publications.jrc.ec.europa.eu/repository/handle/JRC140372
[79] https://www.eea.europa.eu/en/analysis/indicators/terrestrial-protected-areas-in-europe

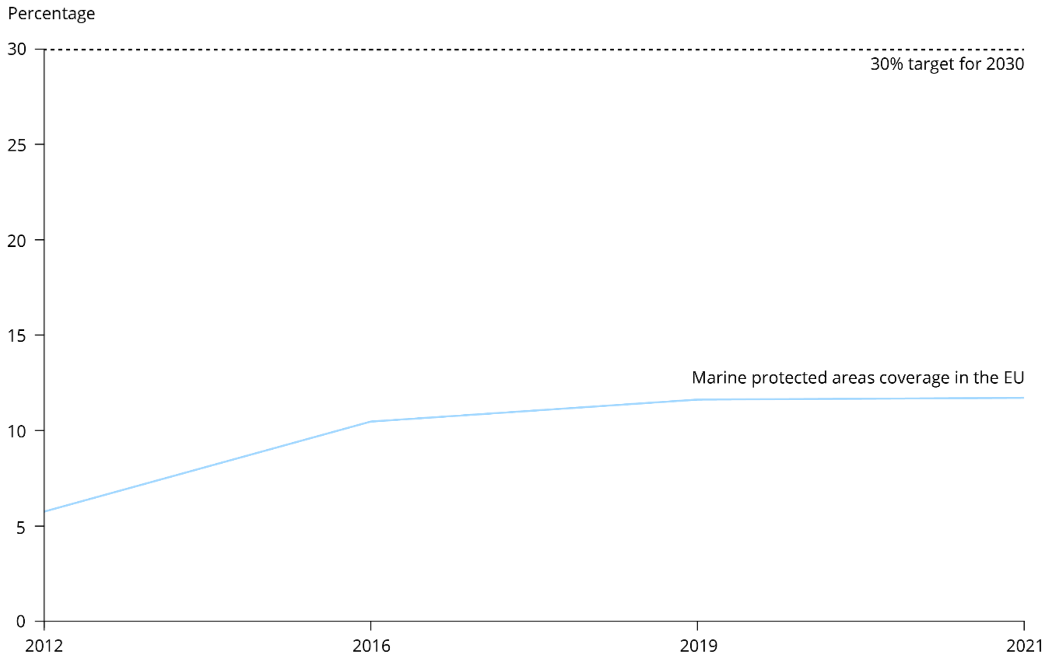
Figure 4-2: Terrestrial protected area coverage by country and in the EU-27 by end of 2021



Marine protected areas (MPAs) play a key role in conserving coastal and marine ecosystems, maintaining biodiversity and ensuring ecosystem service functionality. In 2021, MPAs covered 12.1% of EU seas[80] (Figure 4-3). In order to reach the target of protecting at least 30% of EU seas by 2030 the area of MPAs would need to increase by 17.9%. Three Member States have already designated more than 30% of their waters exceeding the target set, these are Germany, Belgium and France.

[80] https://www.eea.europa.eu/en/analysis/indicators/marine-protected-areas-in-europes-seas

Figure 4-3: Percentage of EU seas designated as Marine Protected Areas in the EU from 2012 to 2021[81]



Target 4: Legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment. By 2030, significant areas of degraded and carbon-rich ecosystems are restored. Habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.

Populations of bird species can be used as an indicator of environmental health, as changes in bird populations reflect pressures and changes in the environment. Within the EU, populations of common birds can help measure the progress towards achieving the EU biodiversity target. Common bird populations have been monitored for multiple decades, making it a valuable long-term dataset. The common bird index tracks populations of 168 common bird species, 34 forest bird species, and 39 farmland bird species between 1990 and 2022.

Since 1990[82], populations of all common bird species have declined by 14% within the EU, forest birds' populations have declined by 3%, and farmland bird populations have decreased by 40%[83] (Figure 4-4). Looking from when the EU BDS was published in 2020, only common forest birds have started to show a positive trend, whereas common birds and farmland birds continued to decline.

Habitat assessments under the Habitats Directive show that, between 2013 to 2018 at the EU level, only 15% of habitats indicated good conservation status (15% off the 30% target) between 2013 to 2018, compared to 16% in the previous years (2007-2012). Meanwhile, species assessments indicated that 28% indicated good conservation status (2% off the 30% target), while 62% of species were in unfavourable conservation status (42% poor and 21% bad)[84]. Compared to the previous data collected (2007-2012), more species are in good status (previously 23%).

[81] Source: https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/c9eba505-f96e-45c8-b653-0127f7ab3f61
[82] Using 1990 as the baseline as set out on the EU Biodiversity Strategy Dashboard: https://dopa.jrc.ec.europa.eu/kcbd/EUBDS2030-dashboard/?version=1
[83] https://www.eea.europa.eu/en/analysis/indicators/common-bird-index-in-europe?activeAccordion=ecdb3bcf-bbe9-4978-b5cf-0b136399d9f8
[84] The numbers do not add 100% because there is a certain percentage that is unknown

Figure 4-4: Common bird index in the EU from 1990 – 2021

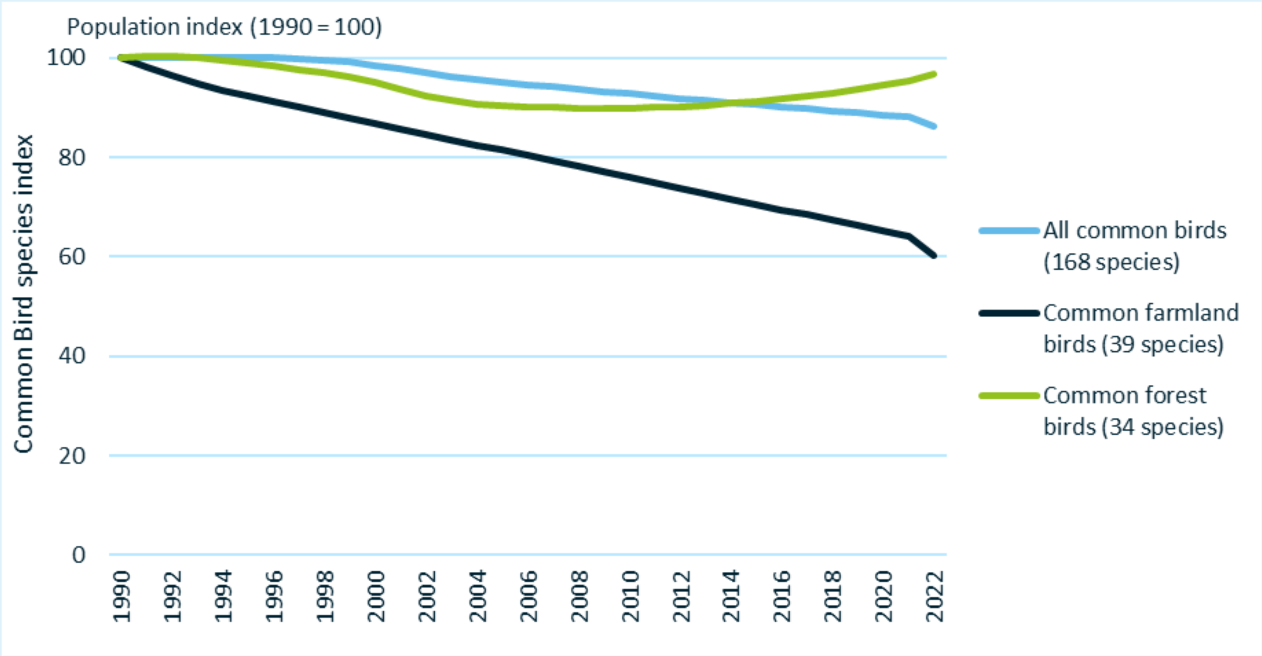


Figure 4-5: Percentage of habitats and species indicating unfavourable (bad or poor) and good conservation status

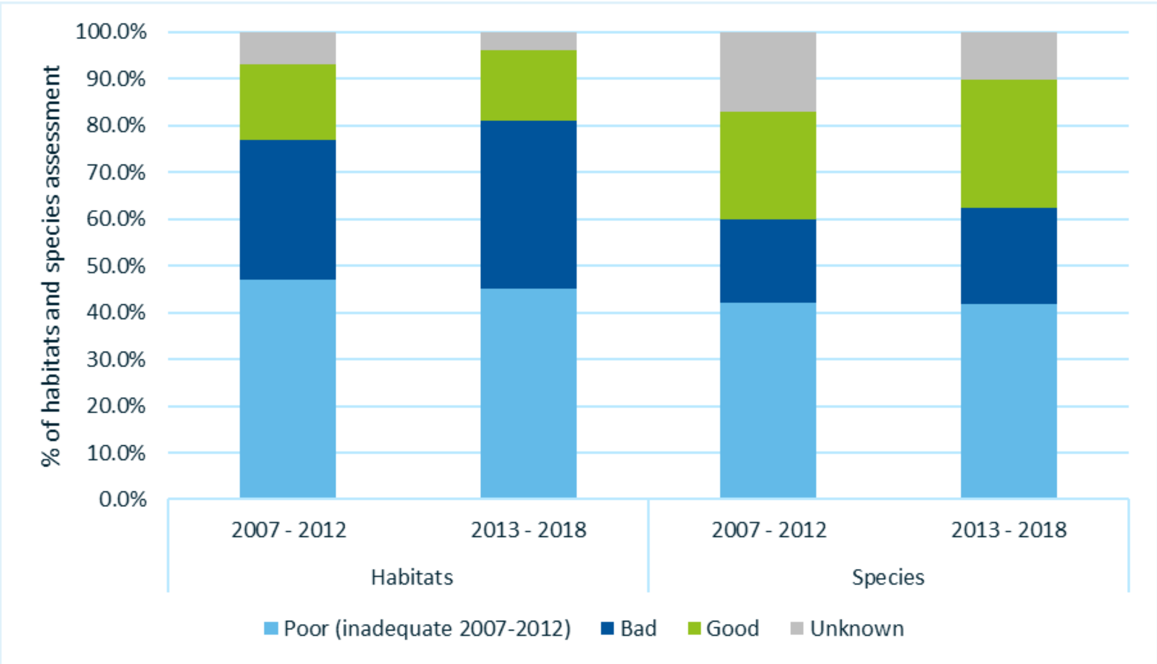


Figure 4-6 shows the breakdown of the conservation status of habitat types in Article 17 of the Habitats Directive in the years 2013-2018[85]. The figure shows that 25% of rocky habitats and 21% of sclerophyllous scrubs were reported to be in good condition. By contrast, only 6.5% of coastal habitat were in good condition. Around 14% of heath & scrub, grasslands and forests habitats were in good condition.

[85] https://biodiversity.europa.eu/europes-biodiversity/habitats-to-be-restored

Figure 4-6: Habitat condition reported for European habitats (2013-2018)[86]

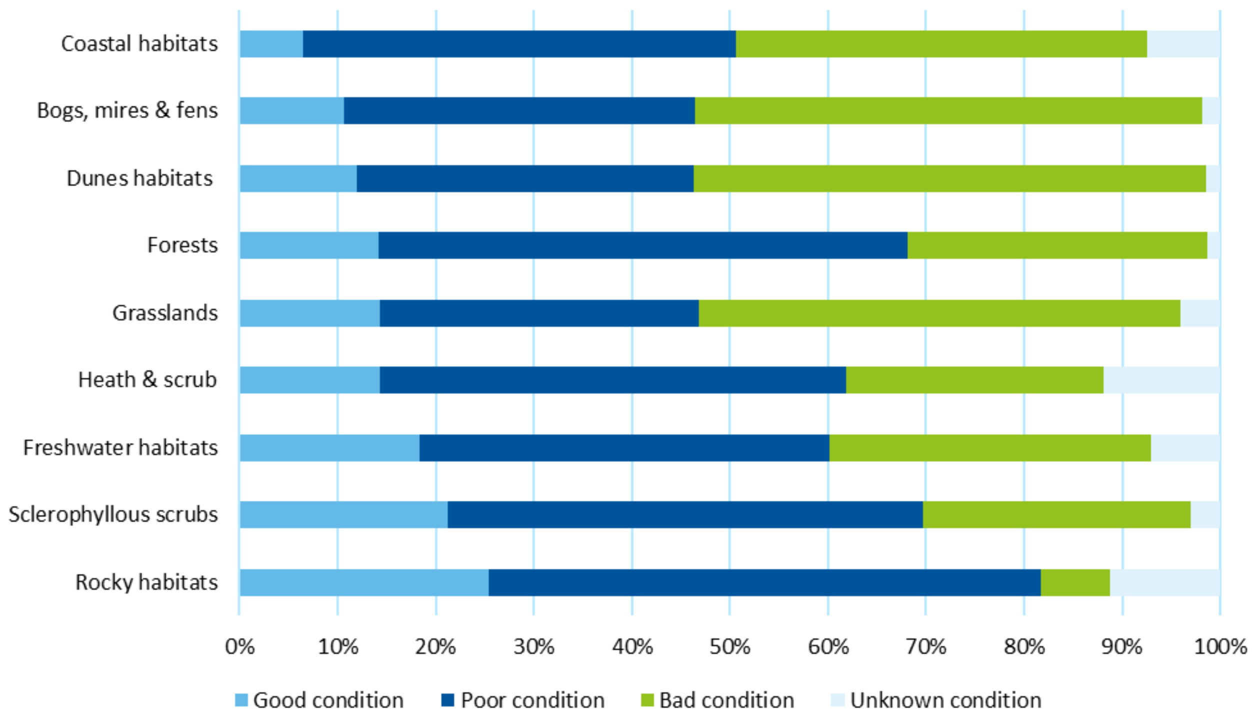


Figure 4-7: Species condition reported for European Habitats (2013 – 2018)[86]

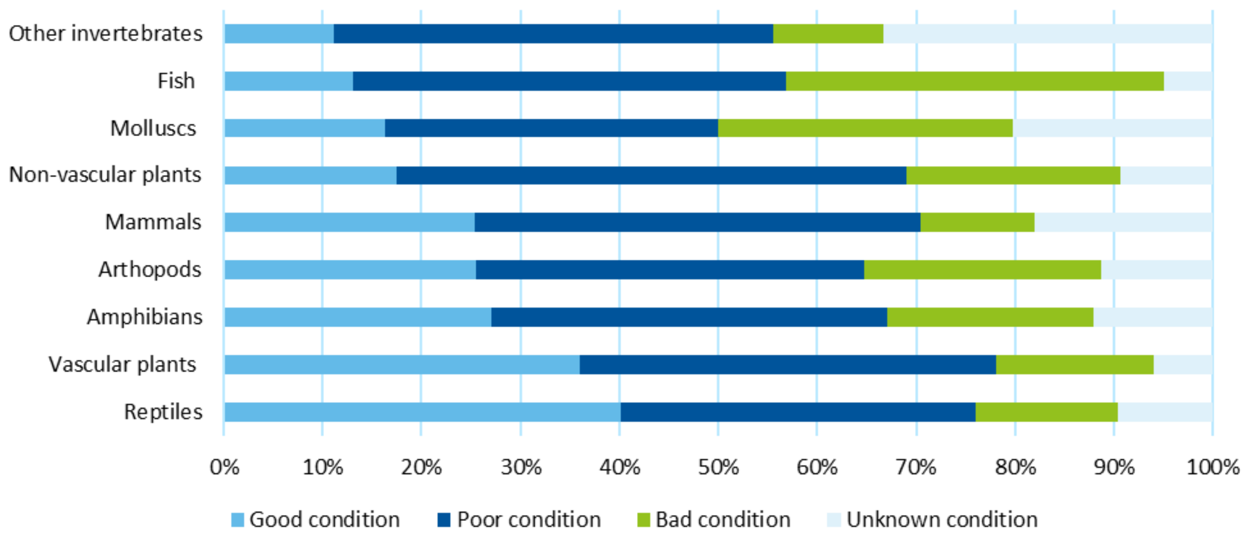


Figure 4-7 shows the breakdown of the conservation status of species types in Article 17 of the Habitats Directive in the years 2013-2018[87]. Of the species reported, reptiles had the highest percentage in good condition at 40%

[86] https://tableau-public.discomap.eea.europa.eu/views/SONConservationstatusandtrend/Story1?%3Adisplay_count=n&%3Aembed=y&%3AisGuestRedirectFromVizportal=y&%3Aorigin=viz_share_link&%3AshowAppBanner=false&%3AshowVizHome=n

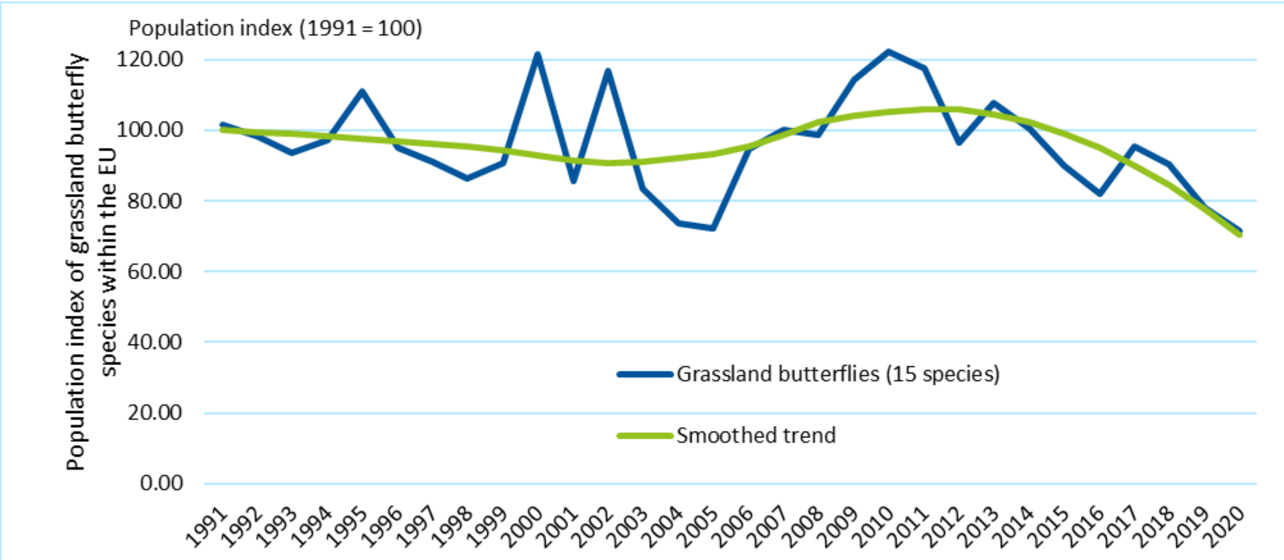
[87] https://biodiversity.europa.eu/europes-biodiversity/habitats-to-be-restored

followed by vascular plants at 36%. The proportions of all other species in good condition were below 30%, with the lowest being other invertebrates at 11%, with fish only slightly higher with 13% in good condition.

Target 5: The decline of pollinators is reversed

Butterflies are a key indicator species for the health of the environment as they are sensitive to environmental changes and react rapidly to such changes. Similarly to the common bird index, the populations of grassland butterfly species have been subject to monitoring since 1991. This long-term monitoring allows year to year variation in populations to be standardised to visualise the changes in population trend over time. The Grassland butterfly index documents the population of 15 butterfly species within 18 EU Member States between the years 1991 and 2020. Using the smoothed trend, since 1991 the population of the monitored butterfly species decreased by 29.5%[88] (Figure 4-8), with the trend not yet showing signs of reversal.

Figure 4-8: Population index of grassland butterfly species within the EU from 1991 – 2020

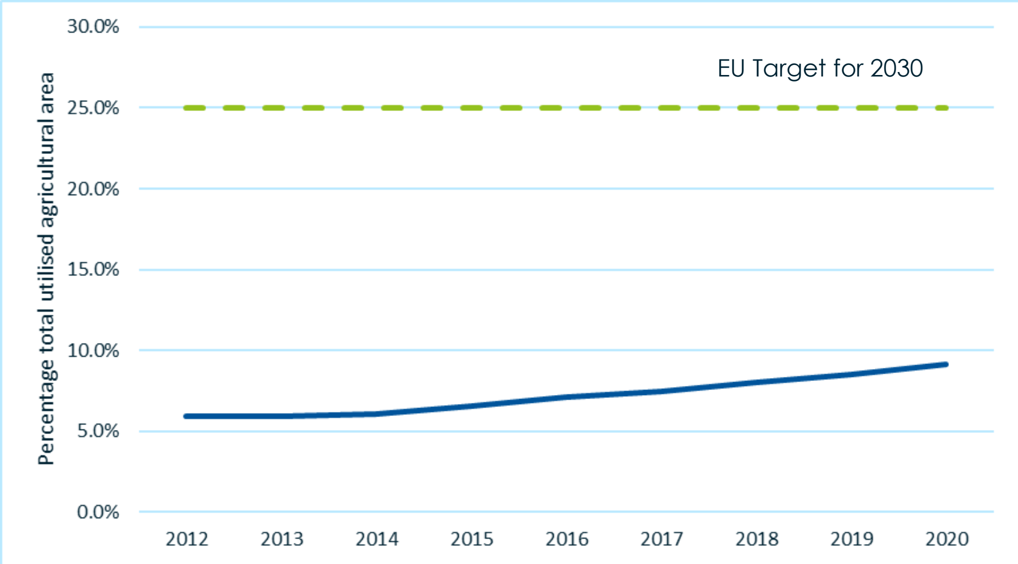


Target 8: At least 25% of agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased

The definition of organic farming as stated by the EEA is '*the production of food using natural substances and processes: It avoids or markedly reduces the use of synthetic chemicals, applies high standards of animal welfare and excludes the use of genetically modified organisms (GMOs)*[89]. The EU BDS set out a target for 25% of EU's utilised agricultural area to be under organic farming to deliver benefits for biodiversity, soil health and water quality. In 2021, 9.9% (14.7 million hectares) of EU's agricultural land was under organic farming, an increase of 3% from 2012 leaving a gap of around 15% (24 million ha) to reach the 25% target (Figure 4-9).

[88] https://www.eea.europa.eu/en/analysis/indicators/grassland-butterfly-index-in-europe-1?activeAccordion=
[89] https://www.eea.europa.eu/en/analysis/indicators/agricultural-area-used-for-organic

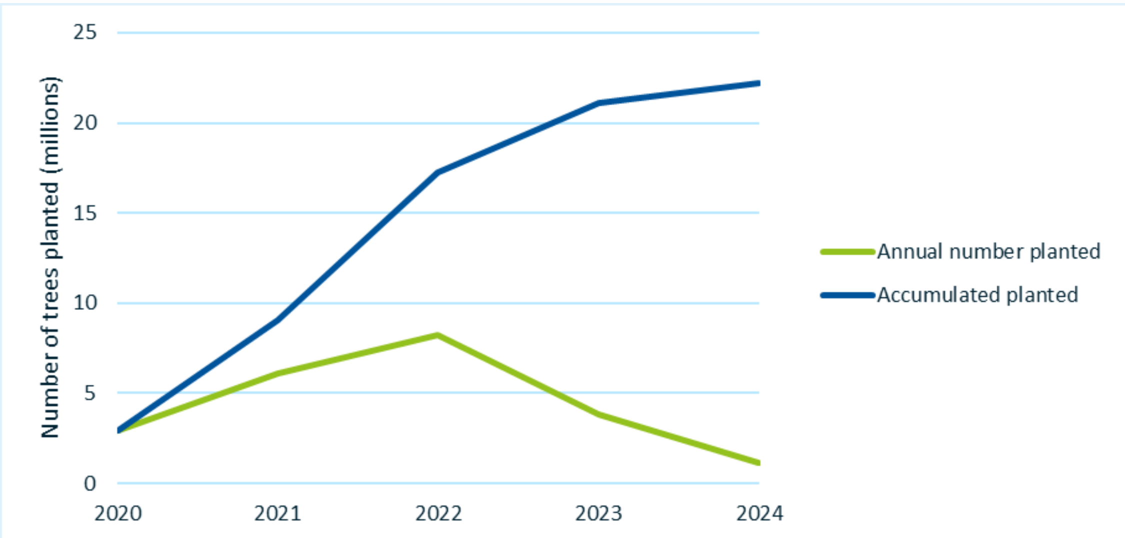
Figure 4-9: Percentage of utilised agricultural area (UAA) that is used for organic farming in the EU from 2012 to 2021



Target 9: Three billion additional trees are planted in the EU, in full respect of ecological principles

The aim of this target is to increase the area of forest and tree coverage in the EU beyond those planted in a 'business as usual' scenario, increasing the resilience of forests and deliver climate change mitigation. The Forest Information System for Europe maintains a live status counter for the EU, reporting the number of trees planted against the three billion trees initiative. The current number of additional trees planted and reported in EU27 is 22.6 million[90] . This is approximately 0.76% of the overall target to reach by 2030. Figure 4-10 shows the number of planted trees between 2020 and 2030 in addition to those that would be planted or grow anyway under a business-as-usual scenario.

Figure 4-10: Number of trees panted as part of the 3 billion trees target within the EU from 2020 to 2024



[90] Accessed 29/08/2024, 09:48

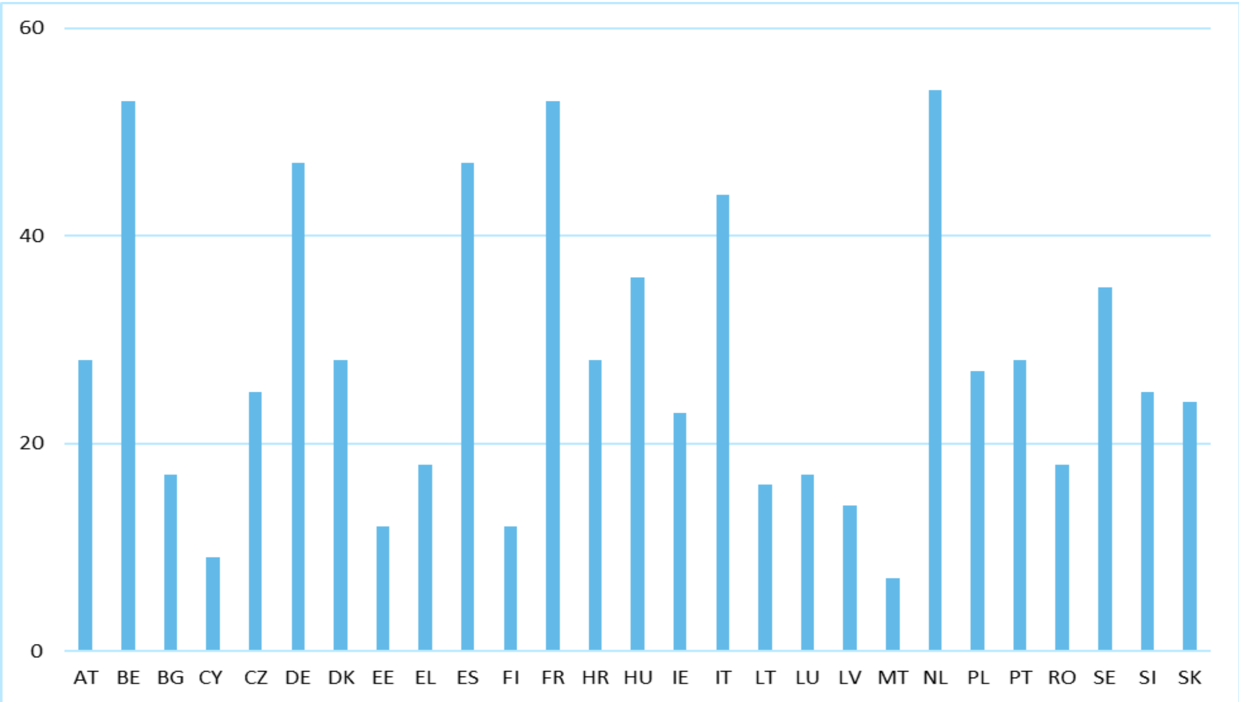
Invasive Alien Species (IAS)

Target 12 of the EU BDS for 2030 sets a target for a 50% reduction in the number of red list species threatened by IAS, however no targets for the IAS themselves are set. To measure a potential implementation gap in terms of whether IAS are being effectively managed, data looking at whether IAS of Union concern were present is used as an indicator.

Using available baseline data from the paper "Informing spatiotemporal trends of IAS of Union concern (UC) with biological knowledge" [91], the number of IAS of UC present in each Member States was calculated. According to the paper, spatial occurrences of 78 IAS of UC (out of the 88 species in the Union list) were retrieved from EASIN for a total of 1,666,900 observations up to 2022[92]. Figure 4-11 shows the results for IAS of UC by Member State. All 78 IAS of UC were recorded in all 27 Member States, with highest numbers (> 40 different IAS) in Belgium, Germany, Spain, France and the Netherlands (Figure 4-11). Each species was recorded at different time intervals (figures in Appendices 1,2 in the paper[93]), showing reporting peaks in correspondence of the IAS Regulation reporting.

More broadly, according to the latest report from the Commission to the European Parliament and the Council[94] on the review of the application of the IAS Regulation, 23 out of the 27 Member States have applied management measures for IAS of UC present in their territory between July 2016 and December 2018. The report determined that it is too early to draw conclusions on most aspects of the IAS Regulation due to deadlines for implementing various aspects were applied gradually between the first Union list in July 2016 and July 2019.

Figure 4-11: Distribution of IAS of Union concern across Member States (data refers to all records of IAS of Union concern by April 2023[95])



[91] Informing spatiotemporal trends of Invasive Alien Species of Union concern with biological knowledge - Publications Office of the EU
[92] For more information on the methodology please see the paper referenced at previous footnote.
[93] ibid
[94] https://ec.europa.eu/environment/pdf/nature/invasive_alien_species_implementation_report.pdf
[95] JRC Publications Repository - Informing spatiotemporal trends of Invasive Alien Species of Union concern with biological knowledge

4.3.2 Limitations and uncertainties of the analysis

Table 4-2 shows some key limitations and uncertainties with the analysis. To measure a potential implementation gap for nature and biodiversity, the indicators available on the EU BSD have been used. However, there are many indicators for which no data is available, and some targets for which indicators have not yet been defined. For example, target 1 for both marine and terrestrial protected areas include *'integrating corridors as part of a true Trans-European Nature Network'* - no indicator is yet defined to measure against this. Therefore, when measuring an implementation gap for some of the targets, only part of the picture can be captured.

Some of the targets do not have a defined timeline. For example, target 4 mentions *'at least 30% reach favourable conservation status or at least show a positive trend'*. This target is difficult to measure due to the ambiguity of 'positive trend' as this could be interpreted in multiple ways. For example, a positive trend may mean a positive trend starting from the 1990 baseline population or a positive trend starting from another year.

Table 4-2: Key limitations and uncertainties in the analysis

Analysis	Limitation and uncertainties in the analysis
Indicator 1.1.1: Terrestrial protected area coverage **Indicator 1.2.1: Marine protected area coverage**	It would have been beneficial to incorporate the submission of pledges for designating new areas by the EU Member States up to 2030. This would have provided a more complete picture of the potential rate of designation up until the target date of 2030[79]. However, this data was not available. Designating an area as protected does not ensure conservation targets will be achieved nor guarantee biodiversity protection. Management of protected sites plays a vital role in achieving the desired outcomes and key aims of designating an area as protected. Information on how designates sites are managed and the effectiveness of the management is currently lacking and therefore cannot be incorporated into the implementation gap at present.
Indicator 4.1.1: Common bird index by type of species	This indicator uses the baseline year of 1990 (the year 1990 is set as the index year) as on the EU BSD. However, it is known that significant declines in native avifauna, across the European Union has occurred at least since records began in 1980. With reports of 560 – 620 million individual birds lost between 1980 to 2017[96].
Indicator 5.0.1: Grassland butterfly index	Grassland butterfly index only includes data on butterfly populations across 18 Member States and not all 27. Therefore , there are 9 Member States missing from the assessment (Denmark, Greece, Cyprus, Portugal, Malta, Bulgaria, Poland, Croatia, Slovakia).This is a limitation in the data and although historical data may not be available for the 9 countries listed, effort should be made to monitor grassland butterfly populations going forward to measure progress towards the EU BDS as well as other pollinators. The European Commission have launched the SPRING[97] project (Strengthening pollinator recovery through indicators and monitoring) with an aim to strengthen taxonomic capacity with regard to pollinating insects, support preparation for the implementation of an EU Pollinator Monitoring Scheme[98] and pilot the scheme in all 27 EU countries. It's still an early programme so not enough data is available in order to become an indicator.
Conservation status of species and habitats	Poor data quality and gaps in data completeness remain one of the largest challenges and limitations for assessing the status of habitats. This is due to gaps in member states reports as the measures are not mandatory and member states are free to use other measures under Article 6.1. The state of nature in the EU report suggests around one fifth of assessments are missing the statuses of species populations, habitats and future prospects.

[96] https://pubmed.ncbi.nlm.nih.gov/34938463/
[97] https://wikis.ec.europa.eu/display/EUPKH/SPRING+project
[98] https://publications.jrc.ec.europa.eu/repository/handle/JRC122225

For IAS, there is no information regarding the population size of IAS within each Member States nor on the impact on Red List species. The IAS regulation has shown some success in eradicating or containing IAS of UC. Further information will be available from the next Member State reports, due in 2025. Such information would provide a much more comprehensive view of the population dynamics in each Member State and offer a more realistic assessment of the effectiveness of policies aimed at reducing IAS.

4.4 Implementation gap cost

4.4.1 Analysis

For this analysis, the implementation gap cost is estimated for some of the targets using available data.

Target 1.1: Legally protect a minimum of 30% of the EU's land area

For this analysis, the loss in benefits to society and people (e.g., food production, recreation, etc) resulting from not meeting the target of legally protecting a minimum of 30% of the EU's land area was calculated.

Using the per-hectare values for the different habitat types from the Impact Assessment accompanying the proposal for a Regulation of the European Parliament and Council on Nature restoration[99] (NRR), and uprating them to 2023 prices from 2020 prices with the latest GDP deflators at market prices[100], these values were applied to monetise the implementation gap. The values from the NRR are based on a literature review and provide per hectare values of the benefits of restoring habitats. All the values used in this analysis can be found in Appendix 2, Nature. There are several assumptions with this valuation which are outlined in more detail in section 4.4.2. However, the key assumption is that habitats prior to receiving protected are degraded, and once protected they are restored and provide multiple benefits. From the analysis in section 4.3.1, at the EU level, only 15% of habitat assessments have a good conservation status, with 81% having poor or bad conservation status[101]. Therefore, applying the values from the NRR seem appropriate as the majority of habitat in the EU is considered poor or bad.

To apply the values from the NRR impact assessment to the implementation gap (0.16 million km^2), firstly the total amount of land that should be protected by 2030 was divided by the current coverage of habitats in protected areas at the EU level using data from the Biodiversity Information System for Europe (BISE)[102]. Table 4-3 shows the current breakdown by ecosystem type.

Table 4-3: EU Ecosystems coverage of protected areas network

Ecosystems	Coverage of protected areas
Rivers and Lakes	11%
Heathlands	11%
Wetlands	44.5%
Forest	15.7%
Agroecosystems	17.4%
Urban	0.3%

[99] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022SC0167&qid=1686750707844
[100] https://data.ecb.europa.eu/data/datasets/MNA/MNA.A.N.I9.W2.S1.S1.B.B1GQ._Z._Z._Z.IX.D.N
[101] https://www.eea.europa.eu/en/analysis/indicators/conservation-status-of-habitats-under?activeAccordion=546a7c35-9188-4d23-94ee-005d97c26f2b
[102] https://biodiversity.europa.eu/data/visualizations/protected_areas/country-protected-areas-ecosystem

For this assessment, the benefits of protecting rivers and lakes were not included in the analysis to avoid double counting with the benefits of protection and restoration of this habitat type would come under the Water Framework Directive (see section 5).

Using these percentages, the per hectare values were applied to the different habitat types. Table 4-4 shows the results. Specifically:

- for ***heathlands***, assuming that 11% of the land that should be protected by 2030 is heathland. The estimated potential loss in ecosystem service benefits (using the min value) amounts to approximately **€4.3 billion a year**. According to the impact assessment for the NRR, the values for ecosystem service benefits were derived from an extensive review of literature on the value of these benefits, which identified changes in per-hectare ecosystem values for restored versus degraded ecosystems. Example benefits include: wildfire prevention, erosion control and recreation and tourism. As well as the multiple ecosystem value, a potential loss in carbon sequestration and storage benefit was calculated which equated to just **over €700 million a year**.

- for ***wetlands,*** if the assumption that 45% of the implementation gap is wetlands, the potential loss in ecosystem service benefits is estimated to be **£10.4 billion per year**. The ecosystem service benefits capture flood alleviation, water quality improvements, carbon sequestration, biodiversity, recreation and other cultural services.

- for ***forests,*** the potential loss in carbon storage and sequestration is potentially just over **€100 million a year,** which forms part of the total estimated loss in ecosystem services of just under **€6.1 billion per year**. Other ecosystem service benefits include: biodiversity improvements, timber production, flood protection, and social and cultural services.

- ***Agroecosystems*** are defined as communities of plants and animals interacting with their physical and chemical environments that have been modified by people to produce food, fibre, fuel and other products for human consumption and processing[103]. For the analysis, it is assumed that the agroecosystems that are protected are habitats that would be defined under the EU Habitats Directive (HD) (Appendix I), which include: semi-natural grasslands such as lowland hay meadows and mountain hay meadows. Using this assumption, the potential loss in ecosystem service benefits from agroecosystems equates to **€7.5 billion per year,** with additional carbon sequestration benefits of **€558 million a year**. According to the NRR impact assessment, the source studies for these values gave a wide range of estimate for restoration benefits. Based on the evidence available, the median value for grassland restoration are €196/ha/yr for carbon sequestration and storage, and €2,630/ha/yr in total for ecosystem values, the latter including a wide range of provisioning (food and fibre), regulating (e.g. water quality, flood management, pollination, soil quality, erosion control, climate regulation) and cultural services (recreation, landscape, aesthetic values) as well as benefits for biodiversity itself.

Adding all the values together, the potential loss in ecosystem service benefits due to not implementing protecting 30% of land in the EU by 2030 is **estimated at €30 billion per year** (median value, ranging from €11 billion to €132 billion per year) (Table 4-5). All habitats deliver significant value from protection, with wetlands delivering the greatest benefit (but also presenting the largest area assumed to be protected). Furthermore, the literature on values is better for some habitats than others. For example, as mentioned in the Nature Restoration Law impact assessment, the carbon storage and sequestration values for forestry are likely to be an underestimate as the value only includes above and below-ground biomass, while dead wood, litter, and soil were not included.

[103] https://biodiversity.europa.eu/europes-biodiversity/ecosystems/agroecosystems#:~:text=Agroecosystems%2C%20are%20defined%20as%20communities,processing%20(Maes%2C%202018).

Table 4-4 Potential loss in benefits from not protecting heathlands by 2030, 2023 prices

	Ecosystem	Coverage	Area km2	Area ha	Service	Min (€ m/yr)	Max (€ m/yr)	Median (€ m/yr)
Heathlands	Heathland and scrubland	11%	18,027	1,802,663	Carbon sequestration and storage	476	2,740	713
		11%	18,027	1,802,663	Multiple ecosystem services	1,144	19,635	4,345
Wetlands	Marshes and other inland wetlands	45%	72,926	7,292,590	All ecosystem services	3,416	86,325	10,431
Forest	Forests	16%	25,729	2,572,891	Carbon storage and sequestration	-	-	114
		16%	25,729	2,572,891	Total ecosystem services	-	-	6,061
Agroecosys tems	HD Appendix I agricultural habitats	17%	28,515	2,851,485	Carbon sequestration		558	558
		17%	28,515	2,851,485	Multiple ecosystem services	139	16,574	7,499

Table 4-5 Total ecosystem service benefits by habitat, 2023 prices

	Ecosystem	Coverage	Min (€ m/yr)	Max (€ m/yr)	Median (€ m/yr)	Notes
Heathland and scrubland	Heathland and scrubland	11%	1,619	22,376	5,058	Carbon sequestration and multiple ecosystem services
Wetlands	Marshes and other inland wetlands	45%	3,416	86,325	10,431	Multiple ecosystem services
Forest	Forests	16%	6,061			Carbon sequestration and multiple ecosystem services
Agroecosystems	HD Appendix I agricultural habitats	17%	139	17,131	8,057	Carbon sequestration and multiple ecosystem services
TOTAL			**11,236**	**131,893**	**29,608**	

Target 4: Economic cost of a decline in bird species

To calculate a potential economic cost in terms of a decline in bird species, the Bioval tool compensation values have been used[104]. These values calculate the cost of compensation associated with damage to the environment, including animal species[105] and are therefore not necessarily designed to look at the loss in benefits to society due to decline in species. Values for 100 species have been calculated, with 80 values available for different bird species. More information on the Bioval values can be found in Appendix 2, Nature.

Using data from the EEA[106], the compensation values for the different bird species were applied to the number of birds that have declined between the reporting years 2008-2012 and 2013-2018[107]. The datasets contain population sizes and trends (short and long term) for breeding and wintering populations, as well as pressures and threats. Each dataset reported minimum and maximum population sizes. For this analysis, the median was taken and then compared to see whether the populations have declined, increased or remained stable. Table A2-10-24 in Appendix 2 shows the population change for 78 bird species using the available data.

Using the available data, 37 bird species reported a decline between the reporting periods, with over a third reporting a loss in more than one million pairs. Applying the Bioval values to the decline in these numbers, calculates a potential **economic cost of around €51 billion** over the timeframe between the two reporting periods. To calculate an illustrative annual value (such that these estimates can be compared with those of other pressures and policy areas which are calculated on an annual basis), a rough mid-point between the two data points has been taken (2010 and 2015) and the total value has been divided by 5 to obtain an illustrative annual value of **€5 billion per year** associated with decline in bird species**.** This assumes firstly that the sample is the same at the points taken between the two data points and secondly that bird species decline at the same rate year on year.

Economic costs of Invasive Alien Species

A paper published in 2021[108] calculated the economic costs of IAS across Europe. This paper synthesised the current state of knowledge on economic costs associated with IAS at the European level and estimated the economic costs of invasive species from 1960 to 2020 using the data from the Invacost database[109]. Overall, economic losses associated with biological invasions were obtained for 39 European countries (including the European part of Russia). The study estimated that the cost of IAS in Europe between 1960 and 2020 was €117 billion, with a **€46 billion** cost recorded for EU27 Member States. The majority of total reported economic costs were related to damage and loss (60% of the total). Management costs (e.g. for prevention, control, education) accounted for 20% of the total costs. The remaining costs were classified under the category "mixed" (i.e. combining both damage-loss and management). The Member States with the most significant costs were Spain, France, Germany and Portugal.

The report also explores the temporal variation in cost. A simple average over the period from 1960 – 2020 suggests an annual average cost of €760 million for the EU27. However, the report notes that averaging across such long time periods may not clearly demonstrate temporal trends and best fitting models of temporal cost trends both predicted a steep linear increase on a log-scale in IAS driven costs to Europe over the 1960–2013 period. Considering all costs, the best model indicated a 12.6 to 14.1-fold increase every ten years of costs incurred from IAS, while considering only reliable costs suggested a 10.7-fold increase every ten years. The report noted that if these trends were to continue over the most recent years for which data is incomplete, then extrapolation to 2020 would yield cost estimates for that year equivalent to the estimated total over the whole

[104] https://biovaltool.eu/calculation-method
[105] https://a.storyblok.com/f/282631/x/bac48ff9e5/final-report-inbo-adjusted-list-03052024.pdf
[106] https://www.eea.europa.eu/data-and-maps/data/article-12-database-birds-directive-2009-147-ec-1/article-12-2020-dataset
[107] https://www.eea.europa.eu/data-and-maps/data/article-12-database-birds-directive-2009-147-ec-1/article-12-2020-dataset
[108] https://neobiota.pensoft.net/article/58196/
[109] https://invacost.fr/en/accueil/

period from 1960-2020 for reliable costs only. As such, the €46 billion estimated impact can be taken as an illustrative cost per year of IAS in 2020.

This value is likely to be an underestimate given the many challenges attached to assigning costs to IAS impacts. The report notes that costs of IAS are generally not restricted to directly quantifiable damages or expenditure on management, but also include indirect costs. For example, impacts on human health, native species or ecosystem services that indirectly harm ecosystem services and undermine human wellbeing. However, these costs are not easy to capture or quantify. The paper found that the UK, Spain, France, and Germany are all reporting significant costs associated with the presence of IAS. Although they do state that the west-European dominance in IAS costs may also be explained by the limited reporting of costs for Eastern European, and potentially also some Nordic, countries.

For comparison, a separate ipbes report[110] in 2019 estimated the global annual costs of biological invasions exceeded $423 billion. The vast majority of global costs (92 per cent) accrue from the negative impacts of IAS on nature's contributions to people or on good quality of life, while only 8 per cent of that sum is related to management expenditures of biological invasions.

4.4.2 Limitations and uncertainties of the analysis

Table 4-6 describes the key limitations and uncertainties in the analysis for valuing the potential cost of non-implementation for some of the targets in the EU BDS. For all the values used in this analysis, it is important to recognise that nature's value has multiple dimensions including for example intrinsic values. Intrinsic values in nature refer to the inherent worth of natural elements, ecosystems, or species, independent of their utility or benefit to humans. In other words, nature is valuable simply for existing, not because of what it provides.

Table 4-6: Key limitations and uncertainties in the analysis

Analysis	Limitations and uncertainties in the analysis
Ecosystem service benefits values from the NRR Impact Assessment[111]	For many ecosystems there are data gaps, and it can be difficult to specify all aspects of an ecosystem to a high degree of accuracy.
	Analysis assumes that habitats are degraded prior to protection, and once protected they are restored and provide multiple benefits. The values from the NRR are based on a literature review and provide per hectare values of the benefits of restoring habitats.
	Some caution is needed in interpreting the benefit estimates. There were some instances where the values varied widely due to range of available benefit estimates. Therefore, when presenting the analysis, the median value is used. For example, the flood management benefits of restoring a wetland vary widely according to its location relative to people and property, while the carbon benefits are more even.
	Where available, benefit values for carbon sequestration/storage were made available. However, according the NRR impact assessment these are likely to provide a conservative estimate of the benefits of ecosystem restoration.
Proportion of habitats used in calculating the implementation gap for target 1.1	To calculate the potential loss in ecosystem service benefits from not restoring 30% of the EU's land area, the area has been divided into different habitats using the EU 27 Ecosystems coverage of protected areas network[112]. Firstly, this assumes that the same proportion of land area will be protected by 2030. Secondly, the assumption is that the agroecosystems that are protected are habitats that would be defined under the EU Habitats Directive (HD) (Appendix I). The types of agroecosystems

[110] https://www.ipbes.net/ias
[111] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022SC0167
[112] https://biodiversity.europa.eu/data/visualizations/protected_areas/country-protected-areas-ecosystem

Analysis	Limitations and uncertainties in the analysis
	protected under the Habitats Directive include for example semi-natural grasslands such as lowland hay meadows and mountain hay meadows.
Using the Bioval values	The Bioval values reflect the monetary amount for the financial compensation for the damage to a species (see Appendix 2, Nature for more information on the values). Therefore, as mentioned previously, it does not capture other potential ecosystem service benefits such as intrinsic values.
	The values were designed for Belgium only. In this analysis they are applied at the European level. One limitation of this that Belgium may score certain species a higher cultural value than other countries. To improve the values, the Bioval methodology paper recommends scaling the formula used to calculate the values to a new socially acceptable amount using a stakeholder workshop and also engaging local experts.
	80 values have been developed for birds and due to trend data availability, the values have been applied to 67 species. However, in the Article 12 – 2020 dataset[113] there are datapoints for over 500 species. Therefore, the valuation only captures a small proportion of the potential economic cost.

4.5 Forward looking assessment

Projections of how nature and biodiversity will change going forward are either not available or subject to significant uncertainty. In light of this, the forward-looking assessment in this study adopted a simple approach projecting forward based on historical trends to illustrate the implementation gap, should these trends continue. The approach first looked at the historical data available for each target and calculated an annual average change. This was then used to project forward to the relevant policy target year. The annual average rate required to reach the target set in the EU BDS (where available) was also calculated. The difference between the two calculations, represents the implementation gap. As explored above, data around the implementation gap itself also has limitations, which in some cases has prevented the analysis of a trend.

Table 4-7 summarises the implementation gap 'in 2030' identified for each target by indicator. Further detail is presented in Appendix 2. For many indicators, should historical trends continue, the implementation gap will continue to close to 2030, but in no cases does the analysis confidently conclude that targets will be met. In some cases (for example trees planted), although the gap is anticipated to continue to reduce, there may still be a significant implementation gap in 2030 without further policy action. In some cases, given the nature of the targets (e.g. target 4 and 5 which are expressed as a reversal of trend) or the data available (i.e. target 12 related to the impacts of IAS), it is not possible to anticipate what the implementation gap will be in 2030.

It important to note that given this analysis is based on extrapolating historical trends, it does not account for the potential impact of the Nature Restoration Law, which entered into force in August 2024. Member States are expected to submit National Restoration Plans to the Commission within two years of the Regulation coming into force (so by mid-2026), outlining how they will deliver on the targets. As part of the forward look, the NRR targets were also assessed. There are currently no indicators available for the NRR therefore no implementation gap is measured for these targets. Some of the targets in the NRR are similar to the BDS, for example, reversing the decline of pollinator populations by 2030.

[113] https://www.eea.europa.eu/data-and-maps/data/article-12-database-birds-directive-2009-147-ec-1/article-12-2020-dataset

Table 4-7: Summary table of the implementation gap of each target and the indicators used to assess the implementation gap.

Targets	Indicators	Implementation gap in 2030
1 – Legally protect a minimum of 30% of the EU's land area and a minimum of 30% of the EU's sea area and integrate ecological corridors, as part of a true Trans-European Nature Network	Terrestrial protected area coverage (including Natura 2000 terrestrial protected areas and Nationally designated terrestrial protected areas)	If historic trend continues, gap reduces to 2030 leading to 27.7% of land being protected (1.1 million km² of land) by 2030. But gap to target remains of 2.3 % equivalent to 93,000 km²
	Marine protected area coverage (including Natura 2000 marine protected areas and Nationally designated marine protected areas)	If historic trend continues, gap reduces to 2030 leading to 18.3% of EU seas would be protected by 2030 (additional 6.21% between 2021 and 2030). But gap to target remains of 11.7%.
4 – Legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment by 2030, significant areas of degraded and carbon rich ecosystems are restored. Habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.	Common bird index by type of species	All common birds and the common farmland birds' indexes declined over historic period. Hence target of species showing a positive trend by 2030 is highly unlikely to be reached without Member States implementing conservation and restoration measures. However, the common forest bird index stopped declining in 2009.
	Species show no deterioration in conservation trends and status, and at least 30% reach favourable status or at least show a positive trend	Trend not robust given only two data points. That said, based on historic data species under the Habitats Directive could reach the target of 30% in good condition by the next reporting cycle. By contrast, habitats reported under the Directive are not likely to reach the 30% target.
5 – The decline of pollinators is reversed	Grassland butterfly index	Grassland butterfly index declined over recent historic period, so it is not possible to anticipate when this trend may be reversed. A broader indicator of the target will be possible when Member States start to produce Nature Restoration Plans from 2026/2027.
8 – At least 25% of agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased	Area under organic farming	If historic trend continues, gap reduces to 2030 leading to 15.9% (26 million ha) of UAA used for organic farming by 2030. But gap to target remains of 9.1% (equivalent to 14.7 million ha)
9 – Three billion additional trees are planted in the EU, in full respect of ecological principles	Number of trees planted in the EU as part of the 3 Billion Trees Pledge	If historic trend continues, gap reduces slightly to 2030 with around 0.8 billion trees planted to 2030 . But significant gap to target remains of 73.5% (equivalent to 2.2 billion trees).

Targets	Indicators	Implementation gap in 2030
12 - There is a 50% reduction in the number of Red List species threatened by invasive alien species	European Alien Species Information Network	No measurable implementation gap as no information on how IAS affect threatened species. Using trend analysis in IAS of UC[114], most IAS showed an increased distribution after 2010 across Europe: • For the 26 plant species with data from 2011 to 2020, almost all (25) showed an increase in occurrences over the time frame, with 20 showing an increase of more than 100%, and 4 showing an increase of more than 1000%. • For the 29 animal species with data from 2002 to 2022, almost all (26) showed an increase in occurrences over the time frame, with 15 showing an increase of more than 100%, and 3 showing an increase of more than 1000%.

4.6 Lessons learnt and recommendations

Going forward, it is anticipated that the data available to express the implementation gap will continue to expand and improve. First, it is expected that the range of targets and indicators, and accompanying data sets, defined under the EU BDS will continue to develop. Furthermore, under the Nature Restoration Law (NRL) which came into force in August 2024[115], Member States are expected to submit National Restoration Plans to the Commission within two years of the Regulation coming into force (i.e. by mid-2026), outlining how they will deliver on the targets. Therefore, there will be different indicators available in 2026 which can then be used to measure an implementation gap.

The methodologies and data used to monetise the implementation gap for nature and biodiversity are relatively nascent in their development (for example, compared to those for air pollution which have been established and applied over many decades). Hence further developments to improve the robustness of these methods, the range of impacts captured, and the representation of impacts across all Member States is anticipated in the future.

[114] Informing spatiotemporal trends of Invasive Alien Species of Union concern with biological knowledge - Publications Office of the EU

[115] https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en#targets

5. Water

- The EU Water Framework Directive (WFD) 2000/60/EC has established a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. Marine waters are addressed in the Marine Strategy Framework Directive (MSFD) 2008/56/EC. The overall target under WFD and MSFD is to achieve 'good status' for all waters.
- Based on analysis of WISE WFD data from the 3rd River Basin Management Plans (RBMP), for inland surface, transitional and coastal waters, in 2021 **30.3% of river length, 33.6% of lake area, 13.6% of transitional water area and 47.5% of coastal water area** achieved good or high ecological status. For chemical status, in 2021 **39.9% of river length, 19.2% of lake area, 28.8% of transitional water area and 33% of coastal water area achieved good chemical status. Across both ecological and chemical status, the central estimate of costs (foregone benefits) of not achieving 'good' status is €51.4 billion per year (2023 prices).**
- For surface waters, WFD Article 4(4) allows time limited exemptions to be applied until 2027 and Article 4(5) allows the setting of less stringent objectives. Article 4(4) exemptions in particular have been applied widely by Member States, capturing the vast majority of waterbodies with status below 'good'. **Taking account of both Article 4(4) and 4(5) exemptions, the central estimate of the remaining cost (foregone benefit) is €5.7 billion per year across surface waters.** This does not reduce the environmental 'costs' of not attaining good status, merely what is considered as the 'implementation gap'.
- For groundwaters, in 2021, 90.9% achieved 'good quantitative status' and 76.8% achieved 'good chemical status'. For chemical status, **this is estimated to equate to a central estimate of costs (foregone benefits) of around €636 million per year in 2021.**
- Looking forward, the crucial date is 2027 when time limited exemptions under WFD Article 4(4) expire (except for "natural conditions") and hence all measures to achieve good status must be in place. Attaining 'good 'status of bodies covered by Article 4(4) exemptions could achieve benefits of around €38.6 billion per year for inland surface, transitional and coastal waters, but will take time to achieve.
- For marine waters, there are still large areas where status has not yet been assessed (latest available data from 2018 - October 2024 submissions from Member States are yet to become available). The Commission's ongoing work on the MSFD evaluation currently estimates that 6.42% of the MSFD specific measures are fully implemented, bringing benefits of some €1.1 billion per year out of an estimated total of €15.8 billion per year of expected benefits of achieving good environmental status in all marine waters. Extending the approach used, this study estimates a further 19.92% of other non-MFSD specific relevant measures that have been fully implemented providing a further €3.2 billion per year of benefits (so €4.2 billion per year total benefits from measures fully implemented). Thus, **the costs (benefits foregone) of the implementation gap are some €11.7 billion per year for marine waters**.

5.1 EU environmental policy and law

5.1.1 Inland surface waters, transitional waters, coastal waters and groundwater

EU water policy is one of the cornerstones of the EU environmental acquis. It has a long history dating back to the 1970s and 1980s, when separate pieces of legislation sought to address issues such as drinking water quality, bathing water quality and discharges of hazardous substances. In 2000, these separate pieces of legislation were revised or repealed, and integrated as elements in the more strategic approach to water provided by the Water Framework Directive (WFD).

The ***EU Water Framework Directive (WFD) 2000/60/EC*** has established a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. It aims to prevent and reduce pollution, promote sustainable water use, protect and improve the aquatic environment and mitigate the effects of floods and droughts. The overall objective is, in short, to achieve 'good' status for all waters implemented by means of river basin management plans (RBMP) and programmes of measures to achieve the objectives. Good status under the WFD means both good chemical and good ecological status for surface water and good chemical and status which are assessed at the hand of a list of underlying parameters and criteria).

The WFD is supported by a number of other pieces of legislation setting out specific criteria, actions and requirements in relation to specific types of waters or sources of pollution/pressure or impacts. Pursuing the objectives of these individual pieces of supporting legislation contributes to the delivery of the overall WFD objective of achieving good status for all EU water bodies. These pieces of supporting legislation include:

- The ***Groundwater Directive (GWD) 2006/118/EC***: provides the detailed procedures and criteria for meeting the WFD's objectives in relation to the protection of groundwater against pollution and deterioration and setting out specific criteria for the assessment of good chemical status.

- The ***Drinking Water Directive (DWD) (EU) 2020/2184***: defines essential quality standards for water intended for human consumption as well as monitoring methods and reporting.

- The ***Bathing Water Directive (BWD) 2006/7/EC***: aims to enhance public health and environmental protection by laying down provisions for the monitoring and classification of bathing waters as 'excellent', 'good', 'sufficient' or 'poor' and public communication on, for example, the nature of pollution and sources that affect the quality of the bathing water.

- The ***Environmental Quality Standards Directive (EQSD) 2013/39/EU***: establishes limits on the concentrations of priority substances that present a significant risk to, or via, the aquatic environment. Any exceedance of such a limit implies 'less than good status,' because of the WFD "one-out-all-out" principle.

- The ***Urban Waste Water Treatment Directive (UWWTD) 91/271/EEC***: targets the protection of the environment from adverse effects of urban wastewater discharges and discharges from industry. The Directive sets minimum standards and timetables for the collection, treatment and discharge of urban wastewater and controls on the disposal of sewage sludge.

- The ***Nitrates Directive (ND) 91/676/EEC***: aims to protect ground and surface waters from nitrate pollution (and resulting eutrophication) inter alia through establishing codes of good agricultural practice and measures to prevent and reduce water pollution from nitrates, designating nitrate vulnerable zones and monitoring and action programmes.

- The ***Floods Directive (FD) 2007/60/EC***: which aims to reduce and manage the risks posed by floods to human health, the environment, infrastructure and property through flood risk maps and management plans focused on prevention, protection and preparedness consistent with WFD requirements and the associated RBMPs.

- The ***Water Reuse Regulation (EU) 2020/741***: which, applicable from June 2023, sets out minimum water quality, risk management and monitoring requirements to ensure safe reuse of treated urban wastewaters in agricultural irrigation as part of efforts to help address water scarcity issues (under the WFD).

5.1.2 Marine Waters

While the WFD seeks to address and manage issues in relation to inland surface waters, transitional waters, coastal waters and groundwater, marine waters are specifically addressed in the Marine Strategy Framework Directive (MSFD) 2008/56/EC. In a similar way to the WFD, the MSFD *establishes a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest* (Article 1(1)). Therefore, there is a certain overlap in the scopes of WFD and MSFD for coastal waters (i.e. up to 1 nautical mile from the baseline). 'Good environmental status' under the MSFD is determined at the level of the marine region or subregion on the basis of the 11 qualitative descriptors set out in Appendix I of the MSFD and reproduced as Table 5-1. An important concept underlying the MSFD is the ecosystem-based approach under which the management of human activities having an impact on the marine environment must integrate the concepts of environmental protection and sustainable use.

Table 5-1: Good status descriptors under MSFD

Descriptor 1: Marine biodiversity – Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions;
Descriptor 2: Non-indigenous species – Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems;
Descriptor 3: Commercial fish and shellfish – Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock;
Descriptor 4: Food webs – All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity;
Descriptor 5: Eutrophication – Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters;
Descriptor 6: Seabed integrity – Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected;
Descriptor 7: Hydrographical conditions – Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems;
Descriptor 8: Contaminants – Concentrations of contaminants are at levels not giving rise to pollution effects;
Descriptor 9: Contaminants in seafood – Contaminants in fish and other seafood for human consumption do not exceed levels established by Union legislation or other relevant standards;
Descriptor 10: Marine litter – Properties and quantities of marine litter do not cause harm to the coastal and marine environment; and
Descriptor 11: Energy, including underwater noise – Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

As it is clear from the list of descriptors, the sources of impacts and pressures affecting the marine environment (and that the MSFD seeks to address) are wide ranging, covering a number of activities, industries and issues[116] for which specific regulation may be in place. However, before the MSFD specific consideration of impacts on marine ecosystems was either absent, insufficient or conflicting. From a wider legislative, perspective, the objective of the MSFD was to contribute to *coherence between and aim to ensure the integration of environmental concerns into, the different policies, agreements and legislative measures which have an impact on the marine environment* (Article 1(4)).

Accordingly, the MSFD target of achieving *good environmental status in the marine environment by the year 2020* was supported, influenced or delivered by actions and measures established under a number of other pieces of legislation. Important among these is the legislation on inland surface, transitional, coastal and ground waters (as described above in section 5.1.1). As many issues, impacts and pressures that affect these waters will also affect marine waters (either indirectly through the flow of water to the sea or from impacts in coastal areas), the MSFD has many issues in common with the Water Framework Directive. In addition, the achievement of good status objectives under the WFD promotes the achievement of good environmental status for descriptors under the MSFD; this is particularly the case for the delivery under: Descriptor 5: Eutrophication; Descriptor 8: Contaminants and Descriptor 9: Contaminants in seafood. The interrelationship between the WFD and the MSFD also extends to an overlap in spatial boundaries. Both apply to coastal and territorial waters with the MSFD

[116] Such as fisheries, agriculture, chemical risk management, waste management, water and water treatment.

covering only aspects not addressed by the WFD in coastal waters (such as underwater noise or marine litter) and the WFD applying only to the chemical status of territorial waters (i.e. not ecological status).

The other status descriptors under the MSFD (namely D1, D2, D3, D4, D6, D7, D10 and D11) are less or otherwise not connected with 'water legislation' *per se* and more connected with other supporting legislation including:

- **Birds (Directive 2009/147/EC) and Habitats (Council Directive 92/43/EEC) Directives** – especially relevant for reaching good environmental status related to marine biodiversity, non-indigenous species and commercial fish and shellfish;
- **Common fisheries policy (Regulation (EU) No 1380/2013)** – one of the objectives of which is to be coherent with the MSFD and its objective of achieving good environmental status. It is especially relevant in relation to the abundance and diversity of marine life, marine food webs and ecosystems, and seabed habitats as well as marine litter (discarded/lost fishing gear);
- **Maritime Spatial Planning Directive (Directive 2014/89/EU)** – which requires that maritime spatial planning should apply an ecosystem-based approach and help to achieve good environmental status under the MSFD;
- **Strategic Environmental Assessment (2001/42/EC) and Environmental Impact Assessment (Directive 2014/52/EU) Directives** – especially relevant to assessing impacts of projects/plans/programmes on hydrographical changes, underwater noise, marine biodiversity, eutrophication and horizontal measures;
- **Waste Framework Directive (Directive (EU) 2018/851), the EU strategy for plastics (COM/2018/028 final) and the Single-Use Plastics Directive (Directive (EU) 2019/904)** – important in relation to litter and marine litter as well as well as contaminants (including microplastics); and
- **Port Reception Facilities (2019/883/EU), Ship-source pollution (2005/35/EC), Safety of Offshore Oil and Gas Operations Directives (2013/30/EU)** – respectively aiming to prevent marine pollution from ships, ensuring that ship-source discharges of polluting substances are regarded as infringements with a common framework for penalties in the EU and the risk of major offshore oil and gas incidents is mitigated.

The protection of marine waters in Europe is also governed by four Regional Sea Conventions between the Member States and neighbouring countries sharing common waters: the OSPAR Convention of 1992 (based on the earlier Oslo and Paris conventions) for the North-East Atlantic; the Helsinki Convention (HELCOM) of 1992 on the Baltic Sea Area; the Barcelona Convention (UNEP-MAP) of 1995 for the Mediterranean; and the Bucharest Convention of 1992 for the Black Sea.

5.2 Environmental target

5.2.1 Inland surface waters, transitional waters, coastal waters and groundwater

The WFD has a central objective of achieving and maintaining 'good status' for all waters falling under its scope (inland surface waters, transitional waters, coastal waters and groundwater bodies). Other pieces of supporting legislation (such as EQSD, ND, UWWTD, etc.) set out specific criteria, actions and requirements in relation to specific types of waters or sources of pollution, pressures or impacts. These in turn contribute to achieving the WFD target of good chemical and good ecological status for surface water bodies (SWB) and good chemical and good quantitative status for groundwater bodies (GWB). Table A2-10-27 in Appendix 2 illustrates the links between supporting legislation and the elements of waterbody status under the WFD for SWB and GWB.

The WFD requires Member States' authorities to develop and publish River Basin Management Plans (RBMPs). Article 13 sets out the timescales for review and updating of RBMPs. To date, there have been three rounds of

RBMPs reported by Member States according to Article 13: 1st round of RBMPs in 2009, 2nd in 2016, and the 3rd in December 2021. In each case, the authorities also report electronically to the European Environment Agency (EEA) which collates and publishes these data in the WFD database as part of the Water Information System for Europe (WISE).

The WISE WFD database contains information on the status of all SWBs in the EU (including number and size, water body category, ecological status or ecological potential[117], chemical status, significant pressures and impacts) and the status of all GWB in the EU (including number and size, quantitative status, chemical status, significant pressures and impacts). Information is available in the database by country, river basin district (RBD), river basin district sub-unit (where applicable) and waterbody level, allowing detailed assessment of the status of European waters (see for example *European waters – Assessment of status and pressures 2018*[118]).

Relevant for this report's assessment, the WISE WFD database provides information on the length/area of SWB and GWB achieving or failing WFD status objectives (chemical/ecological/quantitative) and information on the nature of the impacts and pressures acting on waterbodies and causing failure at individual waterbody level. Since the supporting EU water legislation also aims towards the achievement of the WFD status objectives, the analysis of the WISE WFD data on all surface and ground waters failing to achieve WFD status objectives provides the overall implementation gap for all water legislation as a whole (i.e. WFD, ND, EQSD, GWD, UWWTD, BWD and FD).

5.2.2 Marine Waters

As set out earlier, the environmental target for the MSFD is to *achieve or maintain good environmental status in the marine environment by the year 2020 at the latest* (Article 1(1)). What constitutes 'good environmental status' is determined at the level of the marine region or subregion on the basis of the 11 qualitative descriptors set out in Appendix I of the MSFD and provided earlier.

Whilst it is relatively simple to set out qualitatively what good environmental status entails in relation to each descriptor, establishing monitoring systems to gather the data, setting thresholds and developing consistent methods to measure progress towards the targets for some 5,720,000 km^2 of marine waters has been one of the key challenges of the Directive and its implementation. As identified in the Commission's Implementation Report[119], at the time of adoption of the MSFD, data and knowledge from the marine environment were (and still are) scarce for some topics and regions. Implementation has required constant improvements in data gathering, development of comprehensive marine monitoring programmes, applied research initiatives (for example on plastic and microplastic marine litter and underwater noise), Common Implementation Strategies and a host of other activities.

The implementation of the MSFD initially comprised three major stages:

- In 2012 Member States were to report on status of marine waters (Article 8) and set targets to achieve good environmental status for the 11 descriptors (Article 10);
- In 2014, Member States were to establish monitoring programmes to collect the data necessary to assess progress in achieving good environmental status (Article 11); and

[117] 'Good ecological potential' is the ecological status objective for a heavily modified or an artificial waterbody – the status level is below good water status. Unless explicitly mentioned otherwise, all references to ecological status" include "ecological potential" where relevant.
[118] EEA (2018): European waters - Assessment of status and pressures 2018, EEA Report No 7/2018, https://www.eea.europa.eu/publications/state-of-water
[119] COM/2020/259 final

- In 2016, Member States were to establish programmes of measures that would help them to deliver the objectives (Article 13) and report on their progress in implementing those programmes in 2018 (Article 19).

As identified in the Commission's Implementation Report, owing mainly to inconsistencies in the indicators reported for each criterion, widely differing methodological approaches and gaps in the reported information, the initial assessment of EU marine waters reported by Member States in 2012-2015 did not provide a uniform knowledge base. To improve coherence and consistency in Member States' reports, the Commission adopted a revised Decision for determining good environmental status in 2017, *laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment*[120].

An update of the initial assessment of the environmental status of marine waters was due to be reported by October 2018, coinciding with the beginning of the second cycle of MSFD implementation and the six-yearly timescale for updating reports on status of marine waters (Article 8) required by the MSFD. The Commission recently published an evaluation of the MSFD[121] and information from this work has been used to make an assessment of the implementation gap and gap cost.

The MSFD second cycle was completed with the submission by Member States of updated monitoring programmes by 2020 and updated programme of measures by 2022. As indicated above, the third cycle has just started with the submission in late 2024 of the Member States reports on the states of their marine waters, their determinations of good environmental status and their targets.

5.3 Implementation gap

5.3.1 Analysis – Surface water bodies

Data from each RBMP submission is processed by the EEA and published as part of the WISE database. While information from the 3rd and most recent RBMPs (2021) appears to have been reported by most Member States before the current study, these data had not yet been incorporated into a revised version of the WISE WFD database and presented on the data viewer[122]. The Commission provided the study team with links to the EEA discodata server[123] which facilitated use of the available data tables from the 3rd RBMP for the 19 EU Member States which had reported their WFD data by July 2024[124]. Relevant data were read out of these discodata tables and collated to enable an analysis of the progress towards status objectives for surface and groundwater bodies and the examination of the performance in sub-groups such as, for example, the status of waterbodies with exemptions under Article 4(4) or 4(5) (versus no exemptions) as well as the individual pressures and impacts acting on waterbodies.

In October 2024, the EEA published *Europe's state of water 2024: the need for improved water resilience*[125] which also focuses on the same 19 EU Member States which had reported their WFD data to the EEA by July 2024. The *State of Water* assessment complements the WISE webpage reporting on the WFD[126] which provides an interactive summary of the data[127]. Both the EEA's *State of Water Assessment* and the present study draw on an identical dataset for the 19 Member States. Consequently, the outputs in terms of length/area of different

120 Commission Decision (EU) 2017/848
121 https://environment.ec.europa.eu/document/659eea3a-8a00-410e-bc2f-f94baf210c9b_en
122 https://www.eea.europa.eu/en/analysis/maps-and-charts/wise-wfd-dashboards
123 https://discomap.eea.europa.eu
124 Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden
125 https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024
126 https://water.europa.eu/freshwater/europe-freshwater/water-framework-directive
127 With the inclusion of data for Cyprus and Greece which was incomplete in July 2024.

waterbodies at different status levels are identical and, as such, the outputs from this study provide a 'deeper dive' into the data underpinning the *State of Water Assessment*.

On 4 February 2025, the Commission published its 7th Implementation Report[128] on the WFD, which focuses on the evaluation of the (submitted) RBMPs[129]. This report and underlying documents assess the overall degree of implementation at the hand of the number of water bodies, as status is always classified for an entire water body (regardless of its length or area). For the assessment in this report, this is changed into length (for rivers) or area (the other water bodies), because this accounts for size and thus is more relevant for appraising the costs of non-implementation.

Ecological and chemical status of waterbodies

Table 5-2 provides data on both the ecological and chemical status of river, lake, transitional and coastal waterbodies in terms of the length/area with different status classifications. Table 5-3 reports on status as well but here expressed as percent length/area of the waterbodies in question. In terms of the implementation gap:

- 69.7% of the length of rivers, and 66.4%, 86.4% and 53.5% of the area of lake, transitional and coastal waters respectively are classified as failing to achieve good ecological status; and
- 48.8% of the length of rivers and 77.7%, 68.3% and 61.7% of the area of lake, transitional, coastal and territorial waters respectively are classified as failing to achieve good chemical status.

Table 5-2: SWB – Implementation gap – area/length of waterbodies at different levels of ecological and chemical status (2021)

	River waters (km)	Lake Waters (km^2)	Transitional Waters (km^2)	Coastal Waters (km^2)
Ecological status				
Good/high	297,730	18,893	1,627	87,506
Unknown	24,991	1,634	132	6,424
Moderate	415,789	19,725	3,833	64,540
Poor	171,089	13,023	4,109	19,363
Bad	73,605	2,970	2,220	6,343
Chemical status				
Good	391,986	10,793	3,438	60,855
Unknown	111,491	1,745	346	9,647
Failing to achieve good (less than good)	479,727	43,706	8,136	113,673

128 https://environment.ec.europa.eu/topics/water/water-framework-directive/implementation-reports_en
129 The same Member States as listed in footnote 124 as well as Hungary.

Table 5-3: SWB – Implementation gap – percent area/length of waterbodies at different levels of ecological and chemical status (2021)

	River waters (% Length)	Lake Waters (% Area)	Transitional Waters (% Area)	Coastal Waters (% Area)
Ecological status				
Good/high	30.3%	33.6%	13.6%	47.5%
Unknown	2.5%	2.9%	1.1%	3.5%
Moderate	42.3%	35.1%	32.2%	35.0%
Poor	17.4%	23.2%	34.5%	10.5%
Bad	7.5%	5.3%	18.6%	3.4%
Chemical status				
Good	39.9%	19.2%	28.8%	33.0%
Unknown	11.3%	3.1%	2.9%	5.2%
Failing to achieve good (less than good)	48.8%	77.7%	68.3%	61.7%

Exemptions and impact on the implementation gap

A proportion of the overall implementation gap concerns waterbodies for which exemptions have been applied by Member States. Here, Article 4(4) and 4(5) of the WFD allows for exemptions to the achievement of status objectives for identified waterbodies:

- Article 4(4) allows for an extension of the deadline to attain good status if: (i) the scale of improvements required can only be achieved in phases exceeding the timescale of the programming period, for reasons of technical feasibility; (ii) completing the improvements within the timescale would be technically infeasible or disproportionately expensive or (iii) natural conditions do not allow timely improvement in the status of the body of water. The WFD does not allow a time extension for grounds (i) and (ii) after 2027, meaning that by 2027 all measures that (ultimately) lead to good status need to have been put in place.
- Article 4(5) allows Member States to set less stringent objectives to specific water bodies when they are so affected by human activity or their natural condition that the achievement of good status would be infeasible or disproportionately expensive. The set objective needs to be reviewed per programming period, and have to be expressed as the highest possible status level.

The recent 7th WFD Implementation Report[130] highlights that a large majority of water bodies are covered by various exemptions under Article 4 of the WFD. In fact, the number of such exemptions have increased, but the relation between the amount of exemptions and number of water bodies is not straightforward, since an exemption needs to be put in place for the exceedance of any individual priority substance listed in the EQSD. Furthermore, although justifications for exemptions have generally improved, not all Member States provide

[130] COM (2025)2, Report from the Commission to the Council and the European Parliament on the implementation of the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC), 4 February 2025: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2025%3A2%3AFIN&qid=1738746144581

sufficiently detailed information at the level of the affected water body and only half provide sufficient detail in their RMBPs. It is also important to note that the WISE WFD data suggest that multiple exemptions have been applied for some waterbodies by Member States. As such, there are waterbodies with both Article 4(4) and Article 4(5) exemptions (as well as other combinations)[131]

Surface waterbodies with time limited exemptions under Article 4(4)

Table 5-4 provides information on the length/area of waterbodies for which time limited exemptions have been applied under Article 4(4) and the status of those waterbodies according to ecological and chemical status classification[132].

Comparison of the information in Table 5-4 (time limited exemptions under Article 4(4)) with the information in Table 5-2 suggests that Member States have applied time limited Article 4(4) exemptions to a large proportion of the surface waterbodies found to be in bad, poor, moderate or unknown ecological status (or potential) and/or in waterbodies with unknown or less than good chemical status.

Table 5-4: SWB – area/length of waterbodies WITH Article 4(4) time limited exemptions at different levels of ecological and chemical status (2021)

	River waters (km)	Lake Waters (km^2)	Transitional Waters (km^2)	Coastal Waters (km^2)
Ecological status				
Good/high*	1,964	36	25	270
Unknown*	11,152	256	1	0
Moderate	357,219	17,633	3,342	61,099
Poor	137,965	12,432	2,802	18,165
Bad	58,227	2,862	2,032	6,336
Chemical status				
Good*	156,954	3,601	1,644	6,432
Unknown*	61,399	862	64	2,435
Failing to achieve good	348,174	28,756	6,495	77,004
* Note: exemptions are applied for ecological and chemical status separately, and for the latter per individual chemical (thus allowing multiple exemptions for one single waterbody). Hence, waterbodies which are in good/high ecological status may not be in good chemical status, and vice versa. The same applies for reported 'unknown status' in either status dimension. Exemptions for water bodies in reported good status are likely triggered by an expected lack of good status in 2027. Note also that the status gradation differs: it is more refined for ecological status.				

Table 5-5 provides information on the waterbodies with Article 4(4) exemptions as a percentage of total length or area of the specific waterbody with the same status classification(i.e. the overall implementation gap). These

[131] Thus, the lengths/areas of waterbodies with an Article 4(4) OR an Article 4(5) exemption is not equal to the length/area of waterbodies with Article 4(4) exemptions plus the length/area of waterbodies with Article 4(5) exemptions.

[132] Note that some of these waterbodies also have Article 4(5) exemptions.

data suggest, for example, that Article 4(4) exemptions have been applied to between 79% and 99.9% of the total length/area of waterbodies with bad, poor or moderate ecological status. As noted above, by 2027 all measures to achieve good status must be in place for those waterbodies (but attaining good status may take longer).

Table 5-5: SWB – area/length of surface waterbodies WITH Article 4(4) time limited exemptions as a percentage of the total area/length of surface waterbodies with the same status classification (all waters) (2021)

	River waters (% length)	Lake Waters (% Area)	Transitional Waters (% Area)	Coastal Waters (% Area)
Ecological status				
Good/high	0.7%	0.2%	1.5%	0.3%
Unknown	44.6%	15.7%	0.6%	0.0%
Moderate	85.9%	89.4%	87.2%	94.7%
Poor	80.6%	95.5%	68.2%	93.8%
Bad	79.1%	96.4%	91.5%	99.9%
Chemical status				
Good	40.0%	33.4%	47.8%	10.6%
Unknown	55.1%	49.4%	18.4%	25.2%
Failing to achieve good	72.6%	65.8%	79.8%	67.7%

Surface waterbodies with exemptions under Article 4(5) for less stringent objectives

Member States have also made use of Article 4(5) exemptions (less stringent objectives), but to a lesser extent than Article 4(4) exemptions (time extensions). Table 5-6 provides information on the length/area of waterbodies for which exemptions have been applied under Article 4(5) and the status of those waterbodies according to ecological and chemical status classification[133].

As with the time limited Article 4(4) exemptions set out above, comparison of the information in Table 5-6 (exemptions under Article 4(5)) with the information in Table 5-2 suggests that Member States have applied Article 4(5) exemptions to a significant proportion of the waterbodies with bad, poor or moderate status. This comparison is made quantitatively in Table 5-7 which provides information on the waterbodies with Article 4(5) exemptions as a percentage of all waters (i.e. the overall implementation gap). Evidently, for a proportion of waterbodies, Member States have applied exemptions under both Article 4(4) and 4(5).

[133] Note that some of these waterbodies also have Article 4(4) exemptions.

Table 5-6: SWB – area/length of waterbodies WITH 4(5) exemptions (less stringent objectives) at different levels of ecological and chemical status (2021)

	River waters (km)	Lake Waters (km^2)	Transitional Waters (km^2)	Coastal Waters (km^2)
Ecological status				
Good/high*	6	0	0	0
Unknown*	1,422	28	86	360
Moderate	71,727	1,371	465	15,186
Poor	43,451	4,741	3,016	1,918
Bad	19,003	419	889	41
Chemical status				
Good*	53,751	1,217	514	1,164
Unknown*	18,360	27	229	1,386
Failing to achieve good	63,498	5,316	3,714	14,954
* Note that the data reflects waterbodies for which Member States have applied exemptions. This will include some waterbodies which are in good/high ecological status (but which may not be in good chemical status) and vice versa. The same is the case for those with 'unknown status'.				

Table 5-7: SWB – area/length of waterbodies WITH Article 4(5) exemptions (less stringent objectives) as a percentage of the overall implementation gap (all waters) (2021)

	River waters (% length)	Lake Waters (% Area)	Transitional Waters (% Area)	Coastal Waters (% Area)
Ecological status				
Good/high*	0.0%	0.0%	0.0%	0.0%
Unknown*	5.7%	1.7%	65.3%	5.6%
Moderate	17.3%	7.0%	12.1%	23.5%
Poor	25.4%	36.4%	73.4%	9.9%
Bad	25.8%	14.1%	40.0%	0.6%
Chemical status				
Good*	13.7%	11.3%	14.9%	1.9%
Unknown*	16.5%	1.5%	66.1%	14.4%
Failing to achieve good	13.2%	12.2%	45.6%	13.2%

* Note that the data reflects waterbodies for which Member States have applied exemptions. This will include some waterbodies which are in good/high ecological status (but which may not be in good chemical status) and vice versa. The same is the case for those with 'unknown status'.

Ecological and chemical status of surface waterbodies NOT covered by Article 4(4) or 4(5) exemptions

The implementation gap can be adjusted to include only the waterbodies without an Article 4(4) or 4(5) exemption. Table 5-8 and Table 5-9 provides data on both the ecological and chemical status of river, lake, transitional and coastal waterbodies for waterbodies with no exemptions under Article 4(4) and 4(5).

This confirms the finding that Member States have applied Article 4(4) and/or 4(5) exemptions to almost all waterbodies with bad, poor or moderate ecological status and most waterbodies with failing chemical status. The result is that the implementation gap adjusted to account for Article 4(4) and 4(5) exemptions is much smaller than the scale of the ambition presented by the overall implementation gap without accounting for these exemptions.

Table 5-8: SWB – Implementation gap (no Art. 4(4) or 4(5) exemption) – area/length of waterbodies at different levels of ecological and chemical status excluding those and with Art.4(4) or 4(5) exemption (2021)

	River waters (km)	Lake Waters (km^2)	Transitional Waters (km^2)	Coastal Waters (km^2)
Ecological status				
Good/high	295,760	18,857	1,602	87,235
Unknown	13,063	1,356	45	6,064
Moderate	4,545	947	25	1,749
Poor	798	59	4	0
Bad	526	28	0	0
Chemical status				
Good	186,533	6,051	1,282	53,524
unknown	39,068	867	54	5,826
Failing to achieve good	89,091	14,329	340	35,698

Table 5-9: SWB – area/length of surface waterbodies with no Art. 4(4) or 4(5) exemptions, as a percentage of total area/length of surface waterbodies with indicated status (all waters) (2021)

	River waters (% Length)	Lake Waters (% Area)	Transitional Waters (% Area)	Coastal Waters (% Area)
Ecological Status				
Good/high	99.3%	99.8%	98.5%	99.7%
Unknown	52.3%	83.0%	34.2%	94.4%
Moderate	1.1%	4.8%	0.7%	2.7%
Poor	0.5%	0.5%	0.1%	0.0%
Bad	0.7%	1.0%	0.0%	0.0%
Chemical Status				
Good	47.6%	56.1%	37.3%	88.0%
unknown	35.0%	49.7%	15.5%	60.4%
Failing to achieve good (less than good)	18.6%	32.8%	4.2%	31.4%

5.3.2 Analysis – Ground Water Bodies

Status of all groundwaters

Good status for groundwaters under the WFD means both good quantitative and good chemical status. Table 5-10 provides data on the quantitative and chemical status of groundwaters, representing the 'implementation gap' for groundwaters under the WFD. It reports that 90.9% of groundwaters have good quantitative status; and 76.8% of groundwaters have good chemical status.

Table 5-10: GWB – Groundwater quantitative and chemical status (all groundwaters) (2021)

	Area of GWB (km^2)	Percentage of total GWB area (%)
Quantitative status		
Good	3,459,288	90.9%
Unknown	6,555	0.2%
Poor	341,044	9.0%
Chemical status		
Good	2,922,812	76.8%
Unknown	14,259	0.4%
Failing to achieve good (less than good)	869,817	22.8%

Exemptions and the implementation gap

As with surface water bodies, Article 4(4) and 4(5) of the WFD allow for exemptions to the achievement of status objectives for groundwater bodies. The WISE WFD data suggest that multiple exemptions have been applied by Member States to specific ground waterbodies. As such, there are waterbodies with both Article 4(4) and Article 4(5) exemptions[134].

Ground waterbodies with time limited exemptions under Article 4(4)

Table 5-11 reports on the extent that groundwaters are covered by exemptions under Article 4(4) until 2027 when all measures to achieve good status must be in place (the exemption may last longer on account of "natural conditions"). The data are also provided as a percentage of the overall implementation gap (all ground water bodies).

These data suggest that 71% of the area of groundwater bodies is in poor quantitative status and 20% of the area that is failing to achieve good chemical status is covered by Appendix 4(4) exemptions.

Table 5-11: GWB – Groundwater quantitative and chemical status – waterbodies with time limited Article 4(4) exemption (2021)

	Area of GWB (km²)	As a percentage of overall implementation gap (%)
Quantitative status		
Good	71,641	2%
Unknown	0	0%
Poor	243,745	71%
Chemical status		
Good	142,480	5%
Unknown	442	3%
Failing to achieve good (less than good)	172,465	20%

Ground waterbodies with exemptions under Article 4(5) for less stringent objectives

Article 4(5) exemptions (less stringent objectives) have also been applied. Table 5-12 provides information on the length/area of waterbodies for which exemptions have been applied under Article 4(5) and the status of those waterbodies according to ecological and chemical status classification. 35% of the area of groundwater with poor quantitative status is covered by Article 4(5) exemptions.

[134] Thus, the area of groundwater body with an Article 4(4) OR an Article 4(5) exemption is not equal to the total area of waterbodies with Article 4(4) exemptions plus the area of waterbodies with Article 4(5) exemptions.

Table 5-12: GWB – Groundwater quantitative and chemical status – waterbodies with Article 4(5) exemption (2021)

	Area of GWB (km²)	As a percentage of overall implementation gap (%)
Quantitative status		
Good	3,469	0%
Unknown	0	0%
Poor	117,850	35%
Chemical status		
Good	92,228	3%
Unknown	0	0%
Failing to achieve good (less than good)	29,091	3%

Ecological and chemical status of ground waterbodies NOT covered by Article 4(4) or 4(5) exemptions

The implementation gap can be adjusted to exclude all waterbodies with an Article 4(4) or 4(5) exemption. Table 5-13 provides data on the overall implementation gap and the implementation gap excluding Article 4(4) or 4(5) exemptions. As can be seen from these data, 99% of the area of groundwater with poor quantitative status has an Article 4(4) and/or Article 4(5) exemption (leaving only 1% remaining within the implementation gap excluding the exemptions).

Table 5-13 GWB – Groundwater quantitative and chemical status – implementation gap (waterbodies with no Article 4(4) or 4(5) exemption) (2021)

	Status - All bodies	Status excluding bodies with Art. 4(4) or 4(5) exemption	
	Area (km²)	Area (km²)	As a percentage of overall area with same status (%)
Quantitative status			
Good	3,459,288	3,384,186	98%
Unknown	6,555	6,555	100%
Poor	341,044	2,066	1%
Chemical status			
Good	2,922,812	2,704,058	93%
Unknown	14,259	13,817	97%
Failing to achieve good	869,817	674,932	78%

5.3.3 Analysis – Marine Waters

An update of the initial assessment of the environmental status of marine waters was due to be reported by October 2018, corresponding to the beginning of the second cycle of implementation and the six yearly timescale for updating reports on status of marine waters (Article 8) required by the MSFD. However, by October 2019, only 10 countries had submitted their reports in electronic format (Belgium, Denmark, Germany, Estonia, Spain, Latvia, Netherlands, Poland, Finland, and Sweden) and only four countries in text-based format (Greece, France, Italy and Romania). Nine Member States had not reported. As a result, the summary of progress presented in the Commission's 2020 Implementation Report could not draw upon environmental status information that was expected to be reported in October 2018.

The same was also true for COWI et al. (2019) which, *owing to inconsistency and lack of coherence in status assessments identified by the Commission's report and the lack of available data from the 2018 MSFD status assessment*, did not assess the environmental gap under the MSFD.

As per the six-year update cycle, Member States were due to report updated Article 8 assessments of status of marine waters in October 2024. Information from received updates from Member States is yet to be quality controlled and imported into the central WISE Marine database[135] hosted by the EEA. As such, assessment of the implementation gap in this study is made using a combination of the 2018 status information that is on the WISE Marine database and in the Commission's evaluation of the MSFD.

The former provides data from 2018 on the extent of marine waters where GES has/has not been achieved or where the status has not been reported. Data are provided on the descriptors and composite features listed in Table 5-1 for each of the four regions[136]: Baltic Sea, Black Sea, Mediterranean Sea and North-east Atlantic Ocean. As will be seen in later sub-sections, the area of marine waters that is listed as 'not assessed' in the 2018 dataset makes it difficult to use the data to properly assess progress and the magnitude of any gap (in quantitative terms) either for individual descriptors or across the piece (GES means good is all descriptors). Regardless, plots of the data provide a useful visual illustration of the progress and distance to travel (gap) for individual descriptors and features and so these are provided later in the text.

Also not benefitting from the availability of data from the October 2024 updates, in its assessment of the costs and benefits of the MSFD, the Commission's evaluation of the MSFD[137] adopts an alternative approach to implementation (and consequently non-implementation). Here, the evaluation considers the implementation of Programmes of Measures (PoMs) to achieve GES. Its assessment of benefits assumes that *while benefits from improving the environmental status of marine ecosystems remain limited to date, those to be expected in the future will materialise when the Directive (and underlying GES Decision) is fully implemented, namely when:*

(1) *all new measures for MSFD and other legislation currently proposed are fully implemented;*

(2) *more new measures for MSFD and other legislation are proposed in the forthcoming PoMs and are implemented; and*

(3) *the implemented measures deliver improvements in environmental status and enhanced ecosystem services.*

The estimation of benefits (and cost) in the evaluation focusses specifically on the share of measures that were considered by Member States to be both solely attributed to the MSFD and fully implemented[138]. This is because

[135] https://discomap.eea.europa.eu/App/DiscodataViewer/?fqn=[WISE_Marine].[v1r1].[MSFD_Art8]
[136] Data are also available at sub-regional level but, to preserve readability, this level of detail has not been provided in this report.
[137] https://environment.ec.europa.eu/document/659eea3a-8a00-410e-bc2f-f94baf210c9b_en
[138] As this figure is not reported every year, a proxy was estimated based on the overall shares of measures classified as both 'new and additional' and fully implemented during the PoM two reporting periods since the adoption of the MSFD.

the cost-benefit analysis for the Commission's evaluation addresses the costs versus benefits of actions under MSFD alone.

As the Commission's evaluation and estimation focusses on measures solely attributed to the MSFD, it does not account for measures delivered by actions under other legislation/strategy. Appendix IV of the evaluation does, however, provide estimates of the:

a) Share of measures new and additional;

b) Share of measures fully implemented; and

c) Share of new and additional measures fully implemented (B multiplied by A).

The estimates in the Commission's evaluation are duplicated as Table 5-14.

Table 5-14: Share of new and additional MSFD measures fully implemented (%)

Reporting period	Share of measures new and additional	Share of measures fully implemented	Share of new and additional measures fully implemented
1st PoMs (2012-2018)	25%	16%	4%
2nd PoMs (2018-2022)	42%	21%	8.84%
Average			6.42%

On the basis of these, the Commission's evaluation uses 6.42% as share of the estimated annual benefits of full achievement of GES that are attributable to the MSFD (alone) and accrued to date.

Taking these data and applying the same logic, the share of the estimated annual benefits that is attributable to other (not MSFD specific) measures can be calculated as in Table 5-15. Further, applying the percentage of coastal waters with 'good/high' status under the WFD to represent the percentage share of these measures that have been fully implemented, one can estimate the overall implementation gap. This suggests that the share of MSFD benefits delivered by all measures (MSFD and supporting) not fully implemented is 73.66%.

Table 5-15: Share of MSFD and non-MSFD measures (%)

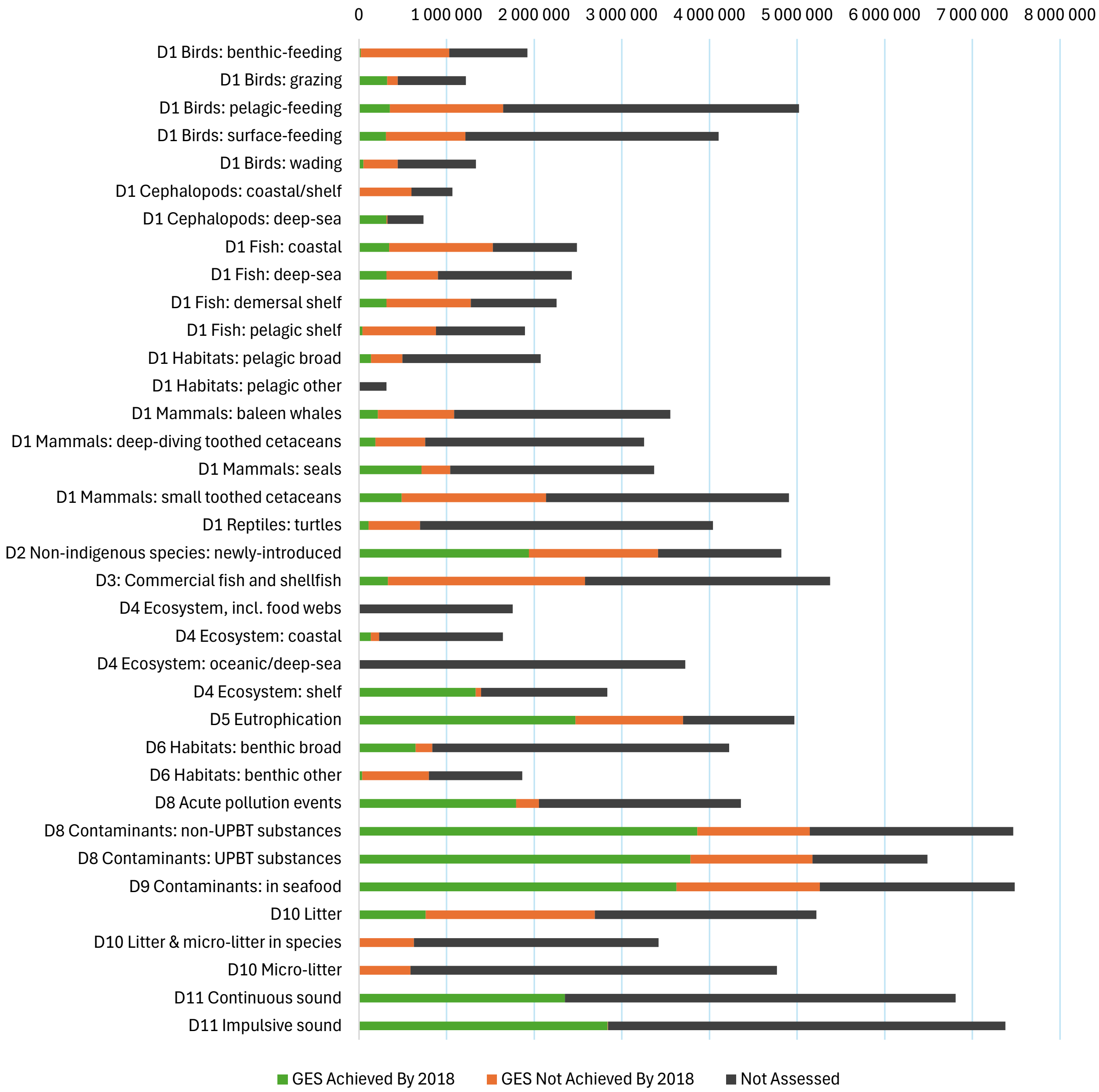
	Value	Source/calculation
Share of measures new and additional – 1st PoMs (2012-2018)	25%	From the table above
Share of measures new and additional – 2nd PoMs (2018-2022)	42%	From the table above
Share of MSFD benefits delivered by MSFD specific measures	33.5%	Average of 1st and 2nd PoMs
Share of MSFD benefits delivered by MSFD specific measures fully implemented	6.42%	From the table above
Share of MSFD benefits delivered by other (not MSFD specific) measures	66.5%	100% minus share of MSFD benefits delivered by MSFD specific measures (33.5%)
Share of other (not MSFD specific) measures fully implemented	30%	Using the proxy of percentage of coastal waters with 'good/high' status under the WFD (see relevant report section above)
Share of MSFD benefits delivered by other (not MSFD specific) measures fully implemented	19.92%	30% of 66.5% (i.e. as for the calculation of 6.42% in the table above)
Share of MSFD benefits delivered by ALL measures fully implemented	26.34%	6.42% + 19.92%
Share of MSFD benefits delivered by ALL measures NOT fully implemented	73.66%	100% - 26.34%

WISE Marine – GES status for all descriptors

As noted above, the area of marine waters that is listed as 'not assessed' in the 2018 dataset on the WISE Marine database makes it difficult to use the data to properly assess progress and the magnitude of any gap (in quantitative terms). However, plots of the data provide a useful visual illustration of the progress and distance to travel (gap) for individual descriptors and features.

Figure 5-1 provides an overview of the status of marine waters for all of the descriptors and features of GES given in the 2018 data. As such, it groups and totals values across all regions (Baltic Sea, Black Sea, Mediterranean Sea and North-east Atlantic Ocean). Appendix 2 to this report provides data on each descriptor for each regional sea area.

Figure 5-1: Area of all marine waters according to GES status by 2018 (km²)



5.3.4 Limitations and uncertainties of the analysis

Inland surface waters, transitional waters, coastal waters and groundwater

As with the EEA *State of Water Assessment*, this study has drawn upon Member State data submitted by July 2024. In this dataset there are:

- incomplete data (no data on status, pressures, etc.) for Bulgaria, Cyprus, Greece, Hungary, and Ireland; and
- data are absent (no data at all) for Finland, Malta, and Slovenia.

The coverage of the 3rd RBMP (from the database indicated above) can be assessed by comparing it to the 2nd RBMP (2016). Such an analysis suggests that the July 2024 iteration of the 3rd RBMP covers:

- some 83.5% of the estimated EU27 total of some 1,178,797 km of rivers;
- some 82.5% of the estimated EU27 total of 683,338 km^2 of lakes, transitional, coastal and territorial waters; and
- some 84.9% of the estimated EU27 total area of 4,488,707 of groundwaters.

Although not entirely complete, as with the EEA *State of Water Assessment*, the 2021 3rd RBMP data from July 2024 still provide the most up to date assessment of status (and implementation gap). Comparison of the (July) dataset used in this study and the viewer launched by EEA in mid-October 2024[139] suggests that no or almost no 3rd RBMP data has been added since that time.

In addition to issues of absence of data for certain Member States, even where there are reported data for the remaining Member States, there are some gaps in information submitted for some individual sections of waterbody (missing ecological status or chemical status or both). These represent the category of 'unknown' status in the preceding tables. Data on chemical status is available for around 89% of river length and 94% of the total area of lake, transitional, coastal and territorial waters. For groundwater, data are available for 99.6% of the area of GWB.

Marine Waters

Member States were due to report updated Article 8 assessments of status of marine waters in October 2024. Information from received updates from Member States are yet to be quality controlled and imported into the central WISE Marine database[140] hosted by the EEA. Whilst the 2018 data on the status of marine waters are available, the large areas of marine waters that are listed as 'not assessed' makes it difficult to use the data to properly assess the gap (in quantitative terms) either for individual descriptors or across the piece (GES means good for all descriptors).

Owing to these issues, assessment of the implementation gap draws on the Commission's evaluation of the MSFD. This adopts an alternative approach which uses the implementation of Programmes of Measures (PoMs) that will (eventually) achieve GES rather than area of marine waters achieving GES which is desirable.

5.4 Implementation gap cost

5.4.1 Analysis – Surface water bodies

Calculation of the benefits of achieving ecological status objectives

To calculate the cost of the WFD implementation gap, COWI et al. (2019) applied an estimate of the overall benefits of achieving good status in EU waters to the percentage of waters below good ecological status in the EU. The estimate of the overall benefits of the achieving good status in EU waters was based on work done in the UK published in 2007[141] which used survey methods to estimate the household willingness to pay (WTP) in England & Wales (E&W) for improvements to the water environment. The 2007 E&W WTP values were updated in 2012 to provide the much more detailed series of National Water Environment Benefit Survey (NWEBS) values[142]. These provide low, central and high estimates of the annual benefit (in £UK) of moving from bad to

[139] https://water.europa.eu/freshwater/europe-freshwater/water-framework-directive - accessed 18 December 2024
[140] https://discomap.eea.europa.eu/App/DiscodataViewer/?fqn=[WISE_Marine].[v1r1].[MSFD_Art8]
[141] Report on The Benefits of Water Framework Directive Programmes of Measures in England and Wales, Nera & Accent, November 2007
[142] https://assets.publishing.service.gov.uk/media/5a75a2e8e5274a4368298cc3/LIT_8348_42b259.pdf

poor, poor to moderate and moderate to good ecological status per km of river and per km^2 of lake, transitional or coastal waters. These updated NWEBS values were not used in the COWI et al. (2019) study.

Owing to the fact that the updated NWEBS values allow for different values for waterbodies of varying status (bad, poor, and moderate), they provide the possibility of measuring (in monetary terms) the benefits of incremental improvements in the ecological status of waterbodies (e.g. moderate to good) from one point in time (such as the present) to a future target (such as achievement of good status in all waterbodies). A search for alternative (more EU based) values has not identified anything that can offer the same capabilities. A project to update the E&W NWEBS is currently being undertaken with a target end date for completion of April 2026 and so not within the timescale of the current study. Primary research to develop similar benefit values specifically for the EU context would clearly be very valuable for policymakers and analysts. For this study, however, we have applied a value transfer approach to convert the E&W NWEBS into an EU Equivalent. This is described in Appendix 2 and produces three sets of average EU values[143] for improvements in the ecological status of waterbodies from bad to good, poor to good, and moderate to good in € per km of river per year and per km^2 of lakes, transitional and coastal waters per year.

These low, central and high values have then been applied to implementation gap(s) expressed as the length/area of rivers, lakes, transitional and coastal waters with bad, poor and moderate ecological status to provide the estimate of the implementation gap cost (foregone benefit) in relation to the ecological status of waters.

Calculation of the benefits of achieving chemical status objectives

The economic values described above relate only to the achievement of ecological status objectives. No similar values are available to estimate the costs and benefits of achieving chemical status objectives.

In the series of (four) studies carried out for DG Environment on registration requirements for 1-10t substances[144], the benefits of reducing chemical risks were estimated by drawing upon the UK NWEBS values discussed above. Total NWEBS values reflect improvement in six components of waterbody status: fish; other animals such as invertebrates; plant communities; the clarity of the water; condition of the river channel/flow of water; and the safety of the water for recreational contact. Where projects/actions only target some of these components the approach used in the UK is to divide the overall NWEBS values equally between the six components and then multiply by the number of components that are affected by the action/project. To estimate the benefits of addressing chemical risks in water, the aforementioned "1-10t" studies assumed that three components would be affected (fish; other animals such as invertebrates; plant communities). Thus, the benefits are 3/6 (50%) of the NWEBS values.

Applying the same approach in this study, the benefits of moving from failing good chemical status to achieving good chemical status are assumed to equal 50% of the average of the per km/km^2 benefits of moving from Bad to Good, Poor to Good and Moderate to Good ecological status (producing low, central and high estimates as with the full NWEBS).

Estimated total benefits foregone

The total costs of non-implementation (benefits foregone) for the implementation gap and the gap excluding Article 4(4) or 4(5) exemptions is the product of the value metric and implementation gap size, namely

[143] Low, central and high across the 19 Member States that had submitted information for the 3rd RBMP by July 2024

[144] Most recently, European Commission: Directorate-General for Environment, Footitt, A., Postle, M., Vencovska, J. and Camboni, M., Gather further information to be used in support of an impact assessment of potential options, in particular possible amendments of REACH Appendices, to modify requirements for registration of low tonnage substances (1-10t/year) and the CSA/CSR requirement for low tonnage substances with or without CMR properties in the framework of REACH – Final report, Publications Office, 2020, https://data.europa.eu/doi/10.2779/37609

respectively the low, central and high EU annual per km/km^2 values discussed above and the implementation gap expressed as:

- The length/area of rivers, lakes, transitional and coastal waters with bad, poor and moderate ecological status; and
- The length/area of rivers, lakes, transitional and coastal waters failing to achieve good chemical status.

As noted in previous sections, for some waterbodies, the ecological status and/or the chemical status is unknown. On the basis that positive information is required to make the classification of 'good' for ecological status and for chemical status, it has been assumed that:

- Waterbodies with unknown ecological status are assumed to be below good ecological status and, for the purpose of aggregating to a total cost (foregone benefit) the simple, straight average of value of the benefits of moving from Bad to Good, Poor to Good and Moderate to Good ecological status has been applied;
- Waterbodies with unknown chemical status are assumed to be failing to achieve good chemical status and, for the purpose of aggregating to a total cost (foregone benefit) are treated as described above for the waterbodies failing to achieve good chemical status.

Table 5-16 provides the resulting low, central and high estimates of costs of non-implementation (foregone benefits) first in relation to ecological status and second in relation to chemical status. As there are many waters that are below good ecological status and are simultaneously also failing chemical status, adding foregone benefits of not achieving good ecological status and good chemical status for the same waterbody may represent a double counting of costs. Accordingly, the total annual cost (foregone benefit) of non-implementation is the sum of the cost of the ecological status gap and the cost of the chemical status gap for waters that are of good/high ecological status but that are failing chemical status objectives. Thus, the total annual cost (foregone benefit) of non-implementation is of the order of:

- **Between €42.3 billion and €60.7 billion with a central estimate of €51.4 billion per year for all water bodies; and**
- **Between €4.7 billion and €6.7 billion with a central estimate of €5.7 billion per year for water bodies with no Article 4(4) or 4(5) exemptions.**

Note that these estimates represent costs across the 19 Member States that had submitted information for the 3rd RBMP by July 2024. As is also identified in the estimation of the gap cost for marine waters, there is likely to be some element of overlap between the foregone benefits estimated with respect to the WFD and the MSFD. Of the total annual cost (foregone benefit) of non-implementation provided above and in Table 5-16, between €2,124 million and €3,068 million with a central estimate of €2,590 million per year relates to coastal waters.

Table 5-16: SWB – low, central and high estimates of total costs of non-implementation (foregone benefits) – € million per year*

		All water bodies – € million per year	Water bodies with no Article 4(4) or 4(5) exemptions – € million per year
'Cost' of ecological status gap	Low	€38,967	€1,390
	Central	€47,390	€1,691
	High	€55,962	€1,997
'Cost' of chemical status gap	Low	€22,294	€5,066
	Central	€27,133	€6,167
	High	€32,031	€7,281
Of which 'Cost' of good/high ecological status but failing chemical	*Low*	*€ 3,326*	*€ 3,273*
	Central	*€ 4,049*	*€ 3,984*
	High	*€ 4,780*	*€ 4,704*
Total 'cost' of ecological and chemical status gap**	**Low**	€ 42,292	€ 4,663
	Central	€ 51,439	€ 5,676
	High	€ 60,742	€ 6,701

* Represents costs/foregone benefits across Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden only.
** To remove potential for double counting the total is equal to the sum of the cost of the ecological status gap and the cost of the chemical status gap for waters that are of good/high ecological status but that are failing chemical status objectives.

5.4.2 Analysis – Ground Water Bodies

Using data on the percentage of drinking water sourced from groundwater sources for each Member State, combined with the data on the percentage area of groundwater bodies which were of 'poor' or 'unknown' chemical status for each Member State, COWI et al. (2019) estimated the number of households receiving drinking water from groundwater with 'poor' (or unknown) chemical status. The study does not specify how these calculations were made and the factors applied to derive the final numbers. As such it has not been possible to reproduce them or update them directly.

To monetise the cost, COWI et al. (2019) applied a household WTP value from a 2005 Danish National Environmental Research Institute technical report[145]. This provides a household WTP of DKK 1,899 per year for 'naturally clean' water and DKK 912 per year for 'purified' water (in 2005 prices). The foregone benefit of improving groundwater chemical status from poor to good was taken as being equal to the marginal increase in the WTP if the supplied drinking water changes from 'purified' to 'naturally clean', i.e. DKK 987 per year (in 2005 prices). COWI et al. (2019) caveats the Danish WTP value, noting that groundwater is the exclusive source of drinking water in Denmark and, thus, that the cost calculation makes an assumption about the consumer

[145] https://www2.dmu.dk/1_viden/2_publikationer/3_fagrapporter/rapporter/FR543.pdf

preferences. It notes that Danish consumers put a high value on groundwater quality as the provision of clean groundwater which has a long tradition in Denmark, introducing a risk that the foregone benefit will be overestimated for other Member States.

It has not been possible to identify an alternative economic value that can be readily applied to the data on the status of groundwater for the purpose of estimating the non-implementation costs in relation to groundwater.

As noted above, COWI et al. (2019) does not provide details on how calculations were made to derive the estimates of number of households receiving drinking water from groundwater with 'poor' (or unknown) chemical status. For completeness and consistency with COWI et al. (2019), we have used available data to update the estimates of the number of households receiving drinking water from groundwater with 'poor' (or unknown) chemical status. This has been achieved by:

- calculating the percentage change in the area of groundwater that is of poor/unknown chemical status from the 2nd RBMP data (2016) to the 3rd RBMP (2021) for each Member State;
- applying this as an adjustment to the COWI et al. (2019) estimates expressed as the percentage of households receiving drinking water from groundwater with 'poor' (or unknown) chemical status in each Member State;
- applying the updated percentage of households receiving drinking water from groundwater with 'poor' (or unknown) chemical status in each Member State to the number of households in each Member State in 2021. This provides and updated estimate of the number households receiving drinking water from groundwater with 'poor' (or unknown) chemical status in each Member State in 2021;
- applying the per household WTP applied for each Member State by COWI et al. (2019)[146] to give an updated estimate of the annual foregone benefit in each Member State in 2019 prices;
- Converting the 2019 prices into 2023 prices[147].

Table 5-17 provides the resulting estimates of numbers of households and non-implementation costs (foregone benefits) for groundwaters. These suggest that forgone benefits have reduced from the €649 million per year from the 2nd RBMP data (2016) to €637 million per year in the 3rd RBMP (2021).

Thus, the costs associated with the implementation gap for groundwater are estimated as being of the order of **€637 million per year**[148]. It has not been possible to provide an estimate accounting for Article 4(4) or 4(5) exemptions within the scope of this study.

[146] This was derived from the Table 4-23 in COWI et al. (2019) by dividing the calculated annual forgone benefit given for each Member State by the number of households given for each Member State.
[147] As elsewhere in the water analysis, 2023 is selected because this is most recent year for purchasing power parity statistics. Inflation factor 2019 to 2023 = 1.18 (https://www.inflationtool.com/euro?)
[148] Represents costs/foregone benefits across Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden only.

Table 5-17: GWB –costs of non-implementation (foregone benefits) measured by the foregone benefit of naturally clean drinking water over purified drinking water – €million per year*

	Estimated households receiving drinking water from groundwater with 'poor' chemical status (COWI et al. 2019)**	Annual foregone benefit (€ million) (COWI et al. 2019)**	Estimated households receiving drinking water from groundwater with 'poor' chemical status in 2021	Annual foregone benefit (€ million) 2019 prices	Annual foregone benefit (€million) 2023 prices
Austria	60,000	€1	84,293	€1.4	€1.7
Belgium	1,799,000	€42	1,256,950	€29.3	€34.6
Croatia	not available		-		
Czechia	795,000	€10	733,968	€9.2	€10.9
Denmark	545,000	€16	891,471	€26.2	€30.9
Estonia	14,000	€0.4	67,917	€1.7	€2.0
France	3,474,000	€76	3,437,184	€75.2	€88.7
Germany	9,445,000	€205	10,078,301	€218.7	€258.1
Italy	5,573,000	€120	4,442,039	€95.6	€112.9
Latvia	0	€0	0	€0.0	€0.0
Lithuania	not available		-		
Luxembourg	33,000	€0.8	36,620	€0.9	€1.1
Netherlands	149,000	€3	150,251	€3.0	€3.6
Poland	648,000	€9	368,194	€5.1	€6.0
Portugal	23,000	€0.5	178,614	€4.0	€4.7
Romania	332,000	€5	282,266	€4.3	€5.0
Slovakia	604,000	€7	449,420	€5.2	€6.1
Spain	2,733,000	€53	2,957,159	€57.3	€67.7
Sweden	42,000	€1	97,173	€2.3	€2.7
Total 2019 prices		**€549.7**		**€539.6**	
Total 2023 prices		**€648.6**			**€636.7**

* Represents costs/foregone benefits across Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden only.
** Taken from Table 4-23 in COWI et al. (2019)

5.4.3 Analysis – Marine Waters

The Commission's evaluation of the MSFD[149] uses 6.42% as the share of the estimated annual benefits of full achievement of GES that are attributable to the MSFD (alone) and accrued to date. Taking these data and applying the same logic, the share of the estimated annual benefits that is attributable to other (not MSFD specific) measures was calculated in Table 5-18, estimating the share of MSFD benefits delivered by ALL measures NOT fully implemented to be 73.66%.

The assessment of benefits presented in the Commission's evaluation relied upon a series of willingness-to-pay (WTP) studies in 13 Member States that assessed the maximum amount of money individuals in those countries would be willing to give up for the improvements associated with the achievement of GES in marine waters. This provided an average of €38.39 per person per year as the value that the average European citizen attaches to improvement of the marine environment brought about by the achievement of GES. A total figure was calculated by multiplying this value by the population of the 22 Member States with a coastline, as follows:

- Total population of the 22 EU Member States, 2020 (412,036,721) multiplied by value of marine improvements from achievement of GES per citizen (€38.39) = €15,818 million per year.
- Applying the percentage attributions of the various MSFD and non-MSFD measures to achieve GES in marine areas (listed above) to this €15,818 million per year provides the monetary estimates of the estimated benefits of measures and measures fully implemented in Table 5-18.

Table 5-18: Estimated benefits of MSFD and non-MSFD measures (€ million per year)

	Value	Benefits (€ million)
Share of MSFD benefits delivered by MSFD specific measures	33.5%	€5,299
Share of MSFD benefits delivered by MSFD specific measures fully implemented	6.42%	€1,016
Share of MSFD benefits delivered by other (not MSFD specific) measures	66.5%	€10,519
Share of MSFD benefits delivered by other (not MSFD specific) measures fully implemented	19.92%	€3,151
Share of MSFD benefits delivered by ALL measures fully implemented	26.34%	€4,167
Share of MSFD benefits delivered by ALL measures NOT fully implemented	73.66%	€11,651

Based on these values, Table 5-19 summarises these values as the costs of non-implementation of MSFD as benefits foregone in € millions per year, providing the total estimate of €11,651 million per year (€4,284 million per year relating to MSFD specific and €7,368 million per year non-MSFD specific measures). As is also identified in the estimation of the gap cost for Inland surface, transitional and coastal waters, there is some overlap between

[149] https://environment.ec.europa.eu/document/659eea3a-8a00-410e-bc2f-f94baf210c9b_en

the WFD and the MSFD. Hence there may or may not be some overlap between the costs calculated in relation to the MSFD and those calculated for the WFD[150].

Table 5-19: Implementation gap cost MSFD (€ million/year)

	Benefits foregone (€ million/year)	Source/calculation
Non-Implementation MSFD specific measures (€ million/year)	€4,284	5,299 minus 1,016
Non-implementation non-MSFD specific measures (€ million/year)	€7,368	10,519 minus 3,151
Non-implementation total (€ million/year)	€11,651	Total of the above

5.4.4 Total non-implementation costs all waters (rivers, lakes, transitional, coastal, marine and ground waters)

Drawing on the tables and text set out above, Table 5-20 provides a summary of the total costs of non-implementation costs for all waters (rivers, lakes, transitional, coastal, marine and ground waters).

Table 5-20: total costs of non-implementation costs for all waters – € million per year

		All water bodies – € million per year	Water bodies without Article 4(4) or 4(5) exemptions – € million per year
Surface waters total non-implementation costs	Low*	€ 42,292	€ 4,663
	Central*	€ 51,439	€ 5,676
	High*	€ 60,742	€ 6,701
Ground water total non-implementation costs*		€636	**Not estimated**
Marine waters total non-implementation costs		€11,651**	
Total non-implementation cost all waters	**Low**	€ 54,580	€ 16,314
	Central	€ 63,727	€ 17,327
	High	€ 73,030	€ 18,352
* Represents costs/foregone benefits across Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden only. ** Owing to overlaps between MSFD and WFD, there is the potential for overlap with the coastal waters element of the Rivers, Lakes, Transitional and coastal waters which estimates between €2,124 million and €3,068 million with a central estimate of €2,590 million per year for coastal waters.			

[150] The total annual cost (foregone benefit) of non-implementation calculated in relation to the WFD and coastal waters is between €2,124 million and €3,068 million with a central estimate of €2,590 million per year.

5.4.5 Limitations and uncertainties of the analysis

Surface and groundwater bodies

As noted in the discussion above around the monetisation of the gap, there are limitations in the approach. First, regarding the costing of the gap specifically, the WTP values for improvements in the status of waterbodies have been drawn from the National Water Environment Benefit Survey (NWEBS) values used in England & Wales (E&W). A search for alternative (more EU based) values has not identified anything that can offer the same capabilities and so a value transfer approach has been applied to convert the E&W NWEBS into an EU Equivalent. Values are also not readily available for chemical status objectives and, as such, drawing on previous work on chemicals we have had to derive values from the EU equivalent values produced for the valuation of ecological status objectives.

Second, owing to the absence of readily available and applicable monetary values for groundwater status valuation we have updated the COWI et al. (2019) estimate for groundwaters. This is based on a Danish WTP value which, as noted by COWI et al. (2019) needs caveating by noting that groundwater is the exclusive source of drinking water in Denmark and, thus, that the cost calculation makes an assumption about the consumer preferences. It notes that Danish consumers put a high value on groundwater quality as the provision of clean groundwater has a long tradition in Denmark, introducing a risk that the foregone benefit will be overestimated for other Member States.

Marine Waters

For the gap costing, the total value of marine improvements from achievement of GES of €15,818 million presented in the Commission's evaluation has been applied. This relied upon a series of willingness-to-pay (WTP) studies in 13 Member States that assessed the maximum amount of money individuals in those countries would be willing to give up for the improvements associated with the achievement of GES.

Appendix II of the Commission's evaluation provides a suitable 'health warning' for the derived figure which, for clarity and transparency is duplicated here: "*While stated preference studies of this type can be a valuable source of information, these studies were not employed for the purpose of conducting a wide-scale assessment of the potential benefits of the MSFD. As such, the methodologies used differ, and it was not possible to adjust for differences in the ecological, socio-economic or cultural context of the different countries (other than adjusting for purchasing power parity). Given the lack of reliable and comprehensive data, the quantitative estimates provided in monetary terms in the evaluation should be interpreted with caution*".

5.5 Forward looking assessment

A key factor in the implementation gap for inland surface, transitional and coastal waters going forward will be the expiry of time limited Article 4(4) exemptions in 2027. The data suggests that Member States have applied time limited Article 4(4) exemptions to a large proportion of the waterbodies with bad, poor or moderate status. Table 5-5 provides information on the waterbodies with Article 4(4) exemptions as a percentage of all waters (i.e. the overall implementation gap). These data suggest, for example, that Article 4(4) exemptions have been applied to between 79% and 99.9% of the total length/area of waterbodies with bad, poor or moderate ecological status.

Applying the same valuation approach used earlier, Table 5-21 provides low, central and high estimates of annual cost (foregone benefit) of the current Article 4(4) exemptions in relation to Inland surface waters, transitional waters, coastal waters. These values also represent the value of expected benefits due to be realised post-2027 although, as noted, these may accrue over time after 2027 as natural conditions delay the impacts if the relevant measures. This is, of course, conditional on Member States meeting their obligations on time as well as not substituting the time-limited exemptions with exemptions under Article 4(5), which provides scope to set less stringent objectives when waterbodies are so affected by human activity or their natural condition is such that the achievement of good status would be infeasible or disproportionately expensive. In relation to the disproportionate cost argument, however, this analysis would imply that costs would have to exceed the benefits in Table 5-21 to be disproportionate.

Table 5-21: SWB – low, central and high estimates of annual costs of Article 4(4) exemptions for inland surface, transitional and coastal waters (foregone benefits) – €million per year*

		Cost (foregone benefit) of Article 4(4) exemptions – € million per year (2023 prices)
'Cost' of ecological status gap	Low	€31,682
	Central	€38,529
	High	€45,501
'Cost' of chemical status gap	Low	€15,355
	Central	€18,687
	High	€22,060
Of which 'Cost' of good/high ecological status but failing chemical	*Low*	*€ 52.6*
	Central	*€ 64.0*
	High	*€ 75.6*
Total 'cost' of ecological and chemical status gap**	**Low**	€ 31,735
	Central	€ 38,594
	High	€ 45,576

* Represents costs/foregone benefits across Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden only.
** To remove potential for double counting the total is equal to the sum of the cost of the ecological status gap and the cost of the chemical status gap for waters that are of good/high ecological status but that are failing chemical status objectives.

Table 5-11 provides the status of ***groundwaters*** covered by exemptions under Article 4(4) until 2027 when all measures to achieve good status must be in place (attaining good status may take longer). The data are also provided as a percentage of the overall implementation gap (all ground water bodies). There are expected benefits that will come online post-2027 although, as noted, these will accrue over time as recovery is not expected to also occur by 2027. It has not been possible to provide a value for the benefits.

The EU Action Plan 'Towards Zero Pollution for Air, Water and Soil' was adopted by the Commission in 2021, with the aim to reduce air, water and soil pollution levels so that they are no longer considered harmful to health and natural ecosystems by 2050. This Action Plan includes a key 2030 target to improve water quality by reducing waste, plastic litter at sea (by 50%) and microplastics released in to the environment (by 30%). A recent Joint Research Centre (JRC) report "Delivering the EU Green Deal. Progress towards targets"[151] provides an estimation of some implementation gaps in achieving climate and environmental policy targets. According to the report, for 35% of zero pollution targets progress is on track and for 30% of targets progress should accelerate. However,

[151] https://publications.jrc.ec.europa.eu/repository/handle/JRC140372

in the water area, progress has been slower due to the input of nutrients into water, chemical pollution and plastic litter at sea, and the report concluded that acceleration is needed to achieve the 2030 target.

5.6 Lessons learnt and recommendations

The data that are available from EEA on the status of waterbodies under the WFD (WISE) and the MSFD (WISE Marine) are well accessible and with relevant detail. Some components (notably status of marine sea areas) were awaiting update when this study was completed but it can be expected that the next iteration of the data will also be excellent.

As is often the case with studies that seek to present the monetary benefits of action (or inaction), the main limiting factor becomes the availability of monetary values to convert environmental outcomes into monetary estimates.

In the case of rivers, lakes, transitional and coastal waters, the UK NWEBS values have been used in the absence of value estimates for EU countries. Developed for explicit application to waterbodies of varying status (bad, poor, and moderate) under the WFD, they provide the possibility of measuring (in monetary terms) the benefits of incremental improvements in the ecological status of waterbodies (e.g. moderate to good) from one point in time (such as the present) to a future target (such as achievement of good status in all waterbodies). Both from the valuation of foregone benefits as a whole (such as produced in this study) or for assessing the costs and benefits of individual actions at waterbody level (for example, to elucidate 'disproportionate costs' or otherwise) they provide a valuable tool.

The downside of the UK NWEBS values is that benefit transfer must be applied to produce EU level estimates which is, at best, difficult and, at worst, controversial. Primary research to develop benefit values similar to NWEBS but specifically for the EU context would clearly improve the information to policymakers and analysts.

Economic values for estimating the benefits of achieving chemical status objectives are also missing or limited both for surface waters and for groundwaters. With further work it might also be possible to value shortfalls in groundwater quantitative status for example by appraising them with respect to irrigation prices or other water tariffs.

There remains much work to be done to develop values for application to the marine environment and the MSFD. This study has not identified any such efforts at this time that will bring together a comprehensive valuation approach.

6. Circular Economy and Waste

- The European Union has established a comprehensive circular economy and waste legislative framework that aims to protect human health and tackle the triple crisis of climate change, biodiversity loss and pollution. Since 2019, several of the EU's waste policies and laws have been reviewed and new legislation has either been adopted or proposed in line with goals of the European Green Deal and the Circular Economy Action Plan.
- This analysis covers 11 separate pieces of legislation, of which 8 set various quantitative targets (with multiple targets under each). For three (Ecodesign for Sustainable Products Regulation, Ship Recycling Regulation, and New Waste Shipments Regulation), there are no quantitative targets and so the analysis considers these qualitatively.
- The implementation gap varies by target and between Members States for each target. For some, the remaining gap is small, such as under the Batteries Directive (e.g. where the gap for the recycling efficiency target is 4%, for lead, 2% for nickel-cadmium and no gap for other battery types) and End of Life of Vehicles Directive (e.g. where the gap to the reuse and recovery targets is 7% and 1%). For other targets, the gap is larger, such as under the Landfill Directive (e.g. where 18 Member States are not currently meeting the target to reduce the amount of municipal waste landfilled) and the Packaging and Packaging Waste Directive (e.g. where multiple Member States are not meeting recycling targets, in particular for plastic).
- The costs associated with not meeting the targets in circular economy and waste legislation which currently apply are estimated to be between €7 billion – 9 billion per year (increasing to €21 billion to 23 billion where illustrative Ecodesign costs are included. That said, the cost increases significantly when considering the gap to future targets to between €65 billion and 76 billion per year (or €79 billion to 90 billion including Ecodesign).
- Looking forward, the ZPAP contains four targets pertaining to waste – but recent studies suggest the EU is far from reaching these targets. Changes to the Waste Framework Directive, Packaging and Packaging Waste Directive and End of Life of Vehicles Directive have been proposed to drive further progress in closing the implementation gap.

6.1 EU environmental policy and law

The European Union has established a comprehensive circular economy and waste legislative framework to protect human health and tackle the triple crisis of climate change, biodiversity loss and pollution. It aims to do so by improving resource efficiency and waste management, limiting waste to landfills, and encouraging innovation in recycling. The EU's circular economy and waste legislative framework covers various waste streams and aspects of waste management, with the waste hierarchy at the centre of all policies[152].

Since 2019, several of the EU's waste policies and laws have been reviewed and new legislation has either been adopted or proposed. These revisions were adopted as a part of the frameworks of the European Green Deal[153], which will guide the transition towards a more competitive and resource-efficient economy, the Circular Economy Action Plan[154] and the Zero Pollution Action Plan[155]. Four of the Zero Pollution Action Plan's 2030 targets pertain to waste: reduce plastic litter at sea by 50%, reduce microplastics released into the environment by 30%, reduce significantly total waste generation, and reduce residual municipal waste by 50%.

The key components of the EU circular economy and waste legislative framework are:

[152] https://environment.ec.europa.eu/topics/waste-and-recycling_en
[153] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[154] https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en
[155] https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en

- **Waste Framework Directive (2008/98/EC)**. The Waste Framework Directive (WFKD) is the cornerstone of EU waste legislation. It sets the basic concepts and definitions related to waste management and establishes the waste hierarchy, which prioritises waste prevention, followed by reuse, recycling, recovery, and then disposal as the least preferred option. The Directive also introduces the concepts of extended producer responsibility. ***Changes since 2019:*** An amendment to the WFKD was proposed in 2023 that would better address the management of waste from the food and textile sectors. The proposed changes regarding food waste would include food waste prevention and reduction measures. For textiles the proposal would introduce extended producer responsibility (EPR) schemes and establish a separate collection system for textiles.

- **Landfill Directive (1999/31/EC).** The Landfill Directive aims to prevent or reduce the adverse impacts of landfilling waste on the environment, particularly surface water, groundwater, soil, and air. It sets strict technical requirements for waste landfills. ***Changes since 2019***: The European Commission is set to review the target for municipal waste landfilled and will consider adding a quantitative target per capita on landfilling by the end of 2024.

- **Packaging and Packaging Waste Directive (PPWD – 94/62/EC)**. This Directive sets rules on the kinds of packaging that can be placed on the market, as well as packaging waste management and prevention. ***Changes since 2019****:* A 2022 proposed revision aims to ensure that all packaging is reusable or recyclable by 2030, prevent the generation of packaging waste and increase the recycled content in packaging.

- **Waste Electrical and Electronic Equipment Directive (WEEE Directive – 2012/19/EU)**. The WEEE Directive aims to reduce the environmental impact of electrical and electronic equipment (EEE) at the end of their life. It promotes the collection and recycling of such equipment. ***Changes since 2019***: The Commission is currently evaluating the WEEE Directive to see if it is still fit for its purpose and determine if a review is needed.

- **Batteries and Accumulators Directive (2006/66/EC)**. The Directive aims to minimise the negative impact of batteries and accumulators on the environment. It prohibits the use of certain hazardous substances in batteries and establishes rules for the collection, recycling, and disposal of waste batteries and accumulators. ***Changes since 2019***: The New Batteries Regulation (Regulation (EU) 2023/1542) entered into force in 2023 and will repeal the Batteries and Accumulators Directive in 2025. The New Batteries Regulation aims to make batteries more sustainable throughout their life cycle. It lays down the minimum requirements for the collection and treatment of waste batteries, as well as requirements for the sustainability, safety, labelling and information of batteries.

- **End-of-Life Vehicles Directive (2000/53/EC)**. This Directive focuses on the environmental impact of end-of-life vehicles (ELVs). It sets measures to prevent waste from ELVs and improve the reuse, recycling, and recovery of ELV components. ***Changes since 2019***: A new regulation was proposed in 2023 to replace Directive 200/53/EC on end-of-life vehicles and Directive 2005/64/EC on the type-approval of motor vehicles. The proposed Regulation lays down circularity requirements on vehicle design and production and the collection and treatment of end-of-life vehicles.

- **Plastic bags Directive (2015/720)**. This Directive is an amendment to the Packaging and Packaging Waste Directive (94/62/EC) and aims to address the overuse and environmental impact of lightweight plastic carrier bags. The Directive sets out specific measures for EU Member States to follow in order to reduce the consumption of these plastic bags.

- **Single-Use Plastics Directive (2019/904)**. This Directive aims to reduce the impact of certain plastic products and fishing gear containing plastics on the environment and on human health. It introduces measures to reduce the use of specific single-use plastic products and promotes alternatives through various requirements, including restricting placement on the market of certain products, product design requirements and labelling requirements. It has been the first piece of EU-legislation to set binding targets for recycled content, in this case for single-use plastic beverage bottles. Moreover, it introduces requirements for EPR schemes for certain single-use plastic products and fishing gear containing plastic.

- **Ecodesign Directive (2009/125/EC)**. The Ecodesign Directive establishes a framework for setting ecodesign requirements for energy related products. The measures initially adopted under the Directive mostly focused on energy efficiency requirements and then, in 2019, product regulations started to systematically include circular economy related measures. While the ecodesign requirements vary for each product group, they incorporate measures on a product's durability, reparability, recyclability and water efficiency, among others. ***Changes since 2019***: The Ecodesign for Sustainable Products Regulation (ESPR – Regulation (EU) 2024/1781) entered into force in 2024 and replaced the Ecodesign Directive. The ESPR aims to improve the circularity, energy performance and sustainability for almost all products by establishing ecodesign requirements on a product's performance and information requirements. Ecodesign requirements for products will be introduced over time; the first ESPR working plan introducing the initial products and their measures is to be published in 2025. Additionally, the ESPR introduces Digital Product Passports and addresses the destruction of unsold consumer products, including a ban on destroying unsold apparel and footwear for large-sized enterprises and, eventually, medium-sized enterprises.

- **Regulation (EU) No 1257/2013 on ship recycling (Ship Recycling Regulation or SRR).** The Regulation aims to reduce the negative impacts of ship recycling on human health and the environment. The Regulation applies to ships flying the flag of an EU Member State, as well as ships flying the flag of a non-EU State when calling at ports in the European Union. The Regulation seeks to ensure that ships are recycled in facilities that are safe for workers and environmentally sustainable. It mandates that these facilities meet specific requirements and standards to prevent, reduce and control adverse effects on the environment and human health. At the same time, the Regulation aims to discourage the practice of "beaching", where ships are driven onto shores in countries with lax environmental and safety regulations for dismantling.

- **Waste Shipment Regulation ((EC) No 1013/2006)**. This Regulation implements obligations of the Basel Convention and establishes rules for the transportation of waste across borders, including banning the export of hazardous waste to non-OECD countries and the export of waste for disposal. ***Changes since 2019***: The new Regulation on waste shipments (Regulation (EU) 2024/1157) entered into force in May 2024 and updates the rules and procedures on transboundary waste shipments within the EU and to third countries to ensure that the EU does not export its waste challenges to third countries, prevent the illegal shipment of waste, and improve waste shipment traceability. This also applies to the export of plastic waste, which is subject to specific rules depending on the type and destination. A ban on waste exports for disposal and hazardous waste exports for recovery to non-OECD countries still applies. However, beginning in 2027, stricter rules will apply that prohibit the exportation on non-hazardous waste to non-OECD countries, unless certain environmental conditions are met.

Besides these, the EU circular economy and waste legislative framework includes other regulations and decisions that cover cross cutting issues and key value chains (e.g., construction and demolition waste, textile waste, and food waste).

6.2 Environmental target

Table 6-1: Overview of targets in circular economy and waste legislation

Legislation	Target description
Waste Framework Directive (EU) 2018/8516	Sets specific targets in Article 11 on the preparation for re-use and recycling of municipal waste and construction and demolition waste. Derogations to

Legislation	Target description
	the 2025, 2030 and 2035 targets on re-use and recycling of municipal waste allow Member States to postpone each target for up to five years and, if a Member State does so, measures should be taken to increase the re-use and recycling of municipal waste to specified minimum levels each target year (e.g., 50% by 2025). Article 9 also sets a target to reduce food waste generation. The proposed changes to the WFKD sets targets for food waste (Article 9a) and textiles (Article 22a and 22d).
Landfill Directive (EU) 2018/850	Sets targets on the amount of municipal waste and biodegradable waste landfilled (Article 5). Both targets have derogations, whereby Member States may postpone the target for municipal waste reduction by up to five years and the target for biodegradable waste by up to four years, provided that certain conditions are met. Additionally, the Directive sets permitting and operations requirements for landfills.
Packaging and Packaging Waste Directive (EU) 2018/852	Specifies targets on the recycling rates of all packaging waste, as well as specific materials in packaging waste (Article 6). Provided that certain conditions are met, Member States may postpone the 2025 and 2030 deadlines for the recycling rate targets for specific materials in packaging waste by up to five years. In the proposed Directive, there are targets planned for minimum recycled content in plastic packaging (Article 7), re-use and refill targets for specific product packaging (Article 26), prevention of packaging waste generation (Article 38) and Deposit and return systems (DRS)(Article 44). The need for derogations from the minimum recycled content targets for contact sensitive packaging from materials other than PET and other packaging will be assessed in 2028 and certain economic operators are exempt from the re-use and refill targets.
WEEE Directive 2012/19/EU	Sets targets for the minimum rates for separate collection rates of either the weight of EEE placed on the market or of the WEEE generated (Article 7). The Directive lays out derogations for ten listed Member States because they lack the necessary infrastructure or have low levels of EEE consumption. These Member States may either achieve a lower collection rate for EEE placed on the market or postpone the date of the collection rate targets until 14 August 2021. Appendix V lists the WEEE recovery targets referred to in Article 11. Targets for recovery and preparation for re-use and recycling vary and depend on which category the WEEE falls in to (see Appendix III for categories).
Batteries Directive 2006/66/EC and New Batteries Regulation (EU) 2023/1542	Sets targets in Article 10 on the minimum collection rates and in Appendix III on minimum recycling efficiencies for different types of batteries. The New Batteries Regulation will repeal the Batteries Directive in 2025 and sets the targets for minimum recycled content in batteries (Article 8), collection rates of batteries (Article 59 and Article 60), recycling efficiencies for batteries, and recovery of different materials (Appendix XII).
End of Life Vehicles Directive 2000/53/EC	Contains targets on the reuse, recovery and recycling of ELVs in Article 7. In the proposed changes to the Directive, there are targets for the reusability, recyclability and recoverability of vehicles (Article 4), minimum recycled content in vehicles (Article 6), and re-use, recycling and recovery by waste management operators (Article 34). The proposed Directive will repeal Directives 2005/64/EC and 2000/53/EC, thus the targets laid out in Articles 4

Legislation	Target description
	and 34 of the proposed Directive are similar to those laid out in the potentially repealed Directives.
Plastic Bags Directive (EU) 2015/720	Article 4 sets the target for the annual consumption of lightweight plastic carrier bags (bags with a wall thickness below 50 microns). Very lightweight plastic bags are excluded (bags with a wall thickness below 15 microns).
Single Use Plastics Directive (EU) 2019/904	Contains targets on the recycled plastic content and the separate collection for recycling of single-use plastic beverage bottles with a capacity of up to three litres, including their caps and lids, in Articles 6 and 9, respectively. Additionally, Article 4 sets requirements for Member States to take measures to "achieve a measurable quantitative reduction" in the consumption of cups for beverages, including cups and lids, and food containers for ready-made food and intended for immediate consumption.
Ecodesign Directive 2009/125/EC and Ecodesign for Sustainable Products Regulation (EU) 2024/1781	Do not contain any measurable targets. However, the product regulations adopted under them contain specific energy efficiency, pollutant emissions, circularity, performance and/or information requirements for specific products and product groups. The setting of these performance and information requirements are known as ecodesign requirements and products placed on the market must conform to them. The Ecodesign Directive is also accompanied by the Energy Labelling Regulation (EU) 2017/1369, which sets labelling and information requirements for usually the same energy-related products. Market surveillance is key to ensure that products placed on the market respect the requirements.
Ship Recycling Regulation (EU) 1257/2013	Contains no quantifiable targets, however there are requirements for ships that fly a flag of an EU Member State and for those that fly a flag from a non-EU country and call at an EU Member State port. Additionally, ships that fly a flag of an EU Member State must be recycled at a facility on the EU list of approved ship recycling facilities.
New Waste Shipments Regulation (EU) 2024/1157	There are no quantifiable targets in the Regulation, however it sets rules on waste shipments between Member States, to OECD countries and non-OECD countries. There is a ban on all waste exports destined for disposal and on hazardous waste exports for recovery to non-OECD countries. Between on 21 November 2026 and 21 May 2029, there will be ban on non-hazardous plastic waste exports to non-OECD countries.

Table A2-10-36 to Table A2-10-43 in Appendix 2 provide more detailed description of targets in each piece of legislation.

6.3 Implementation gap

6.3.1 Analysis

Analysis in this section defines the implementation gap for policies for which an approach is available to cost the gap under the next section. Additional analysis of the implementation gap for policies where the gap cannot be monetised is presented in Appendix 2.

A recent JRC report "Delivering the EU Green Deal. Progress towards targets"[156] provided an estimation of some implementation gaps in achieving climate and environmental policy targets. For the circular economy, targets from the Battery Regulation and Critical Raw Materials Act were assessed. Of the total 35 quantifiable targets, 14 targets are from regulations, i.e. are legally binding. Other targets were taken from Communications and from Proposals for directives or regulations. According to the report, for 30% of circular economy targets progress is on track and for 37% of targets it should accelerate. The report also considered targets related to zero pollution which also link to waste. Here the report found that further efforts are required to achieve the EU's goals of significantly reducing waste and ensuring healthy soils, identifying emerging pollution issues, such as microplastics, lack sufficient data for a comprehensive progress assessment to 2030.

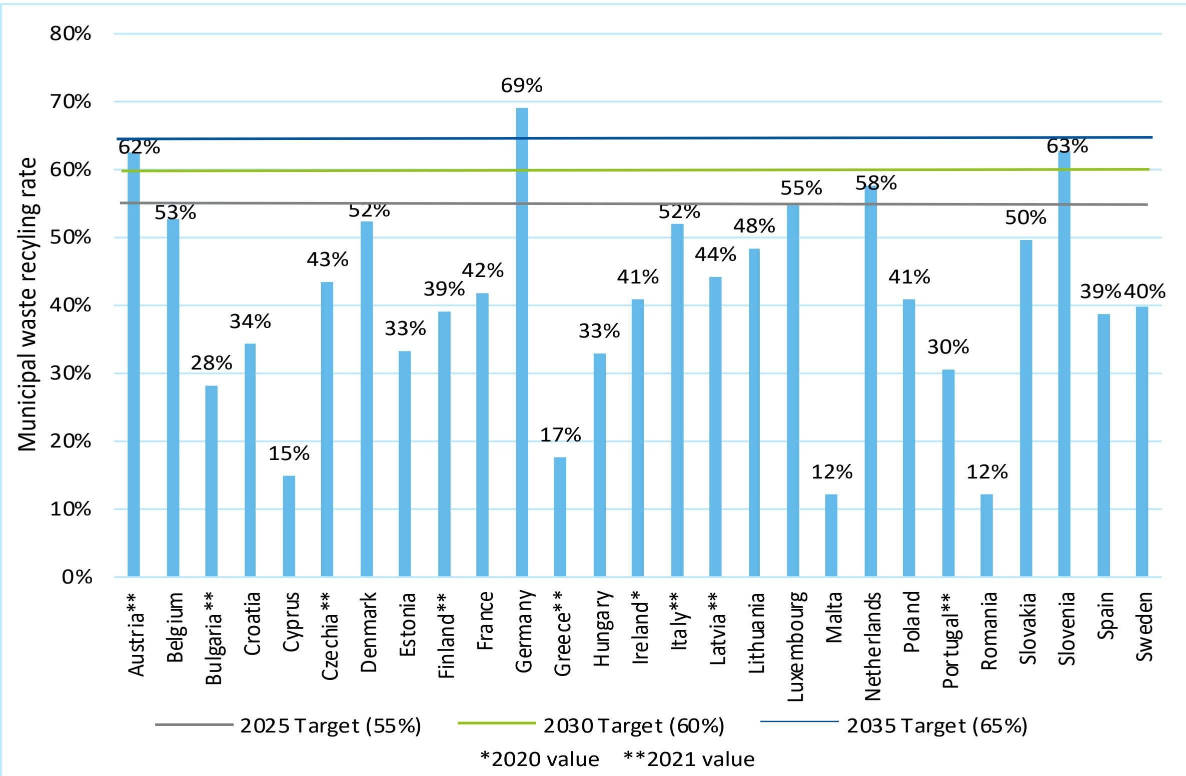
Waste Framework Directive (EU) 2018/851

Target on the preparation for re-use and recycling of municipal waste

The WFKD sets current and future targets for the preparation for re-use and recycling of municipal waste, with the current recycling of municipal waste target rate set at 55% by 2025. Figure 6-1 shows the recycling rate in each Member State against the targets for the recycling of municipal waste. Across the EU-27, there is a 22,629 ktonne implementation gap when considering the current performance against the current target (a 14% gap between the target recycling rate and the current recycling rate of non-compliant countries) (see also Table A2-10-44).

Twenty-three Member States are not meeting the 2025 target, but eight countries have derogations (Croatia, Greece, Hungary, Lithuania, Malta, Poland, Romania and Slovakia). When removing the countries with a derogation from the calculation, the implementation gap is smaller at 14,627 ktonnes (11% gap amongst non-compliant countries without derogations).

Figure 6-1: 2022 municipal waste recycling rates of Member States compared to the 2025, 2030 and 2035 targets for the preparation for re-use and recycling of municipal waste



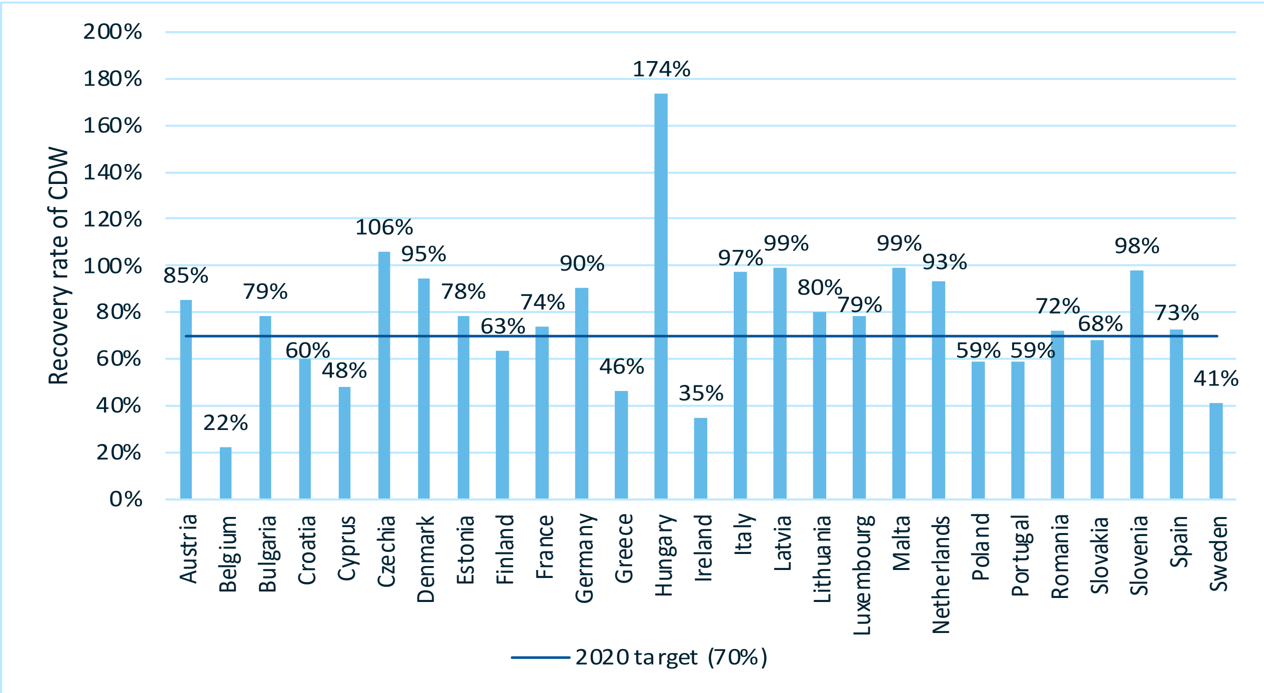
156 https://publications.jrc.ec.europa.eu/repository/handle/JRC140372

Target on the recovery of construction and demolition waste

According to the WFKD, Member States had to ensure the recovery of construction and demolition waste (CDW). The implementation gap of each Member State to the CDW target is shown in Figure 6-2. Ten Member States are not meeting the target for CDW. The implementation gap for the EU-27 is 13.2 million tonnes, or a 33% gap between the target recovery rate and the current recovery rate of non-compliant countries (see also Table A2-10-45 in Appendix 2).

However, several studies have identified uncertainties regarding the collection of CDW waste data (see Limitations and uncertainties of the analysis for a more detailed explanation). The uncertainties limit the reliability and comparability of CDW recovery data between Member States. Additionally, the implementation gap is based *only* on non-hazardous mineral waste and, although mineral waste is the dominant CDW form, other, non-mineral CDW fractions exist, and the gap is not inclusive of *all* types of CDW.

Figure 6-2: 2020 recovery rates for non-hazardous mineral CDW compared to the 2020 target for recovery of CDW



Target on the reduction of food waste

Table 6-2 shows the implementation gap against the Sustainable Development Goal (SDG) to halve per capita food waste at the retail and consumer levels by 2030. In the 2019 report, a 30.8 million tonne gap was estimated against the 2030 target based on 2012 data in the EU-28. Considering the progress the EU-27 has made since then in reducing food waste at the retail and consumer levels, the estimated gap against the target is now 10.1 million tonnes compared to food waste amounts in 2012.

Table 6-2: Estimation of implementation gap for EU retail and consumer food waste reduction potential by 2030, measured against 2012 and 2020 data.

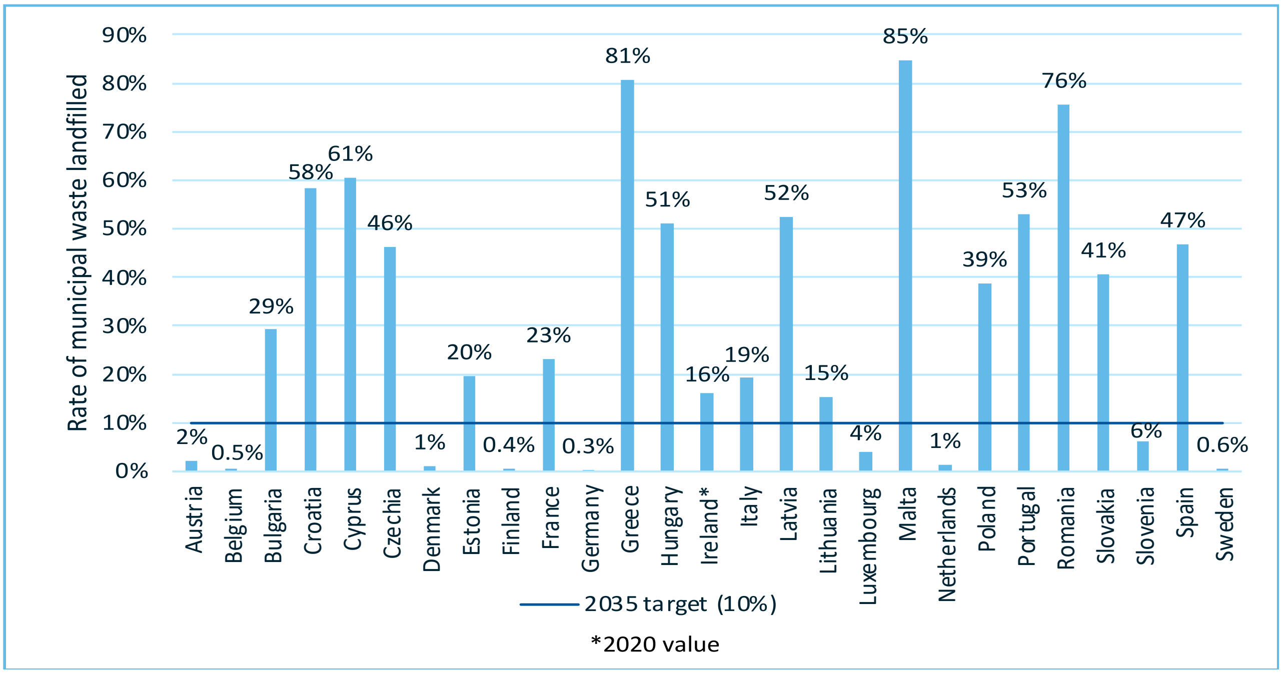
Sector	2012 *EU-28* food waste (million tonnes) with 95% confidence interval (from COWI et al. (2019))	2021 *EU-27* food waste (million tonnes) (from Eurostat)	Percent reduction
Primary production	9.1 ± 1.5	5.1	44%
Processing	16.9 ± 12.7	12.4	27%
Wholesale and retail	4.6 ± 1.2	4.2	9%
Food service	10.5 ± 1.5	5.4	49%
Households	46.5 ± 4.4	31.3	33%
Total food waste	**87.6 ± 13.7**	**58.4**	**33%**
Total retail & consumer food waste	**61.6 ± 7.1**	**40.9**	**34%**
Estimate of compliance gap against 2030 target	*30.8*	*10.1*	*n/a*

Landfill Directive (EU) 2018/850

Reduce the amount of municipal waste landfilled

The long-term future target within the Landfill Directive includes a limit on total municipal solid waste (MSW) sent to landfill, which will come into force from 2035. Figure 6-3 shows the 2021 rates of municipal waste landfilled for each Member State.

Figure 6-3: 2021 rates of municipal waste sent to landfill of Member States compared to the 2035 target limiting overall municipal waste sent to landfill to 10% or less from the total amount of waste



Note: * denote Member States with data from a different year than the others (e.g., Ireland data is from 2020 while others are from 2021)

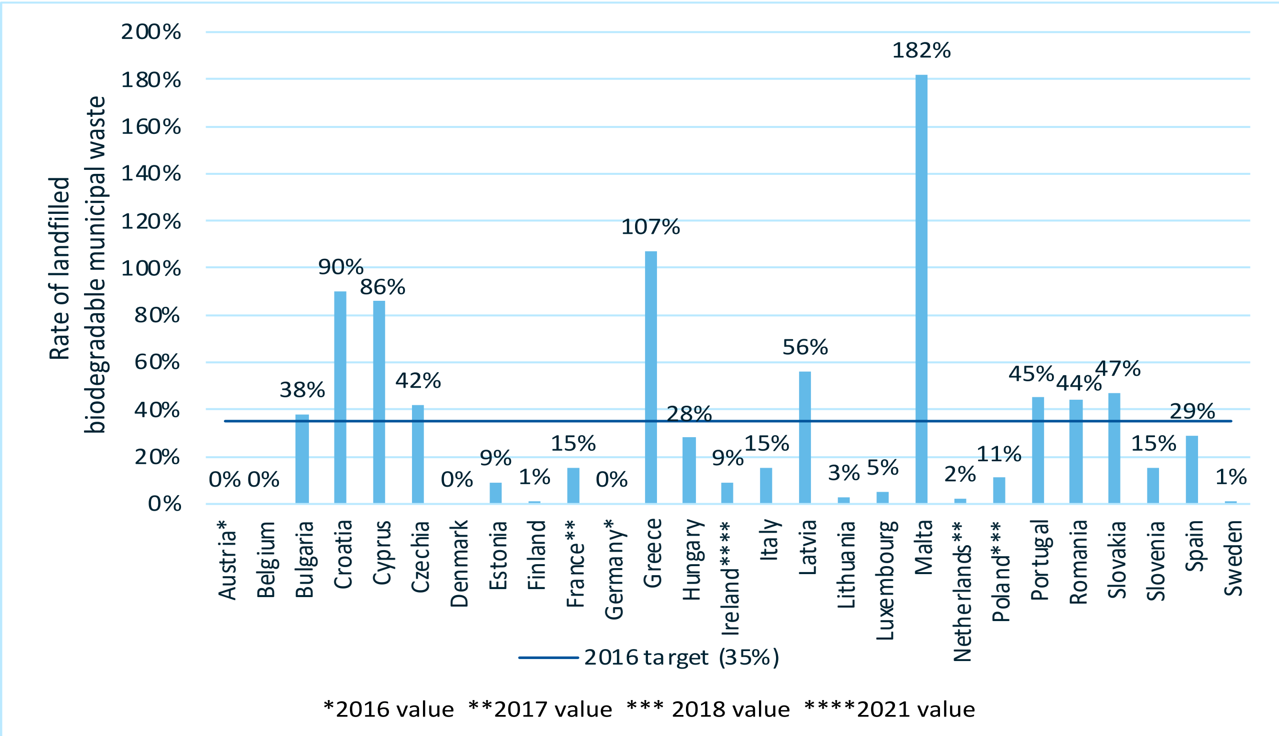
Eighteen Member States are not meeting the target, comprising a 37,019 kt implementation gap across the EU-27 when considering current performance against this future target. The current rate of municipal waste landfilled across the countries with an implementation gap is 36%.

Limit the fraction of biodegradable waste going to landfills

According to the Landfill Directive, Member States had to ensure that by 2016, biodegradable municipal waste going to landfills is reduced to 35% of the total amount (by weight) of biodegradable municipal waste produced in 1995 or the latest year before 1995 for which standardised Eurostat data is available. The EU-27 implementation gap to the target is 3.32 million tonnes in 2019 (see also Table A2-10-48 in Appendix 2). The rate of biodegradable waste going to landfill amongst countries with an implementation gap is 56%. Figure 6-4 shows the amount of biodegradable municipal waste landfilled in each Member State compared to the target level.

Ten Member States are not meeting the target set for biodegradable waste, all of which have a derogation to the 2016 deadline. The 14 countries with a derogation to the 2016 deadline for the 35% target are: Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia. These countries had to meet the target by 2020.

Figure 6-4: 2019 landfilled biodegradable municipal waste compared to the 2016 target for the reduction of the amount of biodegradable municipal waste landfilled



Landfill compliance

Beyond meeting performance targets, all landfilling activities within the EU must take place in compliant facilities. While illegal landfills have decreased in many parts of the EU, it is evident that violations still exist. For instance, in 2023 the European Commission announced its decision to refer Slovakia to the Court of Justice of the European Union for not rehabilitating and closing 21 landfills that do not meet the standards set by the

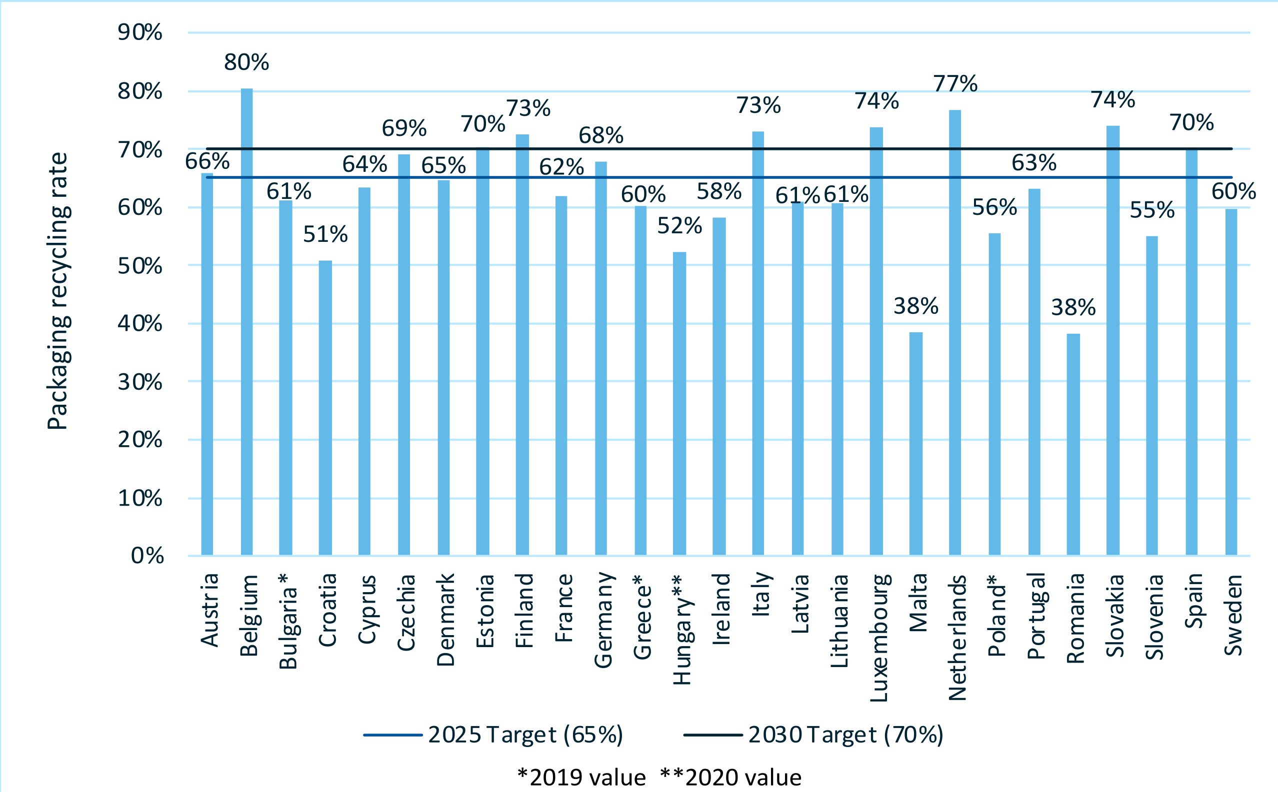
Landfill Directive[157]. In 2021, Romania was also referred to the Court for failing to comply with its obligation to close and rehabilitate 68 landfills[158].

Packaging and Packaging Waste Directive (EU) 2018/852

Targets on the recycling of all packaging waste

The current target in the Packaging and Packaging Waste Directive for the recycling of all packaging waste is a minimum of 65% by weight by 2025. The future target is 70% by 2030. Figure 6-5 shows the packaging recycling rates of each Member State compared to the 2025 and 2030 targets. Eighteen Member States are not meeting the 2025 target and 22 are not meeting the 2030 target. The EU-27 has an implementation gap of 2.84 million tonnes to the 2025 target and 5.47 million tonnes to the 2030 target (the gap for non-compliant countries from both targets is 7%) (see also Table A2-10-49 in the Appendix 2).

Figure 6-5: 2021 packaging recycling rate compared to the 2025 and 2030 targets on recycling packaging waste



Targets on the recycling of specific materials in packaging waste

Member States must also set recycling rate targets for the following materials in packaging waste: plastic, wood, ferrous metal, aluminium, glass, and paper and cardboard. Table 6-3 shows the implementation gaps for Member States between the 2021 current recycling rates for specific materials in packaging waste and the target levels. There are variations in the derogations for the recycling targets for specific materials in packaging waste. See Appendix 2 for a list of the countries with a derogation to the 2025 and 2030 targets and for which material they have a derogation for.

[157] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_164
[158] https://ec.europa.eu/commission/presscorner/detail/FI/ip_21_5354

The implementation gap for the EU-27 to the 2025 targets for various material fractions in packaging waste ranges from a low of 6% (183 ktonnes) for paper and cardboard, to a high of 20% (58 ktonnes) for aluminium (Table 6-3) (see Table A2-10-56 to Table A2-10-59 in the Appendix 2 for a more detailed breakdown of the implementation gap in each Member State).

Table 6-3: Implementation gap for recycling rates of the EU-27 against the 2025 and 2030 targets for recycling of specific materials in packaging waste (all values 2021)

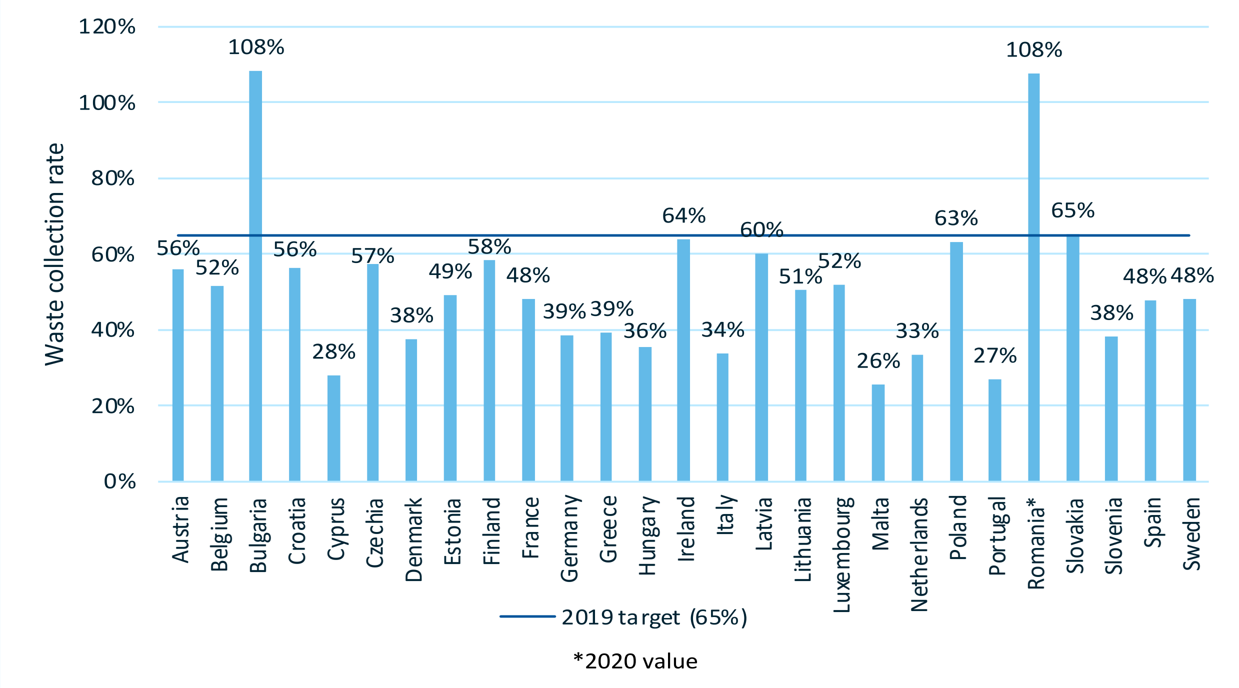
Packaging material	Implementation gap against 2025 material specific recycling targets for packaging (plastic 50%, wood 25%, ferrous metal 70%, aluminium 50%, glass 70%, paper and cardboard 75%)			Implementation gap against 2030 material specific recycling targets for packaging (plastic 55%, wood 30%, ferrous metal 80%, aluminium 60%, glass 75%, paper and cardboard 85%)		
	Tonnes	%	Non-compliant Member States	Tonnes	%	Non-compliant Member States
Plastic	1,793,651	11%	25 Member States non-compliant (only Bulgaria and Slovakia are compliant)	2,597,179	16%	26 Member States non-compliant (only Slovakia is compliant)
Wood	551,744	16%	Croatia, Cyprus, Finland, France, Greece, Hungary, Malta, Romania, Slovenia, Sweden	771,109	15%	Austria, Croatia, Cyprus, Finland, France, Greece, Hungary, Lithuania, Malta, Poland, Romania, Slovenia, Sweden
Ferrous metals	42,310	7%	Croatia, Denmark, Finland, France, Ireland, Latvia, Malta, Romania, Slovenia	165,919	13%	Croatia, Denmark, Finland, France, Ireland, Italy, Latvia, Luxembourg, Malta, Portugal, Romania, Slovenia
Aluminium	58,483	20%	Croatia, Cyprus, Czechia, France, Greece, Ireland, Malta, Portugal, Romania, Slovakia, Slovenia	93,378	18%	Austria, Croatia, Cyprus, Czechia, France, Greece, Ireland, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain
Glass	475,674	11%	Bulgaria, Croatia, Cyprus, Greece, Hungary, Lithuania, Malta, Poland, Portugal, Romania, Spain	692,761	16%	Bulgaria, Croatia, Cyprus, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Spain
Paper and cardboard	183,411	6%	Croatia, Denmark, Ireland, Malta, Portugal, Romania, Slovenia	920,188	6%	Austria, Croatia, Denmark, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden

WEEE Directive 2012/19/EU

Collection target

The WEEE Directive sets a 2019 waste collection target for 65% of the average weight of EEE placed on the market in the 3 preceding years in the Member State. There is a 2.28 million tonne implementation gap (21% gap amongst non-compliant countries) in the EU-27 to this target (see also Table A2-10-60 in Appendix 2). Figure 6-6 shows the waste collection rates of Member States compared to the 65% target rate. Twenty-four Member States are not meeting the target, but ten countries have derogations (Bulgaria, Czechia, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia). These Member States may either postpone the target date to no later than 14 August 2021 or achieve a collection rate lower than 45%, but higher than 40%, of the average weight of EEE placed on the market in the three preceding years. Excluding the countries with a derogation from the calculation, the implementation gap is smaller at 2.16 million tonnes (23% gap amongst non-compliant countries without derogations).

Figure 6-6: 2021 waste collection rate of the Member States compared to the 2019 target for waste collection target of 65% of the average weight of EEE placed on the market in the three preceding years[159]



Recovery rate and preparing for re-use and recycling rate targets

The implementation gap for the EU-27 recovery rate ranges from 1,949 tonnes for product category 1, to 35,861 tonnes for product category 4. The implementation gap for the EU-27 re-use and recycling rate ranges from 1,206 tonnes for product category 5, to 48,545 tonnes for product category 4 (Table 6-4). See Appendix 2 for a breakdown of the recovery and recycling rates in the Member States for the six product categories compared to their respective recovery rate targets that are in place from 2018.

[159] Gap is calculated as the amount of waste EEE collected over the average amount of EEE placed on the market in the 3 preceding years (2018-2020), so gap can be more than a 100% collection rate depending on the average amount of EEE on the market between versus what was collected in 2021.

Table 6-4: Implementation gap for recycling and recovery rates of the EU-27 against the targets for WEEE materials

WEEE Material	Implementation gap against material specific recycling targets for WEEE			Implementation gap against material specific recovery targets for WEEE		
	Tonnes	%	Non-compliant Member States	Tonnes	%	Non-compliant Member States
1. Temperature exchange equipment	5,477	8%	Belgium, Denmark, Hungary, Malta, Portugal	1,949	6%	Belgium, Malta
2. Screens, monitors, and equipment containing screens having a surface greater than 100 cm²	12,277	12%	Cyprus, France, Hungary, Netherlands, Portugal, Sweden	8,423	12%	Cyprus, France, Hungary, Portugal
3. Lamps	2,796	33%	Cyprus, Denmark, Portugal, Romania, Spain, Sweden			
4. Large equipment (any external dimension more than 50 cm)	48,545	10%	Belgium, Cyprus, Denmark, Netherlands, Portugal, Romania, Slovenia, Spain, Sweden	35,861	9%	Belgium, Cyprus, Netherlands, Portugal, Romania, Spain
5. Small equipment (no external dimension more than 50 cm)	1,206	9%	Portugal	2,291	4%	Belgium, Cyprus, Portugal
6. Small IT and telecommunication equipment (no external dimension more than 50 cm)	2,305	33%	Portugal	5,605	10%	Italy, Portugal, Romania, Spain

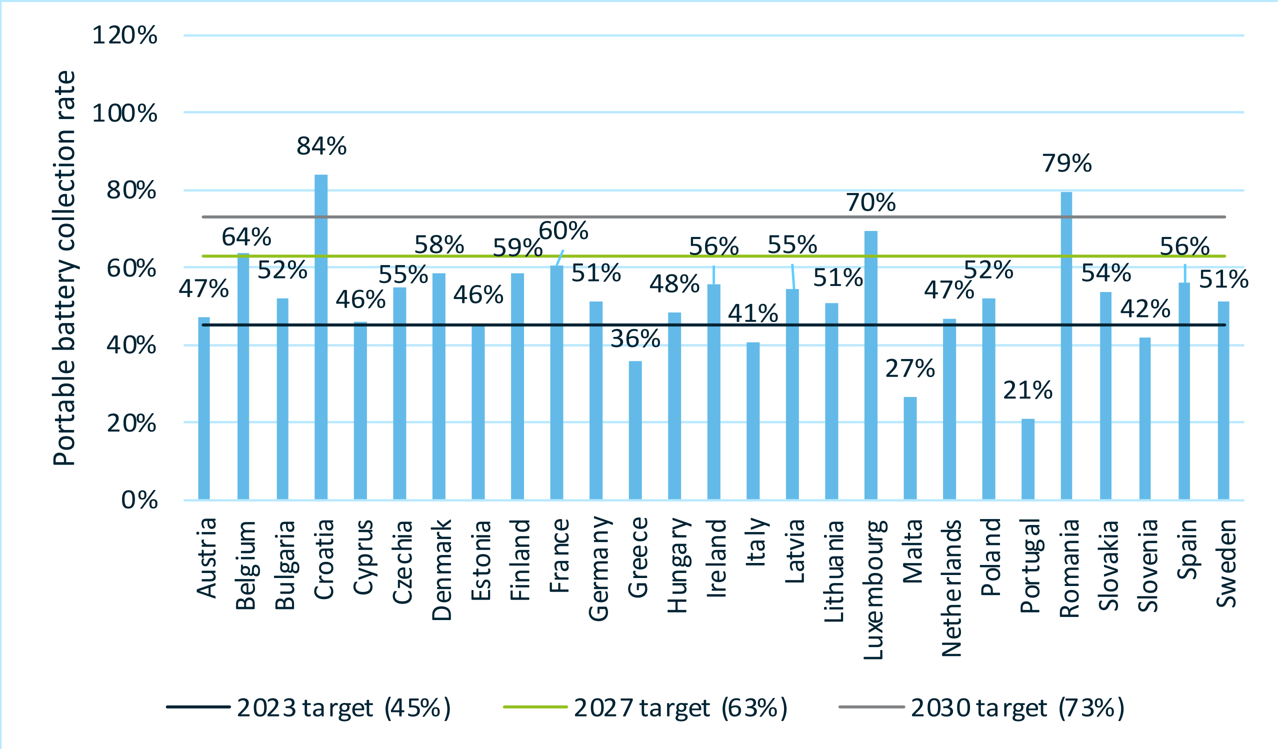
Batteries Directive 2006/66/EC and New Batteries Regulation (EU) 2023/1542

Targets for collection of waste portable batteries for producers

The New Batteries Regulation, which will repeal the Batteries Directive in 2025, also sets targets for collection of waste portable batteries for producers. The collection target for producers is a 45% collection rate by 2023 and a 63% collection rate by 2027. The implementation gap to the 2023 target is 1,830 tonnes and 27,058 tonnes to the 2027 target, when considering the current performance against the future target (see Appendix 2).

Figure 6-7 shows the implementation gap in each Member State for the collection of waste portable batteries targets for years 2023, 2027 and 2030. Five Member States are not meeting the 2023 target, 24 are not meeting the 2027 target and 25 for the 2030 target.

Figure 6-7: 2021 collection rate compared to the 2023, 2027 and 2030 targets for collection of waste portable batteries



Targets for recycling efficiency

The Batteries Directive and New Batteries Regulation have set targets for the recycling efficiency for lead batteries, nickel-cadmium batteries and other batteries. The implementation gap for the EU-27 to the 2025 targets are: 10,373 tonnes (4% gap amongst non-compliant countries) for lead batteries, 40 tonnes (2% gap amongst non-compliant countries) for nickel-cadmium batteries and 0 tonnes for other batteries (see Appendix 2). The New Batteries Regulation has also introduced recycling efficiency targets for lithium-based batteries, however data for this type of battery is lacking and is not included in this report. It should be noted that while there is no separate data in Eurostat for lithium battery recycling efficiencies, they currently fall within the 'other' batteries data in Eurostat.

Figure 6-8 through Figure 6-10 show the implementation gap of each Member State against the recycling efficiency targets for various battery types. Three Member States are not meeting the 2025 target for lead batteries, 12 are not meeting the target for nickel-cadmium batteries, and all Member States are meeting the target for other batteries.

Figure 6-8: 2021 recycling rate of lead batteries compared to the 2011, 2025 and 2030 targets for recycling efficiency

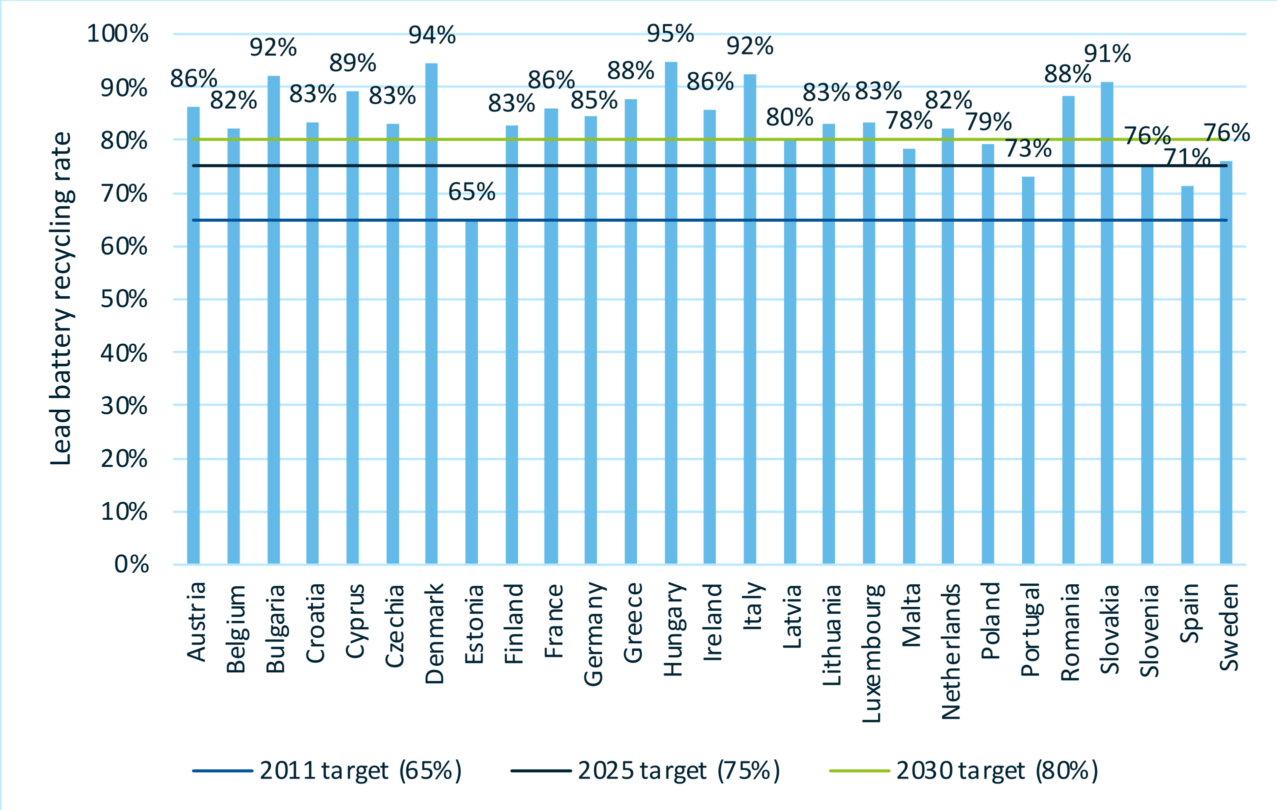


Figure 6-9: 2021 recycling rate of nickel-cadmium batteries compared to the 2011 and 2025 targets for recycling efficiency

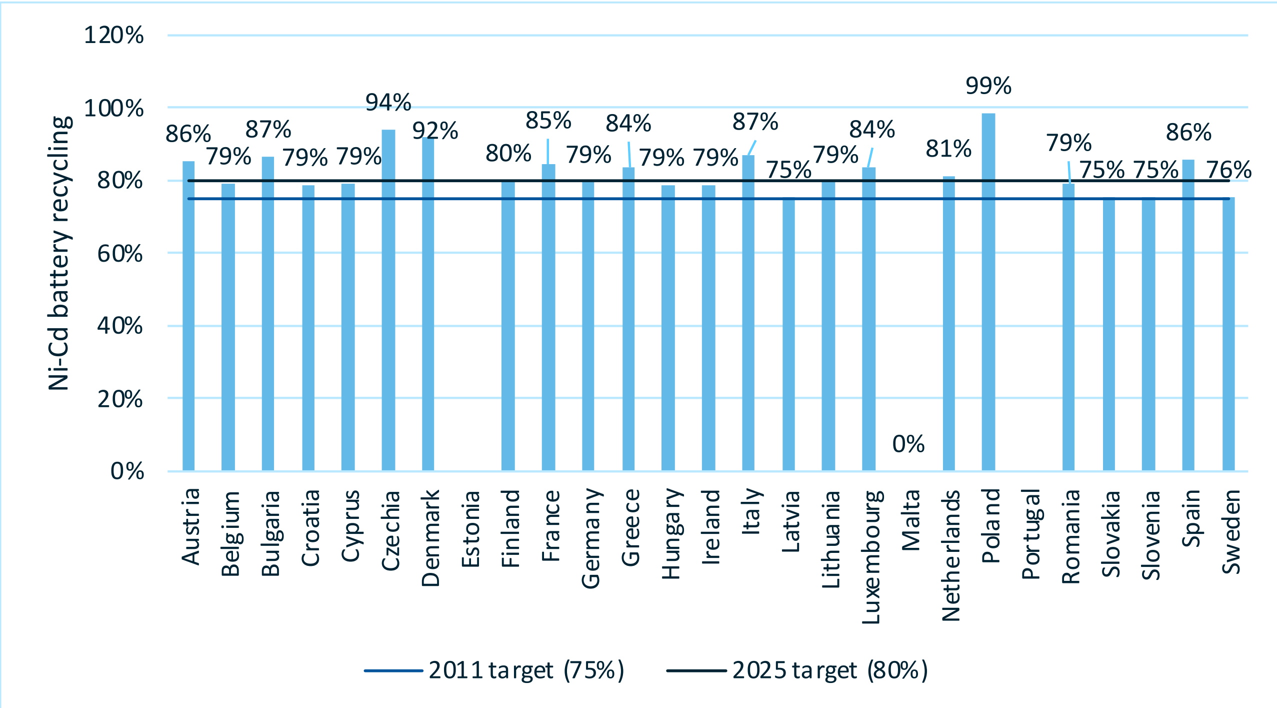
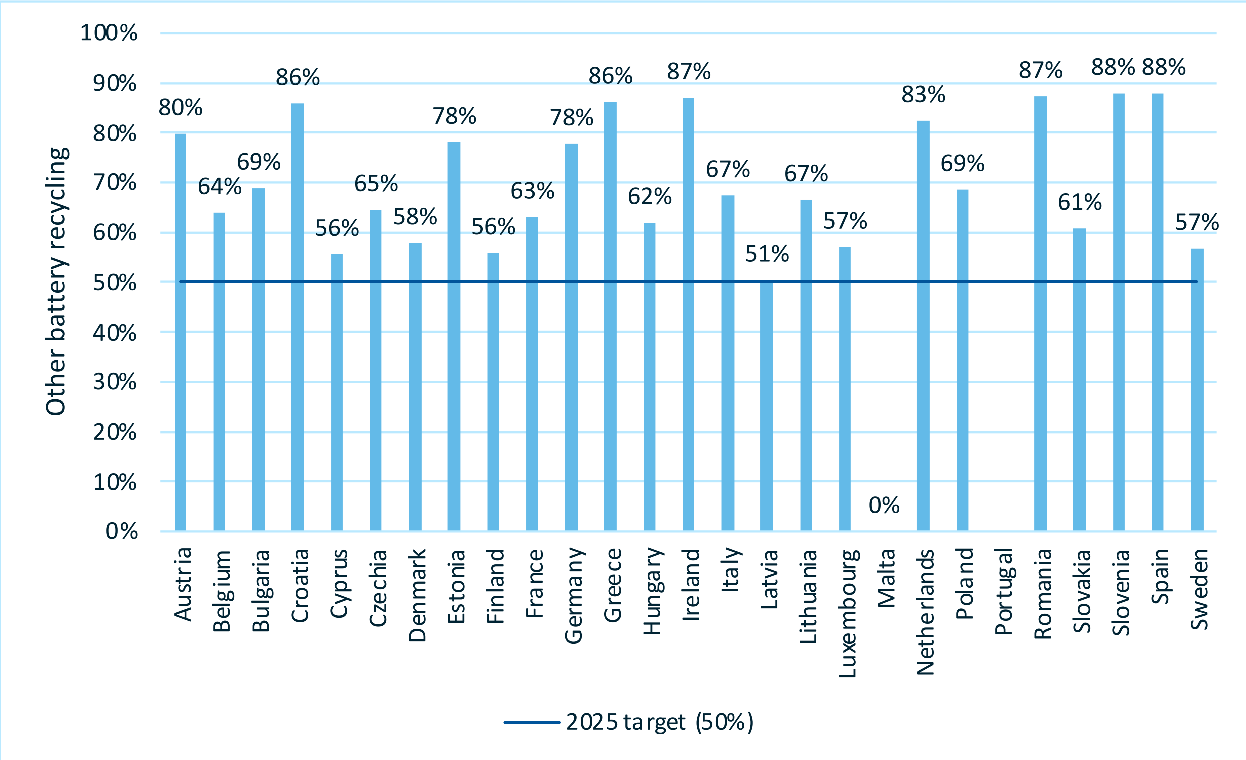


Figure 6-10: 2021 recycling rate of other batteries compared to the 2025 target for recycling efficiency



End of Life Vehicles Directive 200/53/EC

According to the ELVs Directive, Member States had to ensure that by 2015, ELVs met the specified targets on *reuse and recovery* and on *reuse and recycling*. The implementation gap for the EU-27 to the reuse and recovery target is 173 ktonnes (7% gap amongst non-compliant countries) and to the reuse and recycling target is 13 ktonnes (1% gap amongst non-compliant countries) (see also Table A2-10-62 in the Appendix 2). Seven Member States are not meeting the target for reuse and recovery and four are not meeting the target for reuse and recycling. Figure 6-11 and Figure 6-12 show the implementation gap of each Member State to compared to the targets on reuse, recovery and recycling.

Figure 6-11: 2021 reuse and recovery rate of ELVs compared to the reuse and recovery target rate of 95%

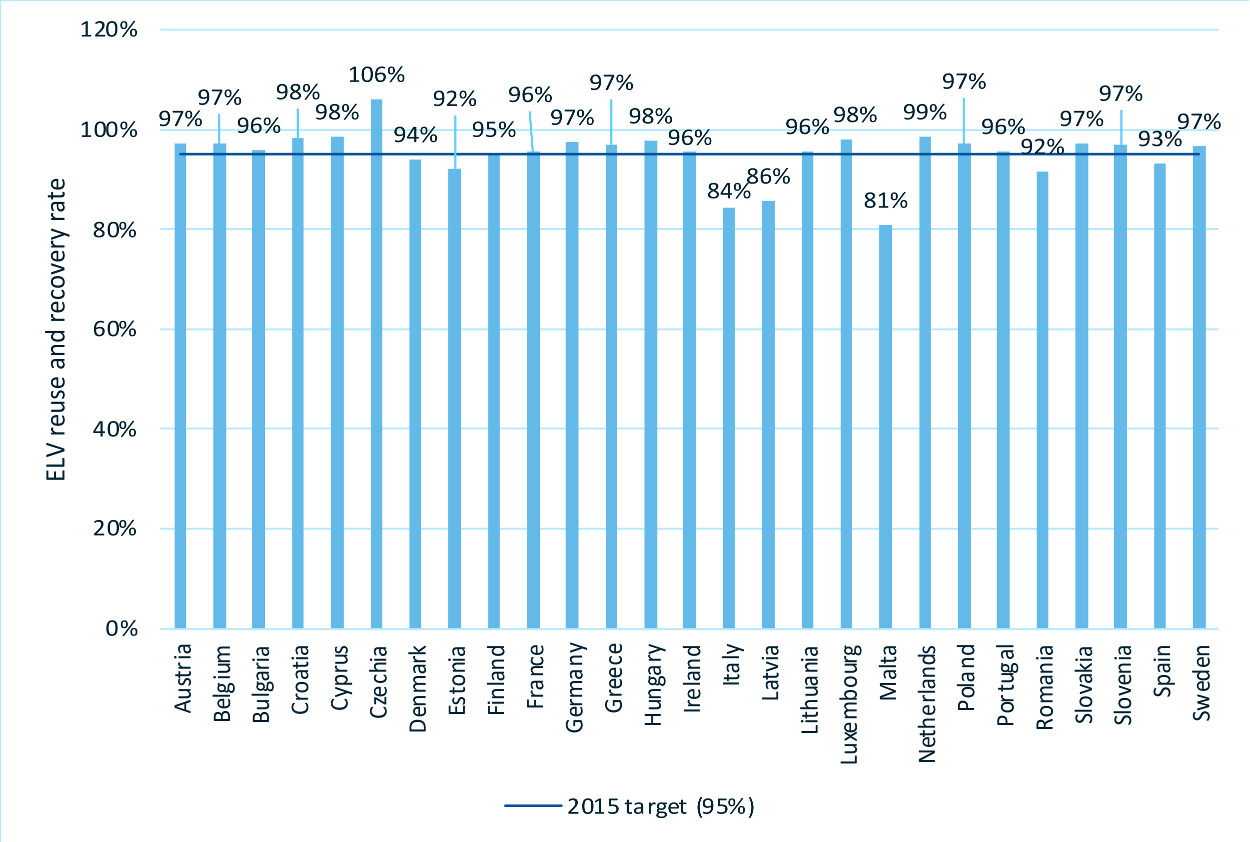
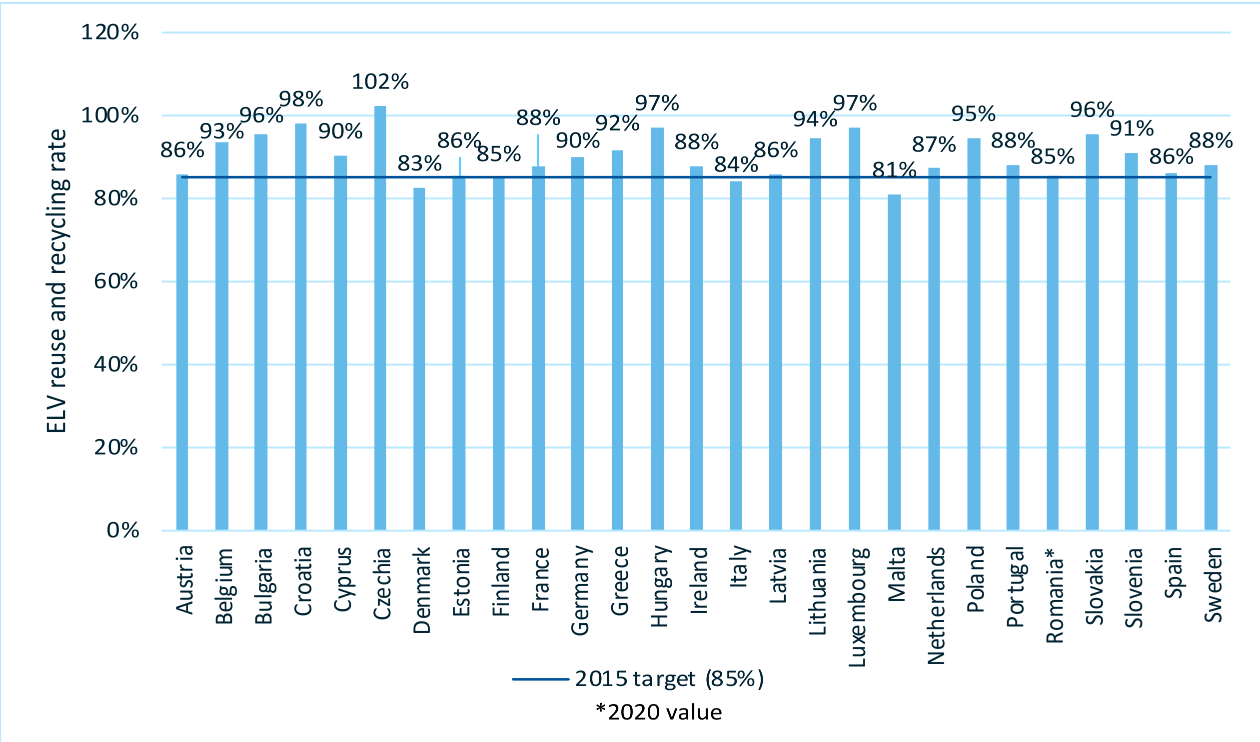


Figure 6-12: 2021 reuse and recycling rate of ELVs compared to the reuse and recycling target rate of 85%



Single Use Plastics Directive (EU) 2019/904

Member States reported the data under the SUP Directive for the first time (for the reference period 2022) in the summer of 2024 to the Commission which is currently being analysed and includes data and information on:

- Separate collection rate for single-use plastic (SUP) beverage bottles,
- Data on SUP cups for beverages and food containers placed on the market, and
- Measures introduced by Member States to reduce consumption of SUP cups for beverages and food containers.

Data on the recycled content in SUP beverage bottles will be reported in 2025 (for the reference period 2023).

Targets for separate collection

While the Member State reported data is currently being analysed, there is data from some Member States on the collection rate of plastic beverage bottles, in particular from countries that have implemented a deposit refund scheme (DRS). At the end of 2023, 12 EU countries had a DRS in place for beverage packaging. The most recent countries to implement a DRS are Latvia, Malta and Slovakia in 2022 and Romania in 2023. Other EU countries are at varying stages in the development of their DRS[160].

Collection rates of SUP beverage bottles are typically higher in countries with a DRS than those without. For example, in Spain, which does not have a DRS, the estimated amount of SUP beverage bottles collected was 36% in 2021[161]. The collection rate of SUP beverage bottles for countries with a DRS established can be seen in the table below. It should be noted that the DRS systems vary in scope in the types of materials, bottle sizes and beverages covered. Furthermore, while the separate collection target laid out in the Directive is for single-use plastic beverage bottles, a study by UNESDA estimated that the sorted for recycling rate of PET beverage bottles in the EU27+3 region (including Norway, Switzerland and the UK) was 75% in 2022, an increase from 64% in 2020[162]. In 2022, the average PET beverage bottle collection rate was:

- Greater than 77% in Belgium, Croatia, Denmark, Estonia, Finland, Germany, Lithuania, Sweden
- Between 60% and 77% in Austria, Czech Republic, France, Italy, Latvia, Luxembourg, Malta, Netherlands, Slovakia, Spain
- Less than 60% in Cyprus, Bulgaria, Greece, Hungary, Ireland, Poland, Portugal, Romania, Slovenia.

[160] https://www.acrplus.org/en/news/deposit-refund-systems-in-the-eu-2023-update-4174
https://www.unesda.eu/wp-content/uploads/2024/05/PET-plastic-Market-in-Europe-State-of-Play-Production-Collection-Recycling-Data_2022.pdf
https://www.reloopplatform.org/wp-content/uploads/2023/05/RELOOP_Global_Deposit_Book_11l202.pdf
[161] https://eunomia.eco/reports/analysis-of-compliance-with-the-targets-for-the-separate-collection-rate-of-plastic-beverage-supd-bottles-up-to-3-litres-in-spain/
[162] https://www.unesda.eu/wp-content/uploads/2024/05/PET-plastic-Market-in-Europe-State-of-Play-Production-Collection-Recycling-Data_2022.pdf#page=24&zoom=100,0,0

Table 6-5: Collection rate of single-use plastic bottles in Member States with a DRS implemented

Member States with DRS	Collection rate of single-use plastic bottles
Croatia (2021 value)	83%
Denmark (2022 value)	93%
Estonia (2021 value)	88%
Finland (2022 value)	90%
Germany (2019 value)	94%
Latvia (2022 value)	77% (overall expected collection rate for SUP, metal and glass beverage packaging)
Lithuania (2022 value)	92% (approx.)
Netherlands (2022 value)	68% (overall collection rate of SUP beverage bottles) 75% (return rate of SUP beverage bottles within the deposit system)
Slovakia (2022 value)	71% (both SUP and metal beverage packaging)
Sweden (2022 value)	86.7%
Malta	No data
Romania	No data
Source: ACR+ (2023) Deposit Refund Systems in the EU[163]	

Recycled content in SUP beverage bottles

A UNESDA study estimated the average recycled content in PET beverage bottles was 24% in 2022 in the EU-27 +3 region[164], which is close to the target recycled content amount of 25% for PET beverage bottles. According to the same study, the average recycled content in PET beverage bottles in 2022 was:

- Greater than 25% in Austria, Belgium, Denmark, Finland, France, Germany, Latvia, Netherlands, Sweden
- Between 15-25% in Czech Republic, Estonia, Hungary, Malta, Lithuania, Luxembourg, Portugal, Slovakia, Spain
- Less than 15% in Croatia, Cyprus, Bulgaria, Greece, Ireland, Italy, Poland, Romania, Slovenia

Ecodesign Directive 2009/125/EC and Ecodesign for Sustainable Products Regulation (EU) 2024/1781

Document inspection

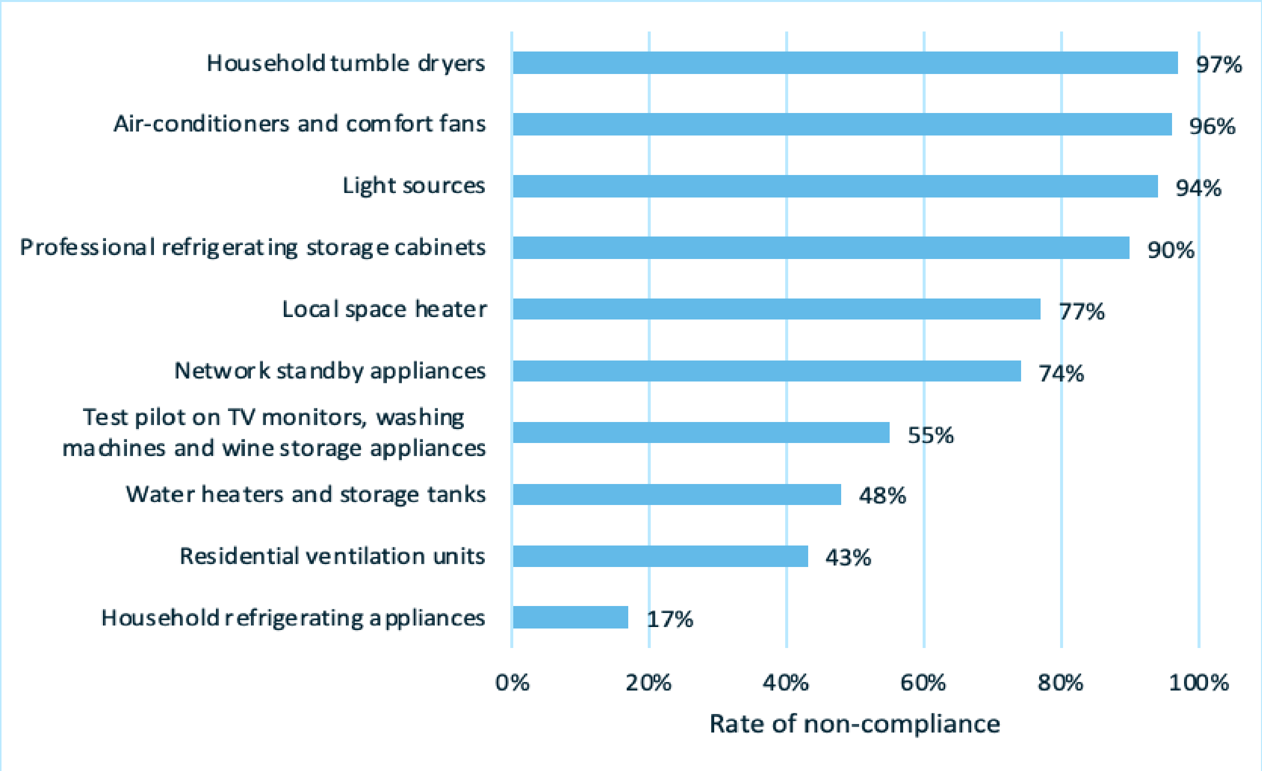
The Ecodesign Directive does not have any quantitative targets, but specific ecodesign requirements relating to a product's environmental performance or supply of information are set in the product regulations. Market surveillance carried out by competent authorities is key to ensuring that products placed on the market respect

[163] https://www.acrplus.org/en/news/deposit-refund-systems-in-the-eu-2023-update-4174?id_details_groupe=45
[164] https://www.unesda.eu/wp-content/uploads/2024/05/PET-plastic-Market-in-Europe-State-of-Play-Production-Collection-Recycling-Data_2022.pdf

the requirements. The Commission ensures support and co-ordination, notably through an Administrative Cooperation Group (or AdCo).

In the context of their work, projects such as EEPLIANT have investigated non-compliance of products with the applicable Ecodesign and Energy Labelling documentation/information requirements. Figure 6-13 shows rates of non-compliance with Ecodesign and Energy Labelling requirements for selected products (e.g., non-conformance with product information, declaration of conformity, technical documentation, etc.). Data is compiled from EEPLIANT 2[165] and 3 (4th Newsletter report)[166] projects. The projects note that market compliance is difficult to measure, and because of the risk-based approach followed by market surveillance authorities the data is ***not*** statistically representative, however the results indicate that rates of non-compliance for products can be potentially high.

Figure 6-13: Rates of non-compliance with documentation requirements for selected products



Laboratory tests

Market Surveillance Authorities also test product models in laboratory to investigate possible non-compliance with the Ecodesign performance requirements. Products are tested for a range of product-specific parameters. Figure 6-14 shows the overall rates of non-compliance and Figure 6-15 shows the rates of non-compliance with energy efficiency parameters compared to other, non-energy efficiency related parameters (varies for each product but includes testing parameter such as noise, heating or cooling capacity, volume, etc.). Data for Figure 6-14 is compiled from reports by EEPLIANT 2[167], EEPLIANT 3 (4th Newsletter report)[168] and the Nordic Council of Ministers[169] and from the two EPPLIANT projects for Figure 6-15. The projects note that market compliance is

[165] https://prosafe.org/images/EEPLIANT2/EEPLIANT2%20-%20Laymans_Report_v9_REV_20210709.pdf
[166] https://eepliant.eu/images/Documents/EEPLIANT3/Newsletter_and_Comm/4th_Newsletter/EN-EEPLIANT3_4th_Newsletter.pdf
[167] https://prosafe.org/images/EEPLIANT2/EEPLIANT2%20-%20Laymans_Report_v9_REV_20210709.pdf
[168] https://eepliant.eu/images/Documents/EEPLIANT3/Newsletter_and_Comm/4th_Newsletter/EN-EEPLIANT3_4th_Newsletter.pdf
[169] https://pub.norden.org/temanord2021-522/#

difficult to measure, and the data is not statistically representative. Similar to the results from the document inspection, the results indicate that levels of non-compliance for some products are potentially high.

Figure 6-14: Overall rates of non-compliance from laboratory tests for selected products

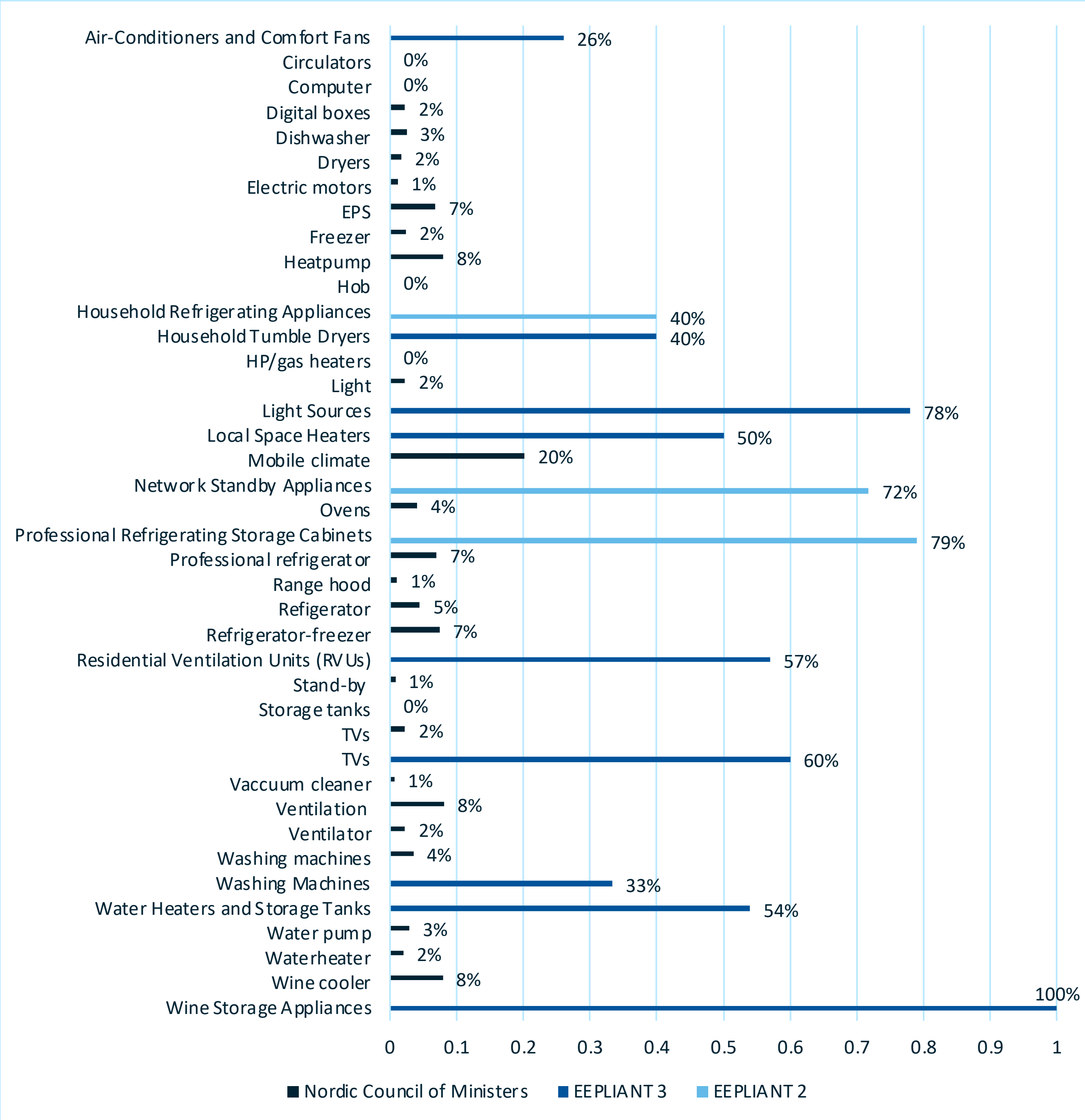
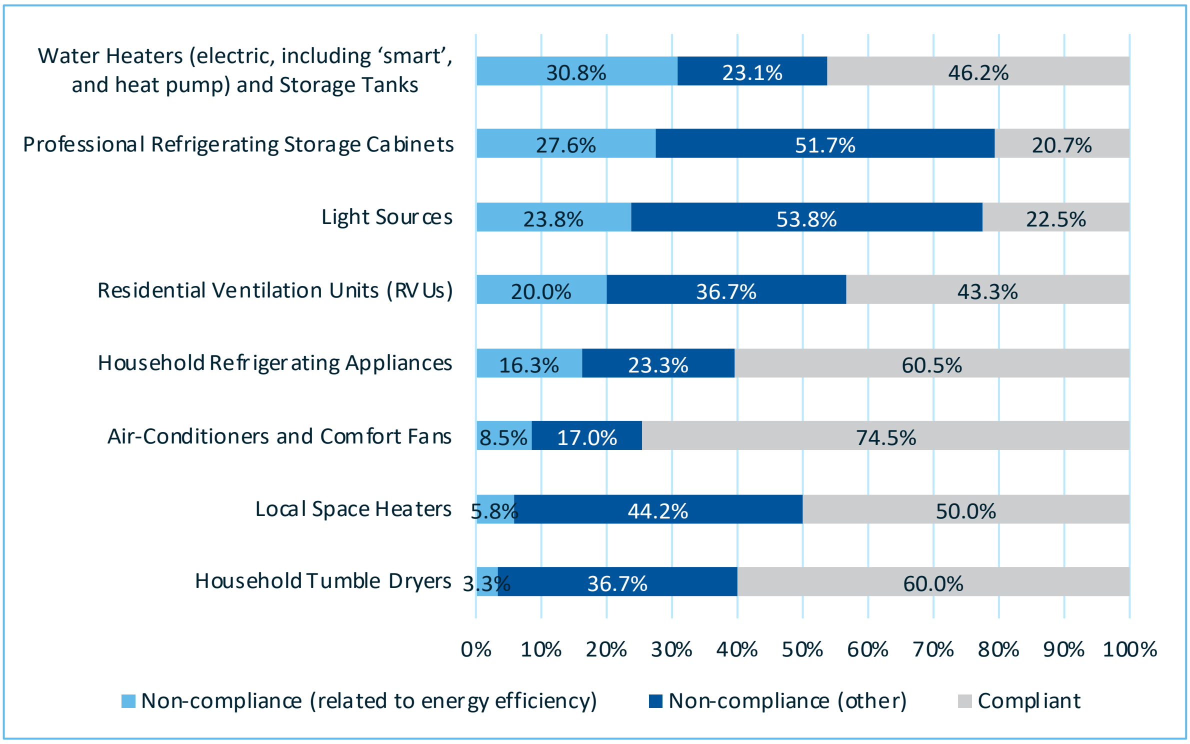


Figure 6-15: Rates of suspected energy efficiency related and other non-compliance rates from laboratory tests for selected products



New Waste Shipments Regulation (EU) 2024/1157

The EU is one of the main exporters of illegal waste shipments[170]. In the most recent implementation of the Waste Shipment Regulation report [171]:

- The total number of recorded illegal shipments in the EU-27 in 2019 was 1,381 (noting the Netherlands and Bulgaria did not submit data for 2019).
- In 2019, except for Latvia, all Member States that submitted data recorded at least one illegal shipment of waste. Across the four-year reporting period, all Member States recorded illegal shipments.
- Belgium had the highest number of reported illegal waste shipments with 952 instances, followed by France with 625. Malta and Latvia recorded the fewest with three instances each.

The reported illegal shipments range in severity, from minor and administrative violations to more environmentally harmful crimes. Regarding criminal cases, most violations related to waste electronic and electrical equipment (WEEE) and end-of-life-vehicles (ELVs) (e.g., illegal shipments of waste or intentional misidentification of waste types). Additionally, the report found an increase in reported illegal waste shipments between 2013-2015 (the previous reporting period) and 2016-2019. The average number of illegal waste shipments per year between 2013 and 2015 was 806[172] versus 1,233 illegal shipments per year between 2016 and 2019[173].

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[170]https://wedocs.unep.org/bitstream/handle/20.500.11822/25713/knowledge_crime_envImpacts.pdf?sequence=1&isAllowed=y
[171] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A142%3AFIN&qid=1679064816881 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0056R(01)
[172] https://eur-lex.europa.eu/resource.html?uri=cellar:44a84bd6-ee4e-11e8-b690-01aa75ed71a1.0001.02/DOC_2&format=PDF
[173]https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0056R(01)

In a more recent project led by IMPEL, between 2018 and 2020, 2,586 violations were found out of 11,843 waste inspections (22% violation rate). Of these violations, 22% were shipments subject to export bans, 18% were administrative violations, 34% were more serious offenses and 26% were unspecified. WEEE (14%), plastics (13%), metals (13%), ELVs and car parts (9%) and paper (7%) were the waste streams with the highest number of violations. Batteries saw the largest increase in number of violations[174].

The New Waste Shipments Regulation has a stronger focus on plastic waste shipments. Interpol has noted an overall increase in global plastic waste shipments, with Europe being a key exporter of plastic waste (65% of all reported exports originated from Europe). Illegal shipments of plastic waste were found in 20% (52 of 257 routes) of global trade routes and 40% of trade routes from Europe to Asia in 2018. Intra-European shipments of plastic waste have also increased and 13% of these trade routes had reported illegal shipments[175].

6.3.2 Limitations and uncertainties of the analysis

Waste Framework Directive (EU) 2018/851

Studies on CDW recovery rates in the EU often use a Eurostat database that is now discontinued (cei_wm040), so this study used the env_wasgen database which only covers mineral waste from CDW. While mineral wastes (e.g., bricks or concrete) are the main type of waste (up to 97% of total mass) in CDW, it does not cover all forms of CDW (e.g., wood or metal)[176]. A study by Moschen-Schimek et al. (2023) provides an overview of CDW recycling rates according to the two Eurostat databases.

Furthermore, although Eurostat data is widely used, there are several limitations to this data such as a lack of harmonised data collection, different national waste classification systems and varying definitions for backfilling activities, that limit the reliability and comparability of recovery rates between countries. Member States vary greatly in the types of CDW produced and their developmental stages of CDW management strategies and available waste management infrastructure[177].

Landfill Directive (EU) 2018/850

The data on the biodegradable waste going to landfills was provided by Member States and published by the EEA in the "EEA Municipal waste management reports", however data was reported differently by the Member States. For example, some reported older data, from 2016 or 2017, and some reported only the percentage of biodegradable municipal waste going to landfills, and not the tonnage.

Data sources for Landfill Directive's biodegradable waste landfilled target had some gaps in the data and some countries were missing data.

Batteries Directive 2006/66/EC and New Batteries Regulation (EU) 2023/1542

Unlike the Batteries Directive, the New Batteries Regulation has separate targets for the recycling efficiencies for lithium batteries. There is no separate data in Eurostat (and minimal data in general) for lithium battery recycling efficiencies. In the present Eurostat dataset (env_wasbat), lithium batteries, as well as other batteries that are not lead or nickel-cadmium batteries, are currently included within the 'other' waste batteries category.

Data sources for the Batteries Directive's recycling efficiencies of lead, nickel-cadmium and other batteries target had some gaps in the data. Some countries had data for recycling rates and not for tonnage and, subsequently, are missing some data.

[174] https://www.sweap.eu/wp-content/uploads/2020/07/SWEAP-inspection-results-2018-2020-updated.pdf
[175] https://www.interpol.int/en/News-and-Events/News/2020/INTERPOL-report-alerts-to-sharp-rise-in-plastic-waste-crime
[176] https://www.sciencedirect.com/science/article/pii/S0956053X23003616
[177] Ibid.

Ecodesign Directive 2009/125/EC and Ecodesign for Sustainable Products Regulation (EU) 2024/1781

A very small share of products within the groups regulated are selected for compliance checks or testing due to the limited resources available within Member States and the large amount of product groups. The market surveillance authorities have the obligation to perform checks on a risk-based approach, meaning that priority tends to be given to products where there may be a suspicion of non-compliance (other criteria apply, e.g. products that are most popular can also be considered as high-risk since any non-compliance would affect a considerable amount of consumers). These factors mean that care is needed to draw any general conclusions from the figures. The EEPLIANT 3 final report is not yet published, so data was compiled using several reports. It should also be noted that some products underwent multiple rounds of laboratory testing so the final conclusions in the reports may be different than what is presented in the charts (e.g., one tumble dryer was suspected of energy efficiency non-compliance, but after additional rounds of testing, all tumble dryers were compliant with energy efficiency requirements). Data in both charts focuses on suspected rates of non-compliance after single testing. See Table A2-10-64 and Table A2-10-65 in Appendix 2 for a more detailed breakdown of the data.

Other policies and laws

In the Ship Recycling Regulation and the New Waste Shipments Regulation, which do not have quantitative targets, information was compiled from implementation reports and/or projects. The projects vary in scope and size, making comparisons between projects difficult to make. Furthermore, the non-implementation of these policies often involves circumvention of requirements through illegal and subversive means, making them ultimately hard to detect and non-implementation hard to estimate.

Due to recent proposals and changes to some of the policies, there is no data available on the targets presented in the following table.

Table 6-6: Targets for which no data is available

Policy	Targets with no data available
New Batteries Regulation	Targets for collection of waste LMT batteries for producers Targets for recycling efficiency for lithium batteries Targets for recovery of materials Targets for recycled content
Single Use Plastics Directive	Targets on separate collection of single use plastic beverage bottles Recycled content
Proposal for Packaging and Packaging Waste Regulation	Minimum recycled content in plastic packaging Targets on re-use and refill

6.4 Implementation gap cost

6.4.1 Analysis

The consequences of not implementing circular economy and waste targets include: health and environment costs due to illegal activities, unrealised market benefits, spillover effects, uncertainty and market distortions, litigation costs for Member States and administrative costs for industry. The main quantifiable costs related to non-implementation are the materials lost to the economy that could have otherwise been re-used or recycled back into the economy and the impacts of increased greenhouse gases (GHG) and air pollutant emissions resulting from the landfilling and incineration of waste as opposed to re-use and recycling.

The cost associated with **the implementation gap against current targets is €6.6 billion – 8.6 billion** (**or €20.6 billion – 22.6 billion including partial costs associated with Ecodesign Directive**).

Taking instead the implementation gap associated with future targets (where both current and future targets apply for the same legislation), the **total implementation gap cost is much larger, estimated to be between €65 billion – 76 billion (or €79 billion – 90 billion including partial costs associated with Ecodesign Directive)**.

Table 6-7: Overview of costs associated with non-implementation of circular economy and waste targets

Policy	Implementation gap costs against current targets (€)	Implementation gap costs against future targets (€)
Major waste directives (WFKD, Packaging and Packaging Waste Directive and Landfill Directive)	3.4-4 billion	7.7-10.4 billion
Food waste prevention	n/a	51-55 billion
Landfill compliance (illegal landfilling)	30 million to 1.3 billion (based on illegal landfilling rates of 0.4% to 15%)	Same as current targets
ELV Directive	99 million	Same as current targets
WEEE Directive	2.2-2.3 billion	Same as current targets
Batteries Directive/New Batteries Regulation	37-47 million	643-647 million
New Waste Shipment Regulation	n/a	1.9-4.7 billion
Single-Use Plastics Directive**	n/a	551 million
Ecodesign Directive and ESPR*	14 billion	Same as current targets
Total	€6.7-8.6 billion (€20.6-22.6 billion including costs associated with Ecodesign Directive)	€65-76 billion (€79-90 billion including costs associated with Ecodesign Directive)
*Costs associated with Ecodesign Directive are presented separately as it investigates the costs of non-compliance in selected product groups only **Due to a limited amount of data and information available, only the cost associated with full implementation of DRS across Member States that have yet to implement a DRS **for one-way plastic beverage containers** is included.		

Implementation gap cost evaluations against existing targets

This section will discuss the costs associated with the implementation gaps to the existing targets in the major circular economy and waste directives (which encompasses the Waste Framework Directive, Packaging and Packaging Waste Directive and Landfill Directive, as analysed in the 2019 report) and other policies. Although WEEE, ELVs and batteries are smaller waste streams compared to the major circular economy and waste directives, failure to implement the targets laid out in the policies and properly dispose of waste from these streams still leads to foregone benefits and a loss of valuable materials to the economy, particularly precious metals and critical raw materials. Furthermore, this section will discuss the costs of non-implementation of the Ecodesign Directive and Ship Recycling Regulation which have non-quantifiable targets.

Major circular economy and waste directives

The EU has made progress towards meeting the targets laid out in the Landfill Directive, but there remains a considerable implementation gap for most of the targets laid out in the Waste Framework Directive and Packaging and Packaging Waste Directive. Considering the existing implementation gaps, failure to implement the major circular economy and waste directives would result in 22.6 million tonnes of MSW not being recycled or re-used by 2025. This includes 3.3 million is biodegradable waste sent to landfill and 2.8 million tonnes of packaging waste. There is a potential total value of **€3.4-4 billion** in materials lost to the economy from not meeting the 2025 WFKD target on the preparation for re-use and recycling of municipal waste. This is based on the composition of total municipal solid waste and residual waste in each Member State and the 2023 average values for recycled materials. The implementation gap costs does not take into account derogations. The cost split by Member State is presented in Table A2-10-66 in Appendix 2.

In addition to meeting the performance targets, all landfilling activities within the EU must take place in compliant facilities. The illegal nature of circumventing this requirement makes illegal landfilling inherently difficult to measure, but COWI et al. (2019) reported estimated the total cost of illegal landfilling at €4-4.5 billion. This is based on the same unit costs for environmental damage and containment and clean-up of illegal landfills from the 2011 report and the assumption that the rate of illegal landfilling reduced at the same rate at legal landfilling. COWI et al. (2019) noted that this estimate is likely an upper limit as targeted actions taken to address illegal landfilling have likely led to a faster decline in illegal dumping. Between 2019 and 2022, MSW landfilling rates have fluctuated, but showed a slight decline of 1.5%. Using the same assumptions as in the previous report, the total costs linked to illegal landfilling have decreased slightly to €3.9-4.4 billion. According to the 2019 report, estimates on the number of illegal landfills vary from 0.4% to 15%, thus bringing the costs from illegal landfilling to **€30 million to €1.3 billion**.

WEEE Directive 2012/19/EU

Most Member States are not meeting the 2019 WEEE collection target, resulting in a potential cost of **€1.2 billion** in terms of lost material value in metals, glass and plastics[178]. In addition, there are around 30 to 41 grams of precious metals lost per tonne of WEEE, based on the 2019 report and the 2024 Global E-waste Monitor[179], respectively. The shortfall in meeting the 2019 WEEE collection target represents an estimated 69 to 94 tonnes of precious metals, which includes 49 to 71 tonnes of silver, 15 to 16 tonnes of gold and 5 to 7 tonnes of palladium. Based on 2023 average market prices for these recycled materials[180] and composition of precious metals in WEEE, this amounts to a value between **€877 million to €1 billion**. The gap costs also do not account for derogations.

Additionally, the WEEE Directive sets targets on the recycling and recovery of WEEE. There is a potential cost of **€33-34 million** for not meeting the recycling target and **€26-27 million** for the meeting the recovery target in lost material value of ferrous and non-ferrous metals, plastic and glass from WEEE. This is addition to **€44-88 million** of foregone value in gold, silver and palladium by not meeting both targets. These values are based on the material composition of WEEE in 2015 and estimated 2018 composition[181] for each of the EU6 product clustering groups[182] and 2023 average market prices of materials[183]. The material composition of e-waste will likely change

[178] Based on the average composition of WEEE from the 6 product categories (https://op.europa.eu/en/publication-detail/-/publication/0a54f944-a5a0-433c-8b2c-7893290c182d) and global composition of WEEE (https://ewastemonitor.info/the-global-e-waste-monitor-2024/)
[179] https://ewastemonitor.info/the-global-e-waste-monitor-2024/
[180] https://prices.mrw.co.uk/prices
[181] The study also estimated the composition of WEEE in 2018. Although it is an estimate, the averages of all 6 product categories are comparable to the composition of WEEE in the 2024 UN Global E-waste Monitor Report.
[182] https://ec.europa.eu/environment/pdf/waste/weee/16.%20Final%20report_approved.pdf
[183] https://prices.mrw.co.uk/prices; https://www.letsrecycle.com/prices/; https://ec.europa.eu/eurostat/statistics-

over time and trends in electronics could result in higher contents of plastic and lower contents of precious metals and glass[184].

Batteries Directive 2006/66/EC and New Batteries Regulation (EU) 2023/1542

The implementation gap for the recycling efficiency targets for lead and nickel-cadmium batteries is small at 10,373 tonnes and 40 tonnes, respectively. Based on 2023 average market prices[185], the value of lost lead from the recycling of lead batteries is **€3 million** and the value of lost nickel and cadmium is around **€142,000** (based on indicative chemical composition of lead-acid and nickel-cadmium batteries[186]).

There are many different types of portable batteries, but they fall into two categories: primary and rechargeable. Primary single-use batteries make up 90% of the batteries placed on the market on unit basis and 64% on a weight basis; alkaline manganese and zinc carbon batteries constitute the majority of these. The remaining third is comprised of rechargeable batteries, of which rechargeable lithium-ion batteries is the dominant battery type[187]. Based on the typical composition of alkaline manganese, zinc carbon and lithium-ion batteries[188] and 2023 average market prices, there is **€2.3-3 million** and **€34-44 million** in lost material value due to the implementation gap against the 2023 and 2027 collection targets, respectively.

End of Life Vehicles Directive 2000/53/EC

The implementation gap to the ELV targets on reuse, recovery and recycling have decreased since 2019 and most Member States are close to or already meeting the targets. As a result, **€92 million** in potential value from material reuse and recovery is currently lost, along with **€7 million** in foregone value from the reuse and recycling of ferrous and non-ferrous metals, glass, plastic, and rubber. This is based on the average material composition of end-of-life passenger cars after depollution from two sources[189] and 2023 average material values[190].

Ecodesign Directive 2009/125/EC and Ecodesign for Sustainable Products Regulation (EU) 2024/1781

The cost of non-compliance with the Ecodesign Directive varies for each product and depends on the rates of non-compliance, difference in energy consumption between compliant and non-compliant products and the number of products sold annually. There are certain limitations and details to be aware of regarding the costs associated with non-compliance with the Ecodesign Directive. First, it should be noted that the non-compliance rates included in the table are non-compliance rates for the relevant *energy efficiency* parameter for each product; non-compliance rates for other, non-energy efficiency related parameters are not included in the rate.

explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator&oldid=629056; https://www.lme.com/

[184] https://ec.europa.eu/environment/pdf/waste/weee/16.%20Final%20report_approved.pdf

[185] https://prices.mrw.co.uk/prices; https://tradingeconomics.com/

[186] Lead-acid: Impact Assessment, Table 12
Nickel-cadmium: https://www.epbaeurope.net/assets/resources/EPBA_Product-Information_10112015.pdf

[187] https://www.epbaeurope.net/assets/news/Report-on-the-portable-battery-collection-rates-Update-Dec-16-full-version-FINAL-rev.1.pdf

[188] Composition of batteries varies by type. Information on the composition of alkaline manganese, zinc carbon and lithium ion derived from: https://www.epbaeurope.net/assets/resources/EPBA_Product-Information_10112015.pdf. For comparison, average composition of NMC 111 lithium-ion batteries (outer casing excluded) was calculated using Tables 3 and 9 from the Impact Assessment Report. (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0335). It was also assumed that each battery type makes up a third of the collected batteries.

[189] https://eur-lex.europa.eu/resource.html?uri=cellar:9d368e81-215c-11ee-94cb-01aa75ed71a1.0001.02/DOC_2&format=PDF and the same source used in the 2019 report: https://ec.europa.eu/environment/pdf/waste/study/final_report.pdf

[190] https://prices.mrw.co.uk/prices; https://www.letsrecycle.com/prices/; https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator&oldid=629056; https://tradingeconomics.com/

The calculation also excludes non-compliance with information requirements, including e.g. incorrect energy label, which can also lead to costs for consumers and the environment (not assessed in this study). Additionally, the selected products were inspected for energy efficiency non-compliance using a risk-based sampling approach. To apply the non-compliance rates from this approach to the broader market, a corrected non-compliance rate for energy efficiency was calculated for each product[191]. However, there are still *limitations in applying these values to the EU market as a whole*. Furthermore, some products, such as ducted air conditioners, all tumble dryers and gas heaters, are not included in the table because all units tested in the lab met the energy efficiency requirements and therefore there is no cost associated with their non-compliance. Biogas heaters were not tested under the Ecodesign Directive and are therefore also excluded. Overall, based on the product impact assessments in the EEPLIANT 3 project, **the total cost of non-compliance with energy efficiency requirements for selected products is estimated as €14 billion**.

Table 6-8: Impact of non-compliance with the Ecodesign Directive for selected products

Product group	Air conditioners and comfort fans	Water heaters and storage tanks			Residential ventilation units	Light sources	Local space heaters
Specific product (if applicable)	Split air conditioner	Electric storage water heaters	Storage tanks	Heat pump water heaters			Electric heaters
Difference in energy consumption between compliant and non-compliant products (kWh/yr)	42	54	194	185	866	12	9
Energy lost (GWh)	485	353	335	236	6,668	44,032	267
GHG emissions (tonnes)	121,275	97,190	92,112	64,762	1,667,050	11,007,975	73,508
Cost of non-compliance (€)*	133 million	88 million	84 million	59 million	1.8 billion	12 billion	67 million
Prices (as used in EEPLIANT 3)	GHG .25 t/MWh Cost 275 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh	GHG .25 t/MWh Cost 275 EUR/MWh	GHG .25 t/MWh Cost 275 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh

Note: * It should be noted that the energy lost, GHG emissions and costs of non-compliance are accumulated over a ten-year operating period for each product. Cost of non-compliance was calculated based on the values provided from the EEPLIANT 3 project. For an additional breakdown of numbers see Appendix 2.

[191] The project assumed that the risk-based sampling approach led to a three times higher non-compliance rate than what is on the market. For example, after laboratory product testing the project found that 2 out of 20 air conditioners were non-compliant regarding energy efficiency (10% non-compliance rate). Applying the correction factor, the non-compliance rate for products on the market is assumed to be 3%. See Appendix 2 and EEPLIANT 3 project for a more detailed explanation.

Implementation gap cost evaluations against future targets

The major circular economy and waste directives also have future targets in addition to the existing targets (e.g., WFKD has targets for 2025, 2030 and 2035 for municipal waste re-use and recycling preparation). In addition, since 2019, several circular economy and waste policies have been adopted that have set targets for various waste streams. Due to a lack of data for these targets, the impact assessments for the policies provide insight into the projected economic and environmental benefits associated with the implementation of these targets.

Major circular economy and waste directives

The overall trends of MSW between 1995 and 2022 show an increase in MSW generation. At the same time, the amount of MSW being recycled, composted or incinerated has risen and the amount of MSW being landfilled has decreased[192]. Against the amount of MSW recycled in 2022, the gap to the 2035 target is around 77 million tonnes of waste. This amounts to nearly **€6 to 7 billion** in foregone material benefits based on the composition of MSW in each Member State and 2023 average material prices (Appendix 2).

In addition to the economic costs, there are environmental, and health costs associated with poor waste management including improper handling of hazardous materials and damage from pollutants. There are also GHG emissions from landfilling and incineration of waste. As a result of changes in waste management over time, specifically the declining landfill rates and increasing rates of incineration and recycling, GHG emissions from waste management are also decreasing[193]. In COWI et al. (2019), it was modelled that full implementation of the 2035 major waste targets would result in a 16,662 kt reduction of CO_2-eq compared to a 2019 business-as-usual baseline. The rate of change in GHG emissions has changed from 2019 to 2022, with the amount slightly increasing in most Member States. Considering the overall decrease in GHG emission from waste management operations over time and the changes in the rate of emissions between 2019 and 2022, it is likely that the GHG emissions reductions from full implementation of the 2035 major waste targets would be smaller at around 14,913 kt of CO_2-eq. There are several values for the social cost of carbon, ranging from €100 per tonne (in line with the value in the impact assessment[194]) to €205 per tonne (adjusting the value in the 2019 report for inflation). In total, there are **€1.5-3 billion** in foregone GHG benefits from non-implementation see Appendix 2 for a more detailed breakdown of the additional GHG emissions and monetised impacts of these additional emissions). COWI et al. (2019) also estimated the foregone air quality benefits at €0.4 billion - assuming the same unit costs of air quality benefits and changes in GHG emissions since 2019, this value is likely closer to **€0.3 billion**.

The implementation gap to the target of halving per capita food waste at the retail and consumer levels by 2030 now stands at 10.1 million tonnes compared to the 2012 levels. Assuming each tonne of food waste landfilled generates 4.2 tonnes of GHG emissions, there are an additional 42 million tonnes of GHG emissions generated. Using an updated value of €4,602 per tonne for post-farm-gate food waste[195] and a value of €100 and €205 per tonne for the social cost of carbon (see above), the total value of lost material and monetised GHG emissions against the remaining implementation gap amounts to **€51-55 billion**.

New Batteries Regulation (EU) 2023/1542

The New Batteries Regulation outlines five new targets (targets for collection of waste LMT batteries and waste portable batteries, targets for recycling efficiency, targets for recovery of materials and targets for recycled content). Targets for the collection of waste portable batteries will have an economic benefit of **€72.7-77 million** per year by 2030 and the targets on recycling efficiency/material recovery will have an economic benefit of **€527 million** per year by 2035 in additional revenues from recovered materials. Targets on the collection of waste LMT batteries is not monetised, but additional amounts of waste batteries collected would mean additional revenues for secondary materials recovered, including valuable raw materials (lithium batteries in particular). In

[192] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics
[193] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200123-1
[194] https://environment.ec.europa.eu/publications/proposal-targeted-revision-waste-framework-directive_en
[195] https://www.wrap.ngo/resources/report/food-surplus-and-waste-uk-key-facts-updated-november-2023#download-file

terms of environmental benefits, the targets would have a combined reduction of 433 -435 ktonnes of CO2-eq avoided per year in 2030. Assuming a social cost of carbon of €100 per tonne of CO_2-eq, this would be **€43 million** in monetised GHG savings. Most of the targets between the proposal and the impact assessment vary; only the targets for recycling efficiency are the same. Most of the targets in the proposal are slightly higher than the targets analysed in the impact assessment and, therefore, the values above are likely a lower limit of the economic and environmental benefits[196].

New Waste Shipment Regulation (EU) 2024/1157

The New Waste Shipment Regulation does not set specific quantitative targets, but it introduces measures on waste exports that will result in more waste being retained within the EU. This will allow for the better environmental treatment of waste and an increase in the availability of secondary materials in the EU. The impact assessment[197] projects that there will be **€1.6-4 billion** in additional revenue each year in 2030 and **€275-687 million** in avoided environmental externalities each year in 2030, depending on the amount of waste retained in the EU.

Single Use Plastics Directive (EU) 2019/904

The SUPD sets specific targets for the recycled plastic content and separate collection of single use plastic beverage bottles. The economic and environmental benefits associated with the future targets are not quantified in the impact assessment and, in general, there is minimal information in the assessment report regarding the impacts of the specific targets[198]. The targets for the separate collection of single use plastic beverage bottles would increase the amount of recycled plastic available, thereby generating additional revenue from the collected materials and reducing the number of SUP beverage bottles sent to landfills and left as litter. Ultimately, there is only a single estimate for the cost associated with introducing DRSs covering plastic beverage bottles, which would help to achieve the collection target[199]. The impact assessment estimates a revenue of **€551 million** in PET material collected and sold from DRS implementation in Member States that have yet to implement a DRS for one-way beverage containers (estimated benefit is not modelled to a certain year, but rather estimates the benefit associated with an introduction of a DRS covering plastic bottles in Member States that have not implemented a DRS).

6.4.2 Limitations and uncertainties of the analysis

In this analysis, effort was made to find updated compositions of materials for the various waste streams and, when available, average 2024 prices of recycled materials. However, material composition and prices of materials vary over time and the simplification of diverse waste streams into separate material parts has inherent variability and uncertainties.

Furthermore, there were difficulties in replicating in detail the work done in COWI et al (2019). Most notably, the 2019 report used the European Reference Model on Waste Generation and Management to calculate value of materials lost and GHG emissions from not meeting the future targets for the major waste directives. This model compared a business-as-usual baseline to a 2035 scenario where all waste targets are met in each Member State. Due to difficulties with operating the model and the seven-year gap since the model was last updated, this reported attempted to update the values provided by COWI et al (2019) on the gap cost analysis to the future targets based on linear extrapolation based on Eurostat data. This approach was used to analyse the change in GHG emissions between 2019 and 2022, in order to understand how GHG emissions have changed since the 2019 report and update the numbers in the previous report. For the costs associated with foregone

196 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0335
197 https://environment.ec.europa.eu/publications/proposal-new-regulation-waste-shipments_en
198 https://op.europa.eu/en/publication-detail/-/publication/a9c49259-af70-11e8-99ee-01aa75ed71a1/language-en
199 One of the proposed changes to the Packaging and Packaging Waste Directive introduces a target that by 1 January 2029, Member States shall set up DRS systems for single use plastic and metal beverage containers.

material value against future waste targets, the implementation gap cost between 2022 MSW recycling amounts and the 2035 MSW target was calculated based on MSW composition and 2023 average material values.

For some circular economy and waste policies and targets (e.g., CDW and ship recycling), there was a lack of information available and limitations to the data that made estimating a cost to non-implementation challenging. The recently introduced circular economy and waste policies had limited data available, with information on the financial benefits from implementing the targets primarily drawn from impact assessments. For certain policies, especially the Single Use Plastics Directive, cost information was restricted to just one aspect of the Directive – the additional material revenue from implementing the Deposit Return Scheme (DRS) in all Member States that have yet to do so. The impact assessment did not include a monetisation of the costs in relation to the targets.

6.5 Forward looking assessment

Circular economy and waste legislation is diverse and several new waste targets have been introduced since 2019 that will continue to impact waste management to 2030. Thus, the forward-looking assessment considers the Zero Pollution Action Plan to capture the overall progress of the EU to where the EU is forecasted to be against the Action Plan's 2030 targets. Additionally, the assessment explores the impacts of the upcoming proposed changes to existing pieces of legislation (Waste Framework Directive, Packaging and Packaging Waste Directive and End of Life Vehicles Directive) on the implementation gap to 2030.

Zero Pollution Action Plan

The Zero Pollution Action Plan has four targets pertaining to waste:

- Reduce plastic litter at sea by 50%,
- reduce microplastics released into the environment by 30%,
- reduce significantly total waste generation, and
- reduce residual municipal waste by 50% by 2030.

According to the analysis done in the zero-pollution monitoring assessment, the EU is **currently not on track** to meet the targets of reducing total waste generation and residual municipal waste and the progress towards the targets for reducing plastic litter at sea and microplastics released is **uncertain**[200].

The assessment of the data for the target on reducing plastic litter at sea is still underway and has so far only been carried out for the Mediterranean Sea. While there has been an overall decrease in the amount of plastic litter on the EU's coastlines between 2016 and 2020, the EU is not on track to meet the target laid out in the action plan[201]. In a model based on data from 2016, 2017 and 2018 in the Mediterranean Sea, a total ban on single-use plastics resulted in a 14% reduction on the total amount of litter (floating and beached) in the Mediterranean Sea by 2030, far from the target of 50%. In an unrealistic scenario of a complete ban on all plastic littering (e.g., banning the use of all plastic items or a perfect waste management system that prevents plastic from reaching the environment) by the EU resulted in a 25% reduction on the total amount of litter in 2030[202].

Additionally, the EU is not on track to reach the target on reducing total waste generation by 2030 based on current and past trends, with waste generation rising between 2010 and 2018. After 2018, there has been a downward trend in waste generation with an 8% reduction in total waste generation between 2018 and 2020.

[200] https://www.eea.europa.eu/publications/zero-pollution
[201] https://www.eea.europa.eu/publications/zero-pollution/ecosystems/marine-pollution/#plastic-pollution
[202] https://publications.jrc.ec.europa.eu/repository/handle/JRC129655

This reduction also follows a decline in the EU's economy and evidence of a decoupling of the EU's economy from waste generation is unclear.

The EU is also far from reaching the zero-pollution target of reducing residual municipal waste by 50%. Between 2016 and 2020, there has been no significant change in the generation of residual municipal waste. The target will not be met even if all Member States achieve the WFKD target on the preparation for re-use and recycling of municipal waste. Additional efforts are needed that focus on preventing municipal waste generation and achieving recycling levels that go beyond the EU's current targets. Despite not being on track to meet the target, the EU's recycling of municipal waste, however, has increased between 2004 and 2020.

Waste Framework Directive (EU) 2018/851

Textiles – Separate collection

As of 2019, it was estimated that 57% (6.2 million tonnes) of all post-consumer textile waste were covered by collection schemes in Member States that have schemes established. For textile wastes subject to separate collection schemes, around 39% were collected in the EU (2.0 million tonnes collected out of 5.1 million tonnes generated). Collection rates vary between Member States[203]. See below for an overview of separate collection schemes in the Member States.

With the introduction of the requirement for separate collection for textiles from 2025, it is estimated that an additional 65,000 to 90,000 tonnes of textile waste will be separately collected each year in the EU, resulting in 3.2 and 3.6 million tonnes separately collected in 2035[204].

Table 6-9: State of mandatory separate collection for textiles in the EU

Current state of mandatory separate collection in place	Country
Mandatory	Belgium, Croatia, Denmark, Estonia, Finland, France, Italy, Latvia, Luxembourg, Poland, Slovenia
Not mandatory	Austria, Bulgaria, Cyprus, Czechia, Germany Hungary, Ireland, Netherlands, Lithuania, Portugal, Romania, Slovakia, Spain, Sweden
Planned in 2024	Greece
Unknown/No response	Malta
Source: https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2024-5-textile-waste-management-in-europes-circular-economy	

Textiles – Mandatory EPR schemes

For waste, the EPR will fund infrastructure to manage textile waste and support the separate collection of textiles for re-use and recycling. With mandatory EPR schemes, of the total amount of textile waste generated, the amount disposed is projected to fall from 74% to 56%, a decrease of almost 670,000 tonnes, by 2035[205]. Table 6-10Table shows the status of EPR schemes in each Member State.

[203] https://environment.ec.europa.eu/document/download/2b240780-35b7-4b8e-b784-bc4246c9d01a_en?filename=IMPACT%20ASSESSMENT%20REPORT_SWD_2023_421_part2.pdf
[204] https://environment.ec.europa.eu/document/download/768d76e9-aab9-4f90-a036-7d841e40494e_en?filename=IMPACT%20ASSESSMENT%20REPORT_SWD_2023_421_part3.pdf
[205] https://environment.ec.europa.eu/document/download/b251b83b-d1e9-4ce7-8aba-b8ca993828c8_en?filename=IMPACT%20ASSESSMENT%20REPORT_SWD_2023_421_part4.pdf

Table 6-10: State of EPR systems for textiles in the EU

Current state of EPR systems for textiles	Country
Mandatory	France, Hungary, Netherlands
Voluntary	Belgium, Luxembourg
Not yet in place	Austria, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, Greece, Ireland, Poland, Portugal, Romania, Slovenia, Spain
In preparation	Germany, Italy, Latvia, Lithuania, Malta, Slovakia, Sweden
Source: https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2024-5-textile-waste-management-in-europes-circular-economy	

Food waste

Between 2020 and 2030, the EU's food waste levels are expected to rise from 56.98 million tonnes[206] in 2020 to 57.04 million tonnes in 2030, only a 0.1% change. With the proposed changes to the WFKD (i.e. the introduction of a target for a 10% reduction of food waste generation in processing and manufacturing, and a 30% reduction of food waste generated per capita in retail and other distribution of food, in restaurants and food services, and in households, both comparing 2030 amounts to 2020), food waste levels are expected to decrease by 13.12 million tonnes (to 43.92 million tonnes) compared to the 2030 projected level[207].

The changes in food waste levels, however, are expected to vary between Member States based on changes in each country's population and economy. Several countries in Eastern and Central Europe are predicted to have a decrease in food waste generation due to decreasing population sizes, despite economic growth[208]. For the implementation gap of Member States between 2020 and 2021 against the 2030 targets on food waste reduction, see Table A2-10-46.

Packaging and Packaging Waste Directive (EU) 2018/852

The projected level of packaging waste generated in 2030 is 209 kg per capita or 92.4 million tonnes, if no action is taken. As a result of the targets in the Packaging and Packaging Waste Directive, the recycling rate of packaging waste is projected to increase to 69.6% in 2030. These amounts are based on the amount generated in 2018 (77.8 million tonnes or 174 kg per capita)[209].

Reduction in packaging waste generated

The proposed changes to the Packaging and Packaging Waste Directive set a target for a 5% reduction in the amount of packaging waste per capita by 2030 compared to the amount in 2018[210]. With this measure in place, the estimated amount of packaging waste generated in 2030 is 74.7 million tonnes (versus 92.4 million tonnes if

[206] At the time of the Impact Assessment Report, the 2020 food waste level was 56.98 million tonnes and the modelling was based on this value. However, in Eurostat at the time of access (September 2024), the 2020 levels of food waste in the EU-27 were slightly higher at 58.4 million tonnes.
[207] https://environment.ec.europa.eu/document/download/2f6d95b0-7a76-4074-a080-341d417f34c1_en?filename=IMPACT%20ASSESSMENT%20REPORT_SWD_2023_421_part1_0.pdf
[208] Ibid.
[209] https://eur-lex.europa.eu/resource.html?uri=cellar:0567fd10-7165-11ed-9887-01aa75ed71a1.0001.02/DOC_2&format=PDF
[210] 2018 levels in the impact assessment report were 174 kg per capita (77.8 million tonnes). Most recent figure in Eurostat for 2018 is 173.25 kg per capita (77.4 million tonnes).

no action is taken in the 2030 baseline). Meeting this target is equivalent to an overall, absolute reduction of 19% (17.7 million tonnes) on average across the EU compared to the 2030 baseline[211] (Figure 6-16).

This measure is expected to have the greatest impact on reducing the amount of wood, paper and cardboard, and plastic packaging generated. See Appendix 2 for the forecasted amounts and percent change from the baseline amount for each material fraction.

Targets on re-use and refill

There are also proposed targets for the re-use and refill for several packaging groups in the food and beverage (retail, hotel, restaurant and café/catering (HoReCa)) and the commercial and industrial sectors. The different packaging groups have different targets. With these targets in place, it is forecasted that there will be a 4.9% or 3.154 million tonne reduction in packaging waste from the 2030 baseline[212] (Figure 6-17).

The target would have different impacts on the various packaging materials, with the greatest reduction occurring in paper and cardboard packaging waste. See Appendix 2 for the changes in packaging waste generation for each material.

Minimum recycled content in plastic packaging

Proposed product requirements on minimum recycled content in plastic packaging sets requirements for economic operators for contact sensitive packaging made from PET, contact sensitive packaging made from plastics other than PET, single use plastic beverage bottles (repeal and replace the ones from Single-Use Plastics Directive), and other plastic packaging than those listed. The measures in the proposal vary slightly from the ambition targets laid out in the Impact Assessment Report (See Appendix 2)[213].

The medium and high ambition targets would increase the amount of recycled content in plastic packaging by 2,980 ktonnes and 4,980 ktonnes, respectively, compared to the 2030 baseline[214]. Based on the expected increase of recycled content in ktonnes based on the medium and high ambition targets (See Appendix 2) and the proposed targets, the amount of recycled content in plastic packaging is likely closer to 2,363 ktonnes in 2030 (sum of contact sensitive high ambition PET value, 10% of contact sensitive high ambition polyolefin and other values, and non-contact sensitive medium ambition total).

Deposit and return systems (DRS)

The proposed changes to the Packaging and Packaging Waste Directive also include a mandatory DRS requirement for plastics and cans, unless Member States can reach a 90% sperate collection rate by weight through other means. This proposal would increase the recycling rate in 2030 for plastic beverage containers and (See Appendix 2 for a comparison of recycling amounts and rates from a mandatory DRS compared to inaction (2030 baseline)). These values are the increase in material recycled after process losses, not the amount of material collected. Additionally, the 2030 baseline also assumes that the Single Use Plastic Directive collection target of 90% for plastic bottles is met[215].

[211] https://eur-lex.europa.eu/resource.html?uri=cellar:0567fd10-7165-11ed-9887-01aa75ed71a1.0001.02/DOC_2&format=PDF
[212] Ibid.
[213] https://eur-lex.europa.eu/resource.html?uri=cellar:0567fd10-7165-11ed-9887-01aa75ed71a1.0001.02/DOC_1&format=PDF
[214] https://eur-lex.europa.eu/resource.html?uri=cellar:0567fd10-7165-11ed-9887-01aa75ed71a1.0001.02/DOC_2&format=PDF
[215] Ibid

Figure 6-16: Past and forecasted levels of packaging waste generated with and without targets on packaging waste reduction

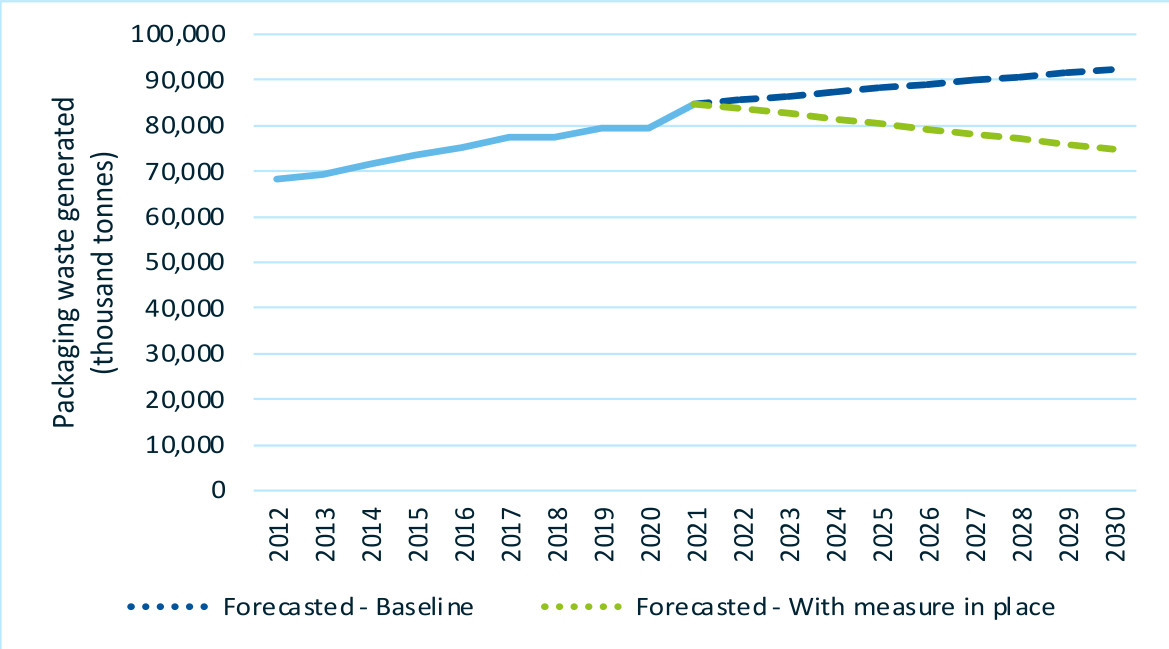
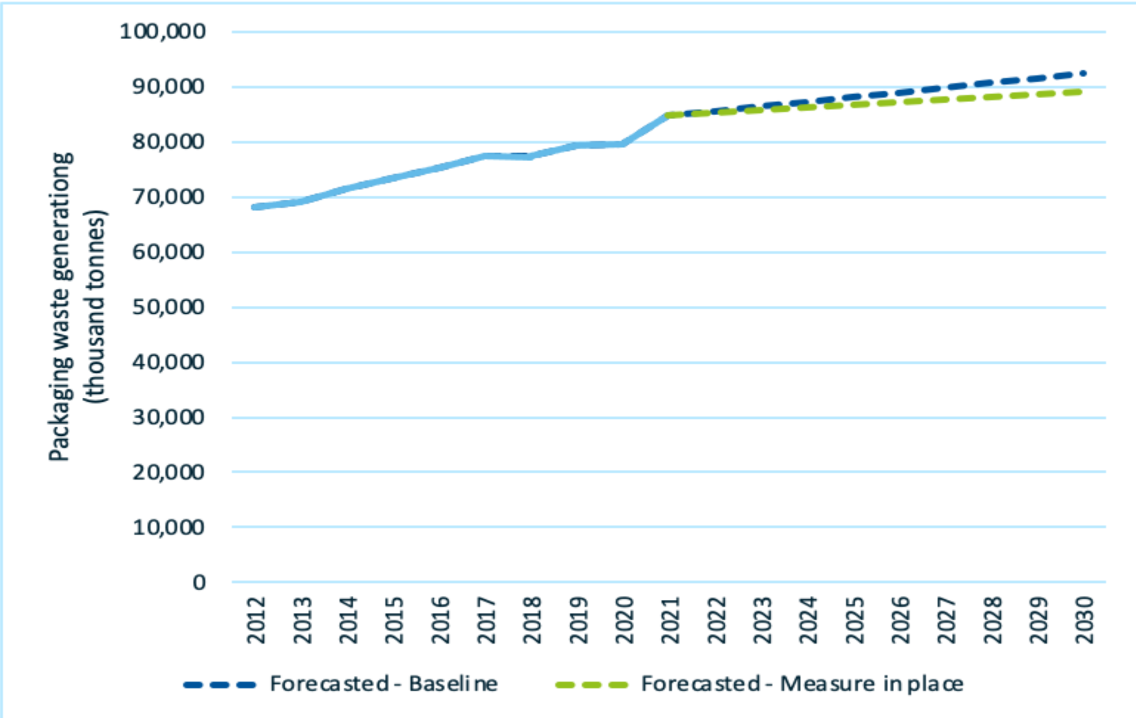


Figure 6-17: Past and forecasted levels of packaging waste generated with and without targets on reuse and refill in place in the food and beverage and the commercial and industrial sectors



End of Life Vehicles Directive 2000/53/EC

The proposed changes to the ELVs Directive propose a new target that each type-approved vehicle shall contain a minimum of 25% of plastic recycled by weight. There is currently no target date. Compared to the baseline level, this target would increase the demand for recycled plastics by 505 ktonnes in 2030 and 713 ktonnes in 2035. The baseline in 2030 is 92 ktonnes and 123 ktonnes in 2035 and assumes that the target of 25% for newly type-approved vehicles starts in 2030[216].

Ecodesign for Sustainable Products Regulation (EU) 2024/1781

The Ecodesign for Sustainable Products Regulation (ESPR) has sought to strengthen the application of the Ecodesign framework through stronger enforcement and market surveillance measures to help lower product non-compliance. The scope of the ESPR extends far beyond energy-related products: under the ESPR framework, ecodesign requirements can be set for virtually all physical products placed on the EU market (with some exceptions, like food or medicinal products). Product groups that will be considered for regulation first will be announced in advance in the multiannual working plan, to be adopted by 19 April 2025. A preliminary list of products which the Commission will be obliged to consider for inclusion in the first working plan has been included in Article 18(3) ESPR, but the Commission has the possibility to depart from the list, by adding or not selecting some of the products listed (with an appropriate justification for these changes). In the anticipation of the working plan, work on textiles has already started based on the commitments made in the Textiles Strategy, with a view to adopting a delegated act by the end of 2026 and ecodesign requirements applying from 2028 (18 months from its entry into force in accordance with Article 4(4) ESPR). Clothes constitute a relatively frequently bought consumer products. It is also the product category most frequently bought online. At the same time, the non-compliance figures are estimated to be higher in the area of online sales, based on studies carried out for the Commission as well as figures reported by stakeholders. Furthermore, online sales are expected to continue to grow in the coming years. It can therefore be concluded that, given the broad scope of the ESPR, including more frequently bought consumer products, and the upward trajectory for the number and value of online sales, the non-compliance gap in the area of ecodesign is likely to increase in the period until 2030.

6.6 Lessons learnt and recommendations

The circular economy and waste legislation sets various quantitative and qualitative targets across a wide range of waste streams. Member States regularly collect data for these quantitative targets, which are subsequently published by Eurostat, enabling the assessment of a Member State's progress in meeting the respective targets. The circular economy and waste legislation has evolved since 2019 and continues to undergo changes. New polices have been adopted or proposed that modify existing targets or introduce new targets, including targets for new waste streams. As a result, limited data is available for certain targets and waste streams, therefore creating challenges and limitations in assessing the implementation gap and costs of non-implementation. The impact assessments for the newly adopted or proposed legislation, however, do provide insights on the economic and environmental impacts of the various policy measures.

Several of these newly adopted and proposed policies and amendments address problems with data collection, such as changes to the calculation method for municipal waste prepared for re-use in the WFKD, or address problems with circumvention of legislative requirements and illegal activities, like the New Waste Shipment Regulation. As more data becomes available over time, a more refined and accurate assessment of the costs associated with non-implementation will be possible.

The recent proposals to the Waste Framework, Packaging and Packaging Waste and ELV Directives will also have considerable impacts on the future implementation gaps and costs of non-implementation in the future. Waste streams targeted in the WFKD and Packaging and Packaging Waste Directives are major contributors to waste generation, and the proposed future measures will have a substantial impact on reducing waste generation and increasing re-use and recycling. These proposed measures and targets will therefore aid in the EU's transition to a more circular economy and further minimise the economic and environmental costs associated with waste disposal.

[216] https://eur-lex.europa.eu/resource.html?uri=cellar:9d368e81-215c-11ee-94cb-01aa75ed71a1.0001.02/DOC_3&format=PDF

7. Chemicals

- The European Union has established a comprehensive chemicals acquis which seeks to protect human health and the environment, whilst enhancing the competitiveness of the EU chemical industry. Multiple pieces of legislation focus on managing risks from chemicals in specific sectors, product types and spheres (i.e. occupational, consumer, professional). The focus of this assessment is on: Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (or 'CLP') including its 2024 update (EU 2024/2865), and Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (or 'REACH'). Registration, Evaluation, Authorisation and Restriction are the four main processes in the REACH regulation - the focus of this assessment is the Authorisation and Restriction processes as these are the most data rich regarding potential costs and benefits and have a major influence on human health and environmental exposure to chemicals.
- Overall, the CLP Regulation was considered effective in a 2019 fitness check with many aspects of its implementation operating efficiently, but some implementation challenges were identified. A revised CLP regulation has been in force since December 2024. This would be expected to address any substantive implementation gaps, but operation of the new arrangements should be monitored carefully.
- The REACH regulation does not have specific environmental protection or improvement targets, although its primary objective is to "ensure a high level of protection of human health and the environment". This requires a different – qualitative - assessment than other chapters in this study. Overall, the regulation is working as intended and has delivered significant benefits, but some elements and processes are not working as efficiently as they could, including the Authorisation process. The efficiency and speed of the process has proved more resource intensive – and slower – than anticipated prior to implementation for several reasons, potentially creating a gap in the level of protection for human health and the environment. It should be noted that the Ombudsman has pointed to the systematic lack of diligent action from the Commission on applications for authorisations after those received scientific opinions of the ECHA Committees.
- The number of REACH Restrictions adopted has not met original, albeit overly optimistic, expectations but there has been a shift in the nature of Restrictions toward groups of substances with multiple uses, with a corresponding increase in human health and environmental benefits anticipated. The current PFAS Restriction process is ongoing and absorbing significant resources to prepare opinions and finalise however, further empirical research should examine actual ex post benefits of adopted Restrictions.
- A quantitative estimate of any implementation gap cost has not been possible for chemicals given that the REACH regulation does not have specific environmental protection or improvement targets.
- Benefit realisation requires effective enforcement of the Regulation by national authorities. Evidence suggests an enforcement implementation gap, with trends improving in Member States but worsening in others.
- Looking forward, a proposed targeted revision to REACH is expected in 2025. Such revisions may encompass changes to several processes. Collectively these changes have the potential to accelerate the rate at which benefits are realised, perhaps significantly.

7.1 EU environmental policy and law

The European Union has established a comprehensive chemicals acquis which seeks to protect human health and the environment, whilst enhancing the competitiveness of the EU chemical industry. In total, 41 pieces of legislation in the EU focus on managing risks from chemicals from specific sectors, product types and settings (i.e. occupational, consumer and professional exposure). There is substantial evidence that this body of legislation has delivered significant benefits to human health and the environment.[217] A summary of the wider policy context as well as further detail on several significant pieces of legislation are covered in Appendix 2.

The *scope* of the current assessment is deliberately designed to be consistent with a previous study (COWI et al. (2019)). As such – as in that study – the present study focuses on two pieces of legislation only as they are the two main pieces of horizontal chemicals legislation:

- Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures ("CLP Regulation, or CLP") alongside the subsequent revision (EU 2024/2865); and
- Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals ('REACH').

The *approach* taken to the assessment however differs somewhat to COWI et al. (2019). The conclusion from the 2019 study was, given there were no explicit environmental targets, the implementation gap was zero. This update has sought to present a more nuanced assessment, reflecting greater evidence that is now available. However, any conclusions on an "implementation gap" in this section should not be interpreted to apply to chemical legislation more generally. The approach here focuses on two important pieces of legislation, but which are a part of a more complex system of legislation which itself has been subject to an extensive Fitness Check[218] evaluation. Both CLP and REACH impart duties not just for the European Commission and the European Chemicals Agency (ECHA) but for Member States, not least in enforcement. But ultimately, it is the duty of industry to comply with the legal requirements.

CLP Regulation

CLP aims to guarantee free movement of chemical products in the single market and beyond while ensuring that their hazards are clearly communicated through supply chains, and in particular to workers and consumers. It aligns the EU legislative framework with the UN Globally Harmonized System (GHS). The main goals of the CLP Regulation are to protect human health and the environment by defining and classifying the hazards of chemical products, and by informing users about these hazards through standard symbols and phrases on the packaging labels and safety data sheets.

The CLP Regulation requires manufacturers, importers, or downstream users of chemicals to classify, label, and package their hazardous chemicals appropriately before placing them on the market. This involves identifying the hazardous properties of chemicals, assigning them to a specific hazard class and category based on the nature and severity of the hazards they present, and communicating these hazards through labels and safety data sheets that include hazard pictograms, signal words, hazard statements, and precautionary statements.

The CLP Regulation is regularly updated to address evolving scientific and technical knowledge and adapt to technological advances. These amendments include updates to the criteria for classifying substances and mixtures according to their health, environmental, or physical hazards; revisions to the hazard communication elements such as the label requirements; and the introduction of new hazard classes and categories (most recently human health and environmental endocrine disruption; persistence, bioaccumulation and toxicity (PBT) and strong persistence and bioaccumulation (vPvB); persistence, mobility and toxicity (PMT) and strong persistence and mobility (vPvM)).

[217] See for example a 2017 Study on the cumulative health and environmental benefits of chemical legislation (CuBA) https://op.europa.eu/en/publication-detail/-/publication/b43d720c-9db0-11e7-b92d-01aa75ed71a1/language-en and the Fitness check of the most relevant chemicals legislation (excluding REACH) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019SC0199

[218] https://commission.europa.eu/publications/fitness-check-most-relevant-chemical-legislation-excluding-reach_en

REACH Regulation

Adopted in 2006, REACH seeks to "ensure a high level of protection of human health and the environment, including the promotion of alternative methods for assessment of hazards of substances, as well as the free circulation of substances on the internal market while enhancing competitiveness and innovation". It involves several interlocking processes each of which support achievement of its objectives, administered by the European Chemicals Agency (ECHA):

- **Registration**: all manufacturers and importers of substances (either on its own or in a mixture) in quantities of one tonne per year or more are required to submit a registration to ECHA. The registration process operates on the principle of 'one substance, one registration', meaning that manufacturers and importers of the same substance must submit a joint registration.

- **Evaluation**: includes two processes: Dossier evaluation: ECHA conducts checks of registration dossiers submitted by industry to ensure they include all the information required; and Substance Evaluation: Member States evaluate substances that have been identified with specific concerns. Substance evaluation is coordinated via the Community rolling action plan (CoRAP), which prioritises substances for evaluation over a three-year period on the basis of risk-based criteria.

- **Authorisation**: EU Member States or ECHA can propose substances for identification as Substances of Very High Concern (SVHC). Following approval by ECHA's Member State Committee (MSC), the substance is added to the Candidate List of SVHCs. Candidate List substances can in turn be recommended for inclusion on the Authorisation List (REACH Appendix XIV). Once on the Authorisation List, the substance must not be placed on the market or used after a "sunset date", provided in Appendix XIV, unless an Authorisation is granted. Companies wishing to continue using the substance must apply for an Authorisation to do so. These applications for Authorisation must contain several technical documents, listed in Articles 62 (4 and 5) and 63 of the Regulation.

- **Restriction**: Member States or ECHA (at the request of the European Commission) can prepare Restriction dossiers for substances, which are submitted to ECHA. Following review by the Committees for Risk Assessment (RAC) and Socio-Economic Analysis (SEAC), and decision by the European Commission a Restriction can be adopted, and the restricted substance is added to Appendix XVII of REACH. In certain circumstances, for carcinogenic, mutagenic or reprotoxic (CMR) substances, the Commission can propose a Restriction directly. Once restricted, a substance must not be manufactured, placed on the market, and/or used, unless the conditions specific to that Restriction are met.

The ***key difference*** between the authorisation and the restriction processes is that the primary objective of restrictions is to address an unacceptable risk from the manufacture, placing on the market or use of a substance by placing specific conditions or preventing some or all uses. In contrast approved authorisation decisions allow temporarily the continuation of their use, under some conditions. As such, the implications of speed of decision making for restrictions are different to those from a slow authorisation decision making, in terms of human health and environmental protection.

7.2 Environmental target

Contrary to other assessments in this report, there are no explicit environmental targets in either piece of legislation. Their objectives instead relate to broad qualitative outcomes[219]. Moreover, the mechanisms through which the legislation works, the types of environment or human health risk addressed, the severity of that risk and

[219] For example, to achieve a *"high level of protection of human health and the environment…"*. via minimising or removing chemical exposure to a range of harmful substances …including the promotion of alternative methods for assessment of hazards of substances, as well as the free circulation of substances on the internal market while enhancing competitiveness and innovation. Article 1 of the REACH Regulation (No 1907/2006).

the route(s) of exposure differ depending on the legislation, substance and use in question. This complicates any assessment of an implementation gap. However, since the 2019 study was prepared several documents have been published which evaluate the two pieces of legislation concerned in detail. These are extremely detailed and are not repeated fully here[220] [221], although a brief recap on some of key issues of relevance to both pieces of legislation are drawn out below.

CLP Regulation

The CLP Regulation plays a key role in hazard classification and communication and hence has a direct link to various other pieces of chemical legislation which trigger controls as a result of the classification. A 2019 European Commission Staff Working Document (SWD) drawing together conclusions from the fitness check of chemicals legislation (excluding REACH)[222] concluded the CLP Regulation is effective and that many aspects of its implementation were operating efficiently. Indeed, it was identified as one of the most efficient aspects of the functioning of the EU chemicals legislative framework, which had not created a disproportionate administrative burden for public authorities. But despite this, the review did identity several areas where implementation challenges have been identified, discussed further below.

REACH Regulation

REACH has made a significant contribution to reducing and avoiding negative effects on human health and the environment from exposure to harmful chemicals[223], but the 2018 REACH review[224] concluded elements of the Regulation are not working as efficiently as they could. Some of the most significant implementation challenges have centred on the Authorisation process. Whilst it has achieved significant benefits, the 2018 REACH review[225] found that the Authorisation process is too slow and administratively burdensome, with complex procedures that require significant resources, for both companies and authorities. A recent publication by the European Ombudsman[226] indicated it takes the Commission on average 14.5 months to prepare draft decisions, although the statutory deadline for doing so is three months[227]. In certain specific complex cases, it has taken several years. NGOs have also raised concerns about the speed of decision making and the corresponding risks to human health and the environment related to EU chemicals legislation more broadly (including CLP), not just REACH or the authorisation process alone [228].

There are a variety of reasons for the apparent discrepancy between the statutory deadline and time taken in practice. First, the inclusion of a relatively small number of substances in Annex XIV, namely some Cr(VI) and

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[220] These include the Commission Staff working document (SWD), Fitness Check of the most relevant chemicals legislation (excluding REACH eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019SC0199R(01) This draws together findings on various pieces of legislation, which includes CLP.

[221] The Commission General Report on the operation of REACH and review of certain elements. Conclusions and Actions {SWD (2018) 58 final https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0116 This is one of several documents drawing together various findings from the second fitness check of REACH referred to as the "second REACH review".

[222] Commission Staff working document (SWD), Fitness Check of the most relevant chemicals legislation (excluding REACH) eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019SC0199R(01)

[223] See for example: https://op.europa.eu/en/publication-detail/-/publication/b43d720c-9db0-11e7-b92d-01aa75ed71a1/language-en

[224] The 2018 REACH Review concluded that REACH is effective, but that there are opportunities for further improvement, simplification, and burden reduction. In its conclusions, the review identified a number of actions to improve the implementation of REACH, including on Authorisation and Restriction. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:116:FIN

[225] ibid

[226] https://www.ombudsman.europa.eu/en/news-document/en/194266

[227] Note that as part of the REACH revision the Commission intends to extend this deadline given experience indicates, in practice, this has not been achievable.

[228] Need-for-speed_Online_Final.pdf (eeb.org); Socio-economic impacts of REACH Authorisations, A meta-analysis of the state of play of applications for Authorisation, ECHA 2021, Socioeconomic impacts of REACH Authorisations (europa.eu)

OPE/NPE, resulted in a significantly greater number of applications than expected[229]. As a result, authority workloads were substantially greater than expected. Second, in some cases the data provided by applicants on uses, exposure and alternatives was scarce or unspecific or the use was described in too broad terms. This has been particularly the case for so-called "upstream applications", submitted by actors upstream in the supply chain on behalf of their downstream users. These cases have made authority decisions on whether the conditions for granting an Authorisation were met challenging. Third, court cases have been necessary to clarify the implementation of the legal requirements for granting Authorisations, in particular with regard to the analysis of alternatives, the suitability of alternatives and the representativeness of exposure data[230], which have added further delay. Fourth, the numerous substitution profiles covered under one broadly described use led, in certain applications, to the authorisation process impeding substitution for some actors (including SMEs) and have made effective, efficient and timely regulatory decision-making difficult and resource intensive[231].

Collectively, these issues have absorbed significant resources and have materially affected timescales for decision making. This has also affected predictability and investment certainty for industry, potentially affecting investments and speed of transition to safer alternatives. It has also resulted in opportunity costs for ECHA, Member States, European Commission and industry that cannot be used for other investments or regulatory risk management decision-making, not least Restrictions which are estimated to deliver significant human health and environmental benefits once adopted[232].

A proposal for a revision of REACH to update the regulation to new scientific evidence and address observed challenges is planned. Whilst a formal proposal has not yet been published[233] options could be implemented by the European Commission from 2025[234]. Several changes were originally announced in the Chemicals Strategy for Sustainability (CSS – see Appendix 2). These may include potential reforms to the Restriction process – notably extending the so called "generic approach to risk management" to additional types of chemical hazards – as well as potential reforms to the Authorisation process.[235] Even in the absence of a formal proposal, since the publication of the CSS substantial work has been undertaken on several actions announced in it[236]. Other, new initiatives are under development and discussion[237].

The CSS notes several objectives for the REACH revision (and for reforms to chemicals legislation more generally). These include supporting innovation for safe and sustainable chemicals; strengthening protection of human

[229] https://echa.europa.eu/received-applications

230 See for example European Parliament versus the European Commission on chromium trioxide https://curia.europa.eu/juris/document/document.jsf?text=&docid=272682&pageIndex=0&doclang=EN&mode=req&dir=&occ=first&part=1&cid=951432 and Sweden versus the European Commission on lead chromates (Case T-837-16). https://curia.europa.eu/juris/liste.jsf?language=en&num=C-389/19%20P

[231] See for example the background paper for the second workshop on substituting targeted hazardous chemicals https://single-market-economy.ec.europa.eu/events/second-workshop-substituting-targeted-hazardous-chemicals-2024-10-01_en

[232]https://echa.europa.eu/documents/10162/17228/costs_benefits_reach_Restrictions_2020_en.pdf

[233] A hearing for the Commissioner designate in November 2024, noted she expected a revision proposal in 2025. https://multimedia.europarl.europa.eu/en/webstreaming/confirmation-hearing-of-jessika-roswall-commissioner-designate-environment-water-resilience-and-comp_20241105-1830-COMMITTEE-CONFIRMATION-HEARING-A

[234] https://multimedia.europarl.europa.eu/en/webstreaming/confirmation-hearing-of-jessika-roswall-commissioner-designate-environment-water-resilience-and-comp_20241105-1830-COMMITTEE-CONFIRMATION-HEARING-A

[235] https://circabc.europa.eu/ui/group/8ee3c69a-bccb-4f22-89ca-277e35de7c63/library/dd074f3d-0cc9-4df2-b056-dabcacfc99b6/details?download=true

[236] For instance guiding criteria and principles for what would constitute 'essential uses' of the most harmful chemicals was published in April 2024 https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2151

[237] For instance, the concept of "substitution planning". See 2024 background paper for first workshop for substitution of targeted hazardous chemicals study: https://www.environmentalpolicyandeconomics.com/getattachment/News/January-2024/Workshop-for-substitution-of-targeted-hazardous-ch/Working-Paper-Substitution-Planning_Final.pdf.aspx?lang=en-GB

health and the environment; and to simplify and strengthen the legal framework on chemicals[238]. Each specific reform contained within the wider REACH revision has more granular objectives. The specific reforms to Authorisation, for example, centre on potential options to simplify the process, to increase regulatory efficiency and minimise the associated draw on authority and industry resources. This in turn was intended to increase the speed of regulatory decision making. Given the significant benefits associated with such regulatory decisions (whether Authorisation or Restrictions), overall, this is intended to support higher levels of environmental and human health protection over time.

Approach to assessment and interpretation

The implementation gap is assessed by taking a simple approach as a snapshot to illustrate several complex underlying issues. These in turn potentially create a gap in the level of protection for human health and the environment with respect to hazardous substances, between what has been possible under the current system and what was sought when the regulation was introduced. Left unaddressed this apparent implementation gap may continue. The assessment examines three indicators:

- First, challenges in the implementation of CLP are qualitatively examined and revisions to the regulation are identified which seek to address these.
- Second, when REACH was implemented, it was originally expected that some of its various processes, particularly Authorisation would be less complex and resource intensive. Hence it was assumed more decisions on both Authorisation and Restriction would have been possible. Various planning documents published by both the European Commission and ECHA at the time and since, set out those expectations. These are compared with outturn numbers[239]. The number of Substance of Very High Concern (SVHCs) identified are also compared to estimates.
- Third, apparent gaps in Member State enforcement identified in the second REACH review are highlighted and associated risk of non-compliance which ultimately is the duty of industry.

7.3 Implementation gap

7.3.1 Analysis

CLP Regulation

At the time of the 2019 SWD[240] , CLP did not at the time include harmonised classification for several important end points (e.g. Persistent, Bio-accumulative and Toxic (PBT), very Persistent and very Bio-accumulative (vPvB), endocrine disruption (ED)). Several other challenges were observed, associated with the pace and focus of harmonised classifications, inconsistencies in industry self-classifications, classification of mixtures and with enforcement[241]. Taking each in turn:

- The number of assessments of harmonised classification (CLH) were lower than expected by ECHA, raising concerns that potentially hazardous chemicals are not addressed as such. This was attributed to capacity constraints, particularly within Member States but also considerable variation between

[238] https://circabc.europa.eu/ui/group/8ee3c69a-bccb-4f22-89ca-277e35de7c63/library/dd074f3d-0cc9-4df2-b056-dabcacfc99b6/details?download=true Page 4. Note following elections in 2024 a new Commission (2024-2029) was instigated. Hearings for Commissioner-designates are ongoing hence the focus and detail of priorities may change somewhat.
[239] We recognise that these two processes draw on earlier ones, not least REACH Registration and Evaluation, for example.
[240] Commission Staff working document (SWD), Fitness Check of the most relevant chemicals legislation (excluding REACH) eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019SC0199R(01)
[241] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019SC0199R(01) Page 48.

Member States in the resources allocated. The study does note there is no quantified objective for the number of such assessment or classifications.

- There are often multiple self-classifications by industry for the same substance, alongside concerns over the reliability and consistency of some of these.
- Issues with mixture classification were raised by some stakeholders (such as those metallic alloys receiving classifications that do not match their real hazard properties).
- The study noted enforcement challenges, given the scope of the regulation. The review noted differences in administrative organisation of Member States and of the frequency of controls and inspections.
- Other issues identified include labels which may be overloaded with information making it difficult for consumers to focus on the essential information, challenges in Safety Data Sheet (SDS) compliance, including for SMEs.

The 2020 Chemicals Strategy for Sustainability (CSS) included a proposal for a revision of CLP to address these challenges and to include new hazard classes. This was introduced in 2022[242]. The revised Regulation provides via delegated act to add definitions and technical criteria for ED, PBT, vPvB, persistent, mobile and toxic ('PMT'), or very persistent and very mobile ('vPvM') properties to be classified into established hazard classes. These came into force in 2023[243]. It also included measures to support clarity on labelling (including digital labelling) and increase compliance particularly via online sales, which was identified as a key challenge. Several measures were also included to speed up the pace at which hazardous substances are identified[244].

The updated CLP regulation (EU 2024/2865) came into force in December 10 2024[245]. Alongside thew new hazard classes, for example, it clarifies rules for classification of mixtures and highlights the role of grouping in harmonised classification to aid efficiency of the process. It also contains new rules and procedures regarding clearer labelling of hazardous chemicals (including the use of digital labels). ECHA advised companies to assess and review their portfolio and inform ECHA about any new classifications, by updating their REACH registration dossier or CLP notification[246]. Dates of applicability for the new rules are phased in, but obligations generally apply from 1 July 2026, with some exceptions. For example, new rules on chemicals label formatting apply from 1 January 2027[247].

REACH Regulation (Authorisation process)

Within the REACH Authorisation process there are numerous steps, from a substance first being identified as a SVHC, to inclusion in the Authorisation (or 'Candidate') List, companies applying to continue using a SVHC for specific uses, the development of opinions by ECHA and the subsequent decision by the European Commission. If approved, applicants may continue using the substance in relevant uses (with time limits and risk management measures/controls in place), pending substitution/phasing out of the substance applied for or submission of a review report for a further Authorisation (i.e. longer use).

The identification of SVHCs, addition to the Candidate List and the Authorisation process result in various identified benefits. For example, some harmful substances are removed from the market, or their uses are

[242] https://environment.ec.europa.eu/publications/proposal-clp-revision_en
[243] https://echa.europa.eu/new-hazard-classes-2023
[244] https://environment.ec.europa.eu/document/download/13dc2e9b-15b2-47cb-bf97-fd7af56a13d9_en?filename=Proposal%20for%20a%20Regulation%20amending%20Regulation%20%28EC%29%20No%2012722008.pdf
[245] https://eur-lex.europa.eu/eli/reg/2024/2865/oj
[246] https://echa.europa.eu/-/revised-rules-for-classification-labelling-and-packaging-enter-into-force?utm_campaign=5cfdec6599bdab0001a52896&utm_content=67583ad2f8035e00015f74b7&utm_medium=smarpshare&utm_source=linkedin
[247] https://environment.ec.europa.eu/news/revised-chemical-labelling-regulation-enters-force-2024-12-10_en

ceased (i.e. no Authorisation application is submitted). For other listed substances, evidence shows that the production and use volumes have decreased (c. 49%) and the Authorisation process itself increases and improves the risk management measures (RMMs) in place to protect workers, users and consumers[248].

In 2001, the Commission estimated that around 1,400 SVHCs (5% of registered substances)[249] may need to be curbed through the Authorisation regime, although no time limit was given[250]. In the 2013 roadmap on SVHCs[251], the Commission sought to have all currently known SVHCs included in the Candidate List by 2020. Once a substance is identified as an SVHC, it is included in the Candidate List. The inclusion in the Candidate List brings immediate obligations for suppliers of the substance, including: supplying a safety data sheet, communicating on safe use, responding to consumer requests within 45 days and notifying ECHA if the article they produce contains an SVHC in quantities above one tonne per producer/importer per year and if the substance is present in those articles above a concentration of 0.1% (w/w).

By 2017, all substances deemed relevant were either: included in the Candidate List for Authorisation; identified for other regulatory risk management measures (e.g. Restriction); or considered to not currently require further regulatory risk management. As such, the total number of substances and groups of substances included in the Candidate List was far less than the 1,400 expected. Between 2008 and 2021 the number of substances on the list reached 233 (an average of 18 substances annually)[252]. Currently, the number of substances listed is 242[253] which suggests that the number added annually has slowed. Overall, this is 1,158 less than the estimated 1,400 SVHCs to be curbed through Authorisation process. ECHA also note that more SVHCs are expected to be identified in the future amongst substances that did not at the point of initial review have adequate information to be able to conclude on their hazard properties[254]. These outstanding substances therefore represent the potential future regulatory workload where regulators are aware of or may have concerns about these substances but have not yet initiated specific regulatory processes to consider the risks and address their use, where relevant.

A publication by the EEB[255] states that the overall Authorisation process (from registry of intention of an SVHC identification to Commission decision for Applications for Authorisation) has been found to take some **six years and two months in the shortest case, while the median time is nine years and three months, and the longest duration has been 13 years and six months**. The same study noted the average duration between submission of the application for Authorisation by the applicant(s) and decision by the European Commission is **around 58 months (4 years and 10 months)**.

This contrasts slightly with data provided by ECHA and the Commission that the Authorisation application process (from the point of submission of the application to the adoption of the decision) can take around **25 months to "over 41 months"**[256]. The average time between the submission of an application for Authorisation to

[248] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. Final Report. Unpublished.
[249] Commission of the European Communities. White Paper Strategy for a future Chemicals Policy. COM(2001) 88 final. Brussels, 27.2.2001. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0088:FIN:EN:PDF
[250] https://eeb.org/need-for-speed-on-chemical-protections-in-europe/
[251] https://data.consilium.europa.eu/doc/document/ST-5867-2013-INIT/en/pdf
[252] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. *Final Report. Unpublished.*
[253] https://echa.europa.eu/candidate-list-table. As of November 2024.
[254] https://echa.europa.eu/documents/10162/1049086/svhc_roadmap_2020_achievements_en.pdf/ea2249db-bf03-a3ed-e3dd-42a2dcce05db
[255] https://eeb.org/need-for-speed-on-chemical-protections-in-europe/
[256] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. Final Report. *Unpublished*.

ECHA and delivery of the opinion to the European Commission for a decision is therefore **around 3 years**[257]. The average number of Authorisation applications processed per year was estimated in 2022 to be 31[258] but has been steadily increasing recently, with ca. 50 decisions taken in 2023 and ca. 90 in 2024[259].

The guideline timeline for this process is ~18 months[260] from a company applying for an Authorisation and paying a fee, to a draft decision being produced by the Commission (either refusing or granting Authorisation). Based on this information, the intended process **should take in between 1.5 and 2 years to complete compared to the current average rate of ~ 3 years**.

A 2022 study[261] examined the costs to different actors associated with the Authorisation process. This indicated, total costs of approximately €15.6 million to €22.4 million per year (2021 prices)[262] for all actors including Industry, European Commission, ECHA and Member States. The same source calculated that for authorities (COM, ECHA and MS) on average an application for Authorisation has been estimated to cost between €78,000 to €223,000[263].

Therefore, due to reasons discussed above, the **overall process is operating considerably more slowly than originally expected**. This means that the **benefits of Authorisation risk being delayed or lost.**

Table 7-1 summarises a series of per year values for aspects of the Authorisation however these steps have no numerical goals/targets set by the legislation, the Commission or ECHA. An implied objective or "target" has been derived for the purpose of this assessment, based on the information discussed above.

[257] https://www.environmentalpolicyandeconomics.com/getattachment/News/January-2024/Workshop-for-substitution-of-targeted-hazardous-ch/Working-Paper-Substitution-Planning_Final.pdf.aspx?lang=en-GB
[258] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. Final Report. *Unpublished*.
[259] Personal communication, DG ENV 07/11/24.
[260] Page 12 'Timeline for granting an Authorisation'. https://echa.europa.eu/documents/10162/13643/Authorisation_application_en.pdf/8f8fdb30-707b-4b2f-946f-f4405c64cdc7
[261] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. *Final Report. Unpublished.*
[262] These costs include the following steps in the Authorisation process: inclusion of a substance on the Candidate List; ECHA prioritisation of candidate substances and draft recommendation; MSC opinion-making; industry preparation of applications; RAC and SEAC opinions; Commission decision-making; and industry preparation of review reports.
[263] These costs include the following steps in the Authorisation process: consultation, opinion and decision making.

Table 7-1: Steps in the Authorisation process with associated targets and actual performance

Authorisation process steps	Expectation or objective	Actual
The average number of substances (SVHCs) added to the Candidate List per year	No numerical goal set in legislation, but implied objective – c. 80 substances per year (i.e. 1, 400 SVHCs over 17 years, from 2007 when REACH entered into force to 2024)	Average of 18 substances annually (*effec report, 2017*[264]) Average of 16 substances annually (*Need for speed report*[265])
The average number of substances added to the Authorisation list (Appendix XIV), per year[266]	No numerical objective/ goal set in legislation	Up until April 2021, 54 substances had been added to the Authorisation List in Appendix XIV (an average of 5 annually). [267]
Numbers of Authorisation decisions adopted, per year	No numerical objective set in legislation	Total applications processed per year = 31[268] Applications for authorisation received (per year; note that one application can contain multiple uses) = 24 Uses applied for Authorisation (per year) = 37 Total uses processed (per year; note that one application for authorisation can contain multiple uses) = 47[269]
Average time taken for Authorisation process (from a company applying for an Authorisation and paying a fee, to a draft decision being produced by the Commission)	A guideline of ~18 months from a company applying for an Authorisation and paying a fee, to a draft decision being produced by the Commission	~3 years
Approximate annual costs to authorities and industry from administering and decision making related to the Authorisation process	No numerical objective set in legislation	Approximately €15.6 million to €22.4 million per year (2021 prices) to Industry, European Commission, ECHA and Member States[270].

[264] https://op.europa.eu/publication-detail/-/publication/a7163b17-1139-11e8-9253-01aa75ed71a1
[265] Need-for-speed_Online_Final.pdf (eeb.org)). https://eeb.org/need-for-speed-on-chemical-protections-in-europe/
[266] REACH requires ECHA to recommend SVHCs for inclusion in Appendix XIV at least once every two years.
[267] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. Final Report. Unpublished.
[268] Note this number is larger than the number of applications received per year due to the processing of a backlog of applications from previous years.
[269] Ibid.
[270] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. *Final Report. Unpublished.*

REACH (Restriction)

Articles 68 and 69 of REACH outline the procedures for Restrictions on the use of substances that pose risks to human health or the environment. They each cover different approaches to imposing Restrictions on chemicals:

- Article 68(1) covers the standard Restriction procedure set out in Articles 69 to 73, which requires the preparation of an Appendix XV dossier to initiate the Restriction process, public consultation, opinions by RAC and SEAC and the consultation of the forum.
- Article 68(2) provides a simplified procedure which the Commission may use in relation to substances classified as carcinogenic, mutagenic or toxic for reproduction (CMR), categories 1A and 1B on their own, in mixtures or in articles that could be used by consumers.
- Article 69(2) also set out the process for preparing a Restriction dossier for a substance listed in Appendix XIV that is used in articles.

At the time of adoption of REACH, it was originally expected that Member States would prepare 11 Appendix XV dossiers for Restriction, per year. This assumed that better information in the registration dossiers, more information on the hazard properties of substances (e.g. through substance evaluation), the ability to target the risk assessment and strict deadlines would significantly increase both efficiency and the ability to identify substances needing Restrictions. This was an approximate prediction, not a target[271].

In a 2022 assessment, the EEB[272] identified 27 Restrictions under the Article 68(1) process where decisions had been taken over a 13-year period (i.e. 2.1 Restrictions on average per year). This is similar to 2022 estimates made in an as yet unpublished study prepared for the European Commission[273]. This indicated of the Article 68(1) Restriction dossiers prepared by ECHA and Member States, on average two were adopted annually. Article 68(2) has been used on fewer occasions, amounting to, on average, 1 Restriction per year[274] over the same period.

The Restrictions Roadmap under the CSS[275] outlines the number of Restrictions already on the Registry of Intentions[276], with a mandate provided to ECHA or with a Restriction dossier recently submitted. In 2022, there were five from ECHA at the Commission's request, one from ECHA itself under Article 69(2) and eight from Member States, adding up to 14 in total. It also lists planned Restrictions which are not yet on the Registry of Intentions for Restriction, of which there are eight, all from ECHA at the Commission's request[277] [278]. ECHA also

[271] https://commission.europa.eu/document/download/f4155fca-2ff3-43a0-9dfb-b21309280b50_en?filename=reach_eval_swd_2018_58_5.pdf
[272] Need-for-speed_Online_Final.pdf (eeb.org). https://eeb.org/need-for-speed-on-chemical-protections-in-europe/
[273] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. *Final Report. Unpublished.*
[274] Ibid. Article 68(2) Restrictions adopted in this time are those for PAHs in rubber and plastic articles, newly classified CMR substances and mixtures for supply to the general public and CMRs in textile articles (Note these included many substances via several amendments to entries 28-30 of Appendix XVII)
[275] Commission Staff Working Document – Restrictions Roadmap under the Chemicals Strategy for Sustainability, SWD (2022) 128 final, Appendix I
[276] See: https://echa.europa.eu/registry-of-Restriction-intentions Currently contains 65 entries (updated Sept 2024)
[277] Commission Staff Working Document – Restrictions Roadmap under the Chemicals Strategy for Sustainability, SWD (2022) 128 final, Appendix I
[278] The listing of a chemical in the Registry of Intentions has been shown to promote substitution activity and to support research and development for alternatives https://echa.europa.eu/documents/10162/13630/250118_substitution_strategy_en.pdf/bce91d57-9dfc-2a46-4afd-5998dbb88500

outline in their Programming Document (2022-2025[279]) the anticipated number of Restriction proposals 68(1) or reports developed under Article 68(2) that were expected in 2022 and 2023. These were reported to be 4 and 5 respectively. In total, 5 opinions have been adopted for Restrictions that were expected in 2022[280].

One Restriction is currently in opinion development that was originally expected in 2023. This is for Per- and polyfluoroalkyl substances (PFAS[281]) and is discussed in further detail here to illustrate some of the reasons why a simple focus on the number of Restrictions delivered could be misrepresentative. This Restriction is intended to target around 10,000 individual substances, encompassing many uses with the corresponding potential to capture widespread health and environmental benefits. As such, it has proved to be very complex and time consuming. The opinion-making process has extended many months beyond the envisaged legal deadlines and could be subject to further delay, for the Dossier Submitters and ECHA's committees to evaluate the large amounts of information submitted in the public consultation on the proposal[282]. Partly as a result, no Restrictions listed on the Registry of Intentions are expected in 2024, but three are expected in 2025. So, in purely quantitative terms, 9 Restrictions were expected over a two-year period and 5 were developed (with one - particularly complex - opinion for PFAS currently in development).

It is also useful to look at the resources ECHA currently has available to prepare Restrictions, alongside the number planned in their programming document. In 2023, it was estimated ECHA had resources to prepare 3-4 Restrictions per year (10-12 full-time equivalent staff members time per year)[283], although this depends on the number and complexity of substance uses in scope. In years where Member States submit more Restriction proposals, ECHA can prepare fewer Restriction proposals as available resources are allocated to the opinion making process. Similarly, resources may also need to be directed to processing Authorisation applications, as outlined above.

As with Authorisation, there is no specific target for the number of Restrictions to be adopted under REACH each year. Whilst the second REACH review noted outturn numbers of Restrictions had not matched expectations, the nature of proposed Restrictions has evolved over time. In broad terms there has a shift from Restrictions of single substances on very targeted uses, to include broader so called "grouped Restrictions" of families of substances on multiple sectors. An exemplar is the current Restriction on PFAS.

As outlined above, whilst complex and time consuming, once adopted Restrictions can deliver significant human health and environmental benefits. To give an idea of the scale of such benefits, a report by ECHA[284] based on a series of case studies suggests that restricting the use of hazardous chemicals under REACH could generate at least four times more benefits to society than their cost. The same report indicates that Restrictions have also been found to promote substitution and replacement with safer alternatives, improving risk management and stimulating innovation. The study acknowledged the trend toward Restrictions with greater scope and suggested – albeit from a low sample size – that the evidence suggested the cost benefit ratio had actually increased. However, it is often difficult to quantify the exact benefits of Restrictions on human health and (particularly) the environment due to limited ex post analysis of effects, limited information available on

[279] https://echa.europa.eu/documents/10162/11209549/mb_39_2021_pid_2022-2025_en.pdf#:~:text=ECHA's%20Restrictions%20work%20supports%20the%20Authorisation%20process,scope%20Restrictions%20(and%20the%20grouping%20work)%20will

[280] https://echa.europa.eu/de/registry-of-Restriction-intentions/-/dislist/details/0b0236e18663449b

[281] The opinion-making process of the 'universal' PFAS Restriction has been extended many months beyond the envisaged legal deadlines and could be subject to further delays. The delay is in order for the Dossier Submitters and ECHA's committees to evaluate the large amounts of information submitted in the public consultation on the proposal.

[282] https://echa.europa.eu/registry-of-Restriction-intentions/-/dislist/details/0b0236e18663449b

[283] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. Final Report. Unpublished

[284] https://echa.europa.eu/documents/10162/17228/costs_benefits_reach_Restrictions_2020_en.pdf

exposure levels and populations and lack of established dose-response relationships. Hence the actual benefits could be much greater.

Overall, whilst the number of Restrictions adopted has not met expectations in quantitative terms, there has been a shift in the nature of Restrictions toward more complex Restrictions on groups of substances in multiple uses, with larger benefit potential. The current PFAs Restriction is particularly complex and ambitious seeking to address up to 10,000 substances. It has taken longer than expected and is absorbing substantial authority and industry resources and the process has not yet been concluded. Once adopted it has the potential to deliver significant human health and environmental benefits and will enable authorities to address Restrictions listed on the Registry of Intentions.

Enforcement gap

Enforcement of REACH is the responsibility of Member States. Each is required to establish its own enforcement authorities and mechanisms to ensure compliance. In the second REACH review, an implementation gap was identified specifically in the context of Member State enforcement. The European Commission concluded that the "average level of REACH compliance reported by the Member States and ECHA" has varied from 79% to 89% from 2007 to 2014[285]. Particular concerns were identified with control of imports and supply chain obligations (e.g. 52% non-compliance for safety data sheets)"[286].

A 2021 publication by the Commission on enforcement indicators[287] tallies with the above numbers reported in 2018 and states that REACH compliance between 2007-2019 has varied between 76% and 87%. However, the minimum level of compliance reported by some Member States has fallen from around 50% (from 2010-2015) to <10% (in 2018 and 2019). This suggests that there is a notable gap in implementation of enforcement in some Member States, with enforcement in some improving and in others worsening. The implications of this possible implementation gap cannot be quantified but would affect – perhaps significantly – the assumed benefits realised by the REACH Regulation (discussed further in the gap costs section).

7.3.2 Limitations and uncertainties of the analysis

The focus of this analysis is the CLP and REACH regulations as two of the key pieces of legislation controlling chemical exposure. Limiting the scope does however mean that substances being controlled or managed by other pieces of legislation or through other mechanisms are not captured in this analysis. This could therefore mean that the implementation gap presented is distorted whereas chemical exposure can take place through a variety of sources and environmental compartments.

Other key limitations are explained in the analysis above. They, include - for REACH - that there are no set quantitative targets to track implementation against. Moreover, initial estimates made at the time of adoption regarding time taken to undertake key processes Authorisation no longer seen to be realistic based on practical experience.

[285] The average level of compliance is calculated annually as the median value of the average levels of compliance reported by Member States. The average level of compliance experienced at Member State levels take into account all controls carried out to REACH duties holders specific year.
[286] See section 5.9 of the 2018 European Commission Staff Working Document on the operation of REACH https://eur-lex.europa.eu/resource.html?uri=cellar:2834985c-2083-11e8-ac73-01aa75ed71a1.0001.02/DOC_1&format=PDF This evidence is indeed somewhat dated, but more recent information is available.
[287] https://op.europa.eu/publication-detail/-/publication/e5c3e461-0f85-11ec-9151-01aa75ed71a1

7.4 Implementation gap cost

7.4.1 Analysis

The preceding sections of this chapter discuss the achievements of the REACH regime and whether these processes have been operating as originally intended, and if not, the reasons why. There are no quantitative targets in the REACH regulation, therefore within this section, we qualitatively discuss the benefits of both Restriction and Authorisation processes to contextualise the scale of benefits over time that are potentially missed if implementation is not as intended.

In terms of Authorisation, the analysis presented in this report suggests that the number of substances being reviewed and identified as SVHCs is behind anticipated levels. Identifying and listing SVHCs ensures that the risks associated with these substances are properly managed, reducing potential harm to human health and the environment and encouraging substitution. Overall, approximately 1,000 additional substances were expected to be curbed through the Authorisation process by this stage, although this target was derived based on percentage assumptions of all substances originally registered through REACH. These outstanding substances therefore represent the potential future regulatory workload where regulators have concerns about the risk of these substances to human health and the environment, yet this is impossible to quantify given the uncertainty over the number of substances that may need to be regulated at the risks posed in each case.

The Authorisation process is noted as being resource intensive, but no target exists on number, timescales for decision making or costs of the processes itself, only that all applications are processed. Therefore, any simple quantification of an implementation gap based on these factors is problematic. The preceding section has focussed on the speed and cost of the process (compared to original expectations and ECHA guidelines) to give a broad idea of whether it is functioning as intended. The process is considerably slower than originally expected (due to reasons discussed above) meaning that the use of SVHCs could be better controlled and exposure risks mitigated or minimised where continued use of a substance is judged appropriate.

Therefore, if the Authorisation process could be revised to be less burdensome and faster, without compromising the rigour of decision-making, exposure to SVHCs could be reduced and additional human health and environmental benefits realised. Unburdening the Authorisation process may mean authority resources (staff time) could be used instead for preparing more Restrictions, for example. ECHA invests, on average, 2-3 full time equivalents to prepare one Restriction report which implies a cost of about €300,000 to prepare one EU wide Restriction dossier[288]. For authorities, applications for Authorisations have been estimated to cost between €78,000 to €223,000 each[289] depending on the complexity of the application so those applications at the lower end of the scale cost ~€145,000 less to process than those more complicated applications. So, in very simple hypothetical terms, for every two additional Authorisations at the lower end of the costs scale, a saving of €290,000 could be made[290]. Again, for illustration, this is broadly equivalent to the resources required for c. 3-4 Authorisations or a further Restriction proposal.

This is significant given the benefits that may be realised on a case-by-case basis from the processes:

- In terms of **Authorisation** the available evidence differs based on each step in the process. For example, there is evidence that the inclusion of hexavalent chromium compounds in the Candidate List in late

[288] https://echa.europa.eu/documents/10162/17228/costs_benefits_reach_restrictions_2020_en.pdf/a96dafc1-42bc-cb8c-8960-60af21808e2e?t=1613386316829

[289] Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH Authorisation and Restriction. Final Report. Unpublished

[290] Note there a several factors behind the differences in resource costs between the lower and the higher end of the range. For example, it may be due to the complexity of the specific case, the nature of the application (e.g. upstream vs downstream, single vs multiple uses, adequate control vs socio-economic routes). The potential REACH revision may encompass changes to several processes which could potentially support increased efficiency in decision making, without affecting quality and rigour.

2010 and the subsequent promotion to Appendix XIV in mid-2013 led companies to invest in additional risk management measures, leading to a steady decline in exposure levels at workplaces (Vincent et al. 2015[291]).

- Other studies estimated minimum benefits of listing Chromium VI and Trichloroethylene in the Authorisation list (Appendix XIV) from avoided cancer cases at €591 million to 1.7 billion and €118 to 430 million respectively for the period 2010-2069[292].

- Several further benefits have been reported as a result of the wider Authorisation application, opinion and decision-making process. Whilst there are challenges and uncertainties, analysis conducted as part of the REACH review estimated that the benefits in terms of avoided costs to industry (and opportunity costs to society) arising from the continued use of the substance were between €32 million and €38 million per applicant, per use[293] (in 2021 prices). The overall societal benefit of continued use of carcinogenic and reprotoxic SVHCs prohibited or restricted under REACH was estimated to be around €8.7 billion annually[294], with monetised health and/or environmental risks (where these can be quantified) related to continued use of SVHCs in the order of €0.5 billion per year.

- A study into the impacts of the REACH Authorisation process in 2017[295] highlighted that the Authorisation process enhances the substitution of SVHCs with safer alternatives where it is economically and technically feasible to do so. Analysis conducted as part of the GRA and Authorisation and Restriction reform impact assessment study[296] indicated that trends in volumes placed on the market for uses subject to Authorisation showed significant decreases. Specifically, volumes are estimated to have approximately halved between 2010 and 2021; a reduction of approximately 6% per year. There is also evidence that the process itself has resulted in improved risk management measures adopted by companies, and an associated substantial reduction in the exposure of workers to hazardous chemicals[297].

- In terms of **REACH Restrictions**, the costs and benefits vary on a case-by-case basis. Each Restriction contains an estimate of the likely benefits to human health and the environment if the use of a substance becomes restricted under certain conditions. In 2021, ECHA published a study examining the

291 Vincent R. et al. (2015). Occupational exposure to chrome VI compounds in French companies: results of a national campaign to measure exposure (2010–2013). Annals of Occupational Hygiene, 59(1), 41-51.
292 Ibid
293 Note this reflects the fact that authorisation applications are approved when using the so called "socio-economic route" where the applicants analysis shows that the socio-economic benefits of continued use outweigh the risks. European Commission (2018). Commission Staff Working Document: COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE Commission General Report on the operation of REACH and review of certain elements. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A116%3AFIN
294 ECHA (2021). Socio-economic impacts of REACH Authorisations: A meta-analysis of the state of play of applications for authorization. https://echa.europa.eu/documents/10162/17229/socioeconomic_impact_reach_Authorisations_en.pdf/12a126f2-9267-1dcd-75e3-ce0f072918e4?t=1619782167012
295 Eftec et al., (2017). Impacts of REACH Authorisation. https://op.europa.eu/en/publication-detail/-/publication/a7163b17-1139-11e8-9253-01aa75ed71a1/language-en/format-PDF
296 VVA, RPA Europe, Okopol, Logika Group, and Ineris (2023). Study to support the impact assessment for potential amendments of the REACH Regulation to extend the use of the Generic Risk Management Approach to further hazard classes and uses, and to reform REACH authorization and Restriction: Final Report (unpublished)
297 ECHA (2021). Socio-economic impacts of REACH Authorisations: A meta-analysis of the state of play of applications for authorization. https://echa.europa.eu/documents/10162/17229/socioeconomic_impact_reach_Authorisations_en.pdf/12a126f2-9267-1dcd-75e3-ce0f072918e4?t=1619782167012

costs and benefits of 12 REACH Restrictions proposed between 2016-2020[298] where benefits had been monetised. The Restrictions examined prevent adverse health effects such as cancer, sexual development disorders, sensitisation, and occupational asthma, with monetised health benefits estimated at **around €2.1 billion per year**. Of these 12 cases, the mean benefit per Restriction was €178.5 million and the median benefit per Restriction was €66 million[299].

- Restrictions also mitigate environmental and human health impacts by reducing emissions of harmful substances, with ECHA concluding that (based on the Restrictions covered in the study above) approximately 95,000 tonnes of emissions of substances of concern could be prevented annually. This leads to cleaner air, water, and food, benefiting both consumers and workers with positive health impacts or removed risk estimated for at least 7 million citizens[300]. Note these estimates are notably bigger than those in the 2018 REACH review[301] , which stated health benefits (of 9 Restrictions) of more than €380 million per year, a reduction of about 70 tonnes of releases of substances of concern, and positive health impacts or removed risk for thousands of consumers and workers.

7.4.2 Limitations and uncertainties of the analysis

It is challenging to estimate the impacts of Restrictions on human health and the environment as this varies by substance and there is a lack of information on exposure levels and exposed populations, and unknown dose-response relationships. In some cases, the predicted benefits can only be partially monetised and without specific targets this makes the quantification of costs challenging and inherently uncertain.

An ex-post evaluation to assess the actual costs versus realised benefits of Restrictions imposed under REACH has not been conducted, so accurately evaluating the impact on human health and the environment due to the unmet targets is complicated by insufficient data.

7.5 Forward looking assessment

In terms of CLP, **an updated CLP regulation is now in force which includes new classification and addresses observed problems with implementation. This would be expected to address any substantive implementation gap, but operation of the new arrangements should be monitored** and will be subject to Fitness Check review in due course, as per the original regulation.

REACH Authorisations are submitted at the initiative of industry as companies are applying for authorisations to continue using a substance. The objective for this process is that all applications received should be processed. That has been met and can be expected to continue in future. From a timescale perspective, the guideline is that decisions should take ~18 months from the date an applicant submits a file (a draft Authorisation decision should be provided to the REACH Committee within 3 months of the reception of RAC/SEAC opinions on the application). Current timescales for processing Authorisation applications are significantly longer than was originally intended (approximately twice as long). This is reflected in the resources allocated to administration and decision making by authorities. As outlined above, this reflects several underlying reasons, but the process – in particular applications for some specific uses – have proved to be resource intensive for both industry to prepare and authorities to process. **Whilst the number of Authorisation decisions has increased in 2023 (ca 50) and 2024 (ca 90), in the absence of a REACH revision and if the existing pace continues, by 2030 the number of Authorisation decisions taken on industry applications would be expected to remain significantly behind**

[298] https://echa.europa.eu/documents/10162/17228/costs_benefits_reach_restrictions_2020_en.pdf/a96dafc1-42bc-cb8c-8960-60af21808e2e?t=1613386316829
[299] These averages comprise a very wide range of costs, with the smallest benefit of €90,000 coming from the Restriction of TDFAs in spray products, and the largest benefit of €708 million coming from a Restriction of skin sensitising substances in textiles, leather, synthetic leather, hide and fur.
[300] Other benefits to the EU environment listed in the report include reduced emissions of toxic substances on 230,000 hectares of arable land and the avoidance of lead poisoning of about 700,000 water birds per year.
[301] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2018:58:FIN

originally anticipated levels. Moreover, the significant staffing resources allocated to this process would not then be available for other risk management and policymaking activities, unless additional resources were made available.

In contrast, REACH Restrictions are at the initiative of authorities. Existing data suggests that the number of Restrictions adopted has not met original, overly optimistic, expectations, but more recent expectations for Restriction have largely been met. Moreover, there has been a shift in the nature of Restrictions toward groups of substances with multiple uses with a corresponding increase in human health and environmental benefits anticipated. However, the current PFAS Restriction process is ongoing, absorbing significant resources to prepare opinions and finalise before any benefits are realised and authority resources can focus on further planned Restrictions or other activity. Forecasting any changes in implementation of enforcement in Member States is both challenging and uncertain, given that some are improving and others worsening and the reasons behind these patterns are largely unknown publicly. The enforcement gaps may persist to 2030 if not addressed. However, there are a series of Forum enforcement projects[302] ongoing or planned such as' SDS and checking the conformity with the requirements of the new Appendix II of REACH' and 'Enforcement of chemical products sold on-line' which are designed to harmonise enforcement in each Member State and check the current level of compliance with regard to particular obligations imposed on industry by the REACH and CLP regulations. The goal of the REACH-EN-FORCE projects is to improve the quality of enforcement in the Member States but also to improve the compliance of registrants with the REACH and CLP regulations, which should help address some of the implementation shortcomings discussed in the above section on 'enforcement gap'.

7.6 Lessons learnt and recommendations

The following bullet points cover some lessons learnt during the analysis of the implementation gap and associated cost for chemicals:

- **Authorisation**: Little is known publicly about the exact changes that may come about in the REACH revision. The initial expectations for several processes under REACH, were overly optimistic and challenges have been observed in implementation. To address these and to update the regulation, a revision of the REACH regulation was announced. This was subsequently delayed, now expected during 2025. This is expected to include potential changes to several elements which will include simplifying the Authorisation process, improving the clarity of requirements, and streamlining procedures to reduce administrative burdens and improve the predictability of regulatory actions. This may mean increases in efficiency in Authorisations (or even that it is reformed more fundamentally). It may also facilitate different uses of both processes in future (i.e. increased use of Restrictions in place of Authorisation). This could address the implementation gap discussed in this report.

- **More research into the empirical assessment of actual benefits of Restriction is required:** There is a need for more empirical research to assess the actual benefits of Restrictions imposed under REACH. The study published by ECHA is based on estimates made during the Restriction development process itself. This research should focus on further evaluating and quantifying the health and environmental benefits, costs and any unintended consequences of these.

- **Time is needed to see how CLP functions:** Revisions to the CLP Regulation have been adopted. Post-revision period monitoring will shed light on persisting barriers to implementation, such as the adequacy of labelling for downstream users, integration with complementary regulations (e.g., REACH), and the effectiveness of communication across the supply chain, before a more substantive fitness check evaluation in due course.

[302] https://echa.europa.eu/about-us/who-we-are/enforcement-forum/forum-enforcement-projects

8. Industrial Emissions and Major Accident Hazards

- Regulation of industrial emissions and major accident hazards centres around four key pieces of legalisation: the Industrial Emissions Directive (IED), Medium Combustion Plants Directive (MCP Directive), Mercury Regulation and Seveso III Directive. Our analysis focuses on the IED and Seveso to avoid double counting of effects and given the impacts of the MCP Directive will be more visible from 2025 onwards.
- Neither the IED nor Seveso set specific targets to be met. Instead, the IED requires installations to operate within activity thresholds specified in their permit (emission limit values), which in turn must be based on relevant BATC and AELs. Assessing the implementation gap with respect to the IED is challenging as this can be expressed in different ways, each difficult to assess. For this study the main analysis explores the difference between emissions under current conditions and under stricter permit requirements, hence the analysis does not strictly assess non-compliance but illustrates the benefits of greater ambition. The Seveso III Directive establishes requirements for the prevention and remediation of major accidents involving dangerous substances, which can be considered qualitatively.
- Several reports found that Member States mainly set emission limit values in the least stringent (i.e. upper end) of the BAT-AEL ranges, with 75-85% of all emission limit values being at (or above due to derogations) the upper end of the range. Derogations from AELs are allowed where costs would be disproportionate: evidence indicates that the number of derogations granted has increased over time, and they are most prominent in the glass, CLM and pulp and paper sectors. Setting emission limit values at the upper BAT-AEL range and derogations are both compliant with the Directive. That said, modelling studies show that additional emissions reductions (356 ktonnes of NOx, 261 ktonnes of SO_2 and 50 ktonnes of $PM_{2.5}$) could be saved in 2025 where limits were set at a more ambitious level (noting that this is not required by the IED). The cost of not achieving these additional potential benefits can be large, ranging from €27 to 98 billion/year in 2025, capturing human and environmental health impacts.
- With regard to Seveso-III Directive, summative reports and case studies highlight an implementation gap where a small but significant number of installations did not have an external emergency plan (EEP), with many more not showing evidence of testing and review. Furthermore, major accidents continue to occur, with recent reports recording 42 industrial incidents over the period 2022 to 2023. Such accidents can have significant associated costs, in terms of human health (fatalities and casualties), damage to buildings, etc.
- Looking forward, the emissions gap between the upper and lower end of the AEL range would grow to 2030. That said, the IED 2.0 contains new provisions which require permits to be set at the strictest achievable level, and as such this gap should be expected to reduce.

8.1 EU environmental policy and law

Regulation of industrial emissions and major accident hazards centres around four key pieces of legalisation:

- ***Directive 2010/75/EU on Industrial Emissions (IED)***[303]: Emissions to air, land and water from industrial sources are primarily regulated in the EU by the IED. As such, the IED is the focus of the analysis in this policy area as it captures the main environmental impacts of industry in the EU and is described in further detail in the next section. In 2024, the Commission adopted Directive (EU) 2024/1785 amending Directive 2010/75/EU (also known as 'IED 2.0'). The revised IED requires that competent authorities set emission limit values at the strictest achievable level for specific installations, as well as other new requirements including binding quantitative resource efficiency requirements (BAT-AEPLs) and keeping of a chemicals inventory of hazardous substances within Environmental Management Systems (EMS).

[303] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02010L0075-20110106

- Directive 2015/2193/EU on the limitation of emissions of certain pollutants into the air from ***Medium Combustion Plants (MCP Directive)***[304] requires operators to take preventive action to meet emission limit values set for SO_2, NOx and dust to air from MCP. Presently, emission limit values apply to new plants and will be applied to existing plants between 5-50MW from January 2025, and existing plants of 1-5MW by January 2030, with compliance reporting occurring one year after implementation. Recent analysis of Member State reporting under the MCP Directive[305] found that the majority of MCPs in the EU fall into the category of 'existing' (more than 95% of total numbers) and have therefore not yet had to achieve compliance with the emission limit values in the Directive. Furthermore, there is a lack of data on implementation for new MCPs which prevents analysis of any potential non-implementation.

- The ***Mercury*** regulation establishes measures and conditions concerning the use, storage of and trade in mercury, mercury compounds and mixtures of mercury, and the manufacture, use of and trade in mercury-added products, and the management of mercury waste, to ensure a high level of protection of human health and the environment. In terms of implementation, the IED and permit conditions remain key to regulating mercury industrial emissions and as such the mercury regulation is not appraised separately in this study.

- ***Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances (Seveso III Directive)***[306]: establishes requirements for the prevention and remediation of major accidents involving dangerous substances. Among other things, the Seveso Directive requires operators to report dangerous substances on site and maintain a major accident prevention policy and emergency plan. The Directive aims to prevent major accidents.

8.2 Environmental target

The IED requires that all installations operating above certain activity thresholds in specified industrial activities do so in compliance with a permit issued by the competent authorities. Permit conditions must be based on the relevant Best Available Techniques (BAT) conclusions (BATC). The BATC are adopted as a standalone legal document. BATC can contain BAT-Associated Emission Limits (referred to as BAT-AELs – a numerical range of emission levels) and where applicable, permit conditions shall include emission limit values (emission limit values) which have been set in range of BAT-AELs. Permits must be updated, and the operator must achieve compliance within four years following the adoption of the BATC.

Installation operators may apply for a derogation from specific BAT-AELs, where they can demonstrate that achieving the BAT-AELs would lead to disproportionately higher costs compared to the environmental benefits owing to the geographic location, local environmental conditions, or technical characteristics of the installation.

The Seveso III Directive establishes requirements for the prevention and remediation of major accidents involving dangerous substances. Among other things, the Seveso Directive requires operators to report dangerous substances on site and maintain a major accident prevention policy and external emergency plan (EEP). The Directive aims to prevent major accidents. The Seveso III Directive however lacks limit values or targets against which success might be measured in a relatively straightforward manner, hence a qualitative and case study-based approach is taken to exploring the implementation gap.

[304] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L2193
[305] Analysis and assessment of Member State reports on CO emissions from Medium Combustion Plants - Service Request 9 under European Commission Framework FRA/C.4/ENV/2019/OP/0018
[306] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0018

8.3 Implementation gap

8.3.1 Analysis

Industrial Emissions Directive

Assessing the implementation gap with respect to the IED is challenging as this can be expressed in different ways, each difficult to assess. For example, there may be an implementation gap where permit writers do not update permits to reflect BATC or set emission limit values in the BAT-AEL range – however this would require a detailed review of multiple installation permits, and separate studies that have reviewed a selection do not indicate that this is an issue (these are summarised below). A further example may be where installations are emitting pollutants not in line with their permit, which again requires a comparison at installation level. For this study, instead the analysis assesses several aspects: emission limit values set in permits, derogations and modelling studies comparing emissions scenarios. Hence the analysis explores the difference between emissions from installations under current conditions and under stricter permit requirements. Setting emission limit values at the upper end of the BAT-AEL range and derogations are compliant with the Directive. Hence the analysis does not strictly assess non-compliance but instead explores what benefits could have been captured through greater ambition.

Emission limit values set in permits

Although not related to non-implementation, it is informative to look at emission limit values expressed in permits relative to the BAT-AEL range to assess the level of implementation of the Directive with regards to effectiveness and stringency. Several studies have explored this with varying coverage of sectors and Member States:

- In COWI et al. (2019), to analyse the implementation gap a review of permits for one sector (cement production) across seven Member States found that 58% of emission limit values were set at the upper-BAT level (although this was only presented as an example due to the small number of countries and permits assessed).
- Eunomia (2019)[307] looked at 117 permits for cement installations and 24 electric arc furnaces and found that 79% set emission limit values in line with the upper-BAT AEL
- The study "Assessment of the permits of ex-TNP plants"[308] assessed the permits of LCP plants after expiry of transitional national plans but before the coming into effect of the LCP BATC. This found that a large number of permits exceeded the BAT-AEL ranges for NOx, SO_2 and dust.
- The study "Assessment of BAT Conclusion Implementation in IED permits"[309] assessed 271 permits in 3 sectors and found that for the glass, wood-based panels, non-ferrous metals, and production of pulp, paper and board sectors, most emission limit values are set at the upper BAT-AEL range.
- The earlier evaluation of the IED[310] also found that the majority of emission limit values are set at the upper end of the range.

Drawing on the above studies, the 2022 impact assessment on the proposal for the revision of the IED[311] found that Member States mainly set emission limit values in the least stringent (i.e. upper end) of the BAT-AEL ranges, with analysis showing that between 75-85% of all emission limit values are at (or above due to derogations) the upper end of the range.

307 Not published
308 Not published
309 Not published
310 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1913-Industrial-emissions-evaluating-the-EU-rules_en
311 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022SC0111&qid=1710420235405

Additionally, divergent Member State approaches to measurement uncertainty and compliance assessment lead to differences in EU-wide compliance and therefore actual emission levels. This can lead to a variation of up to 25% even where permits set emission limit values at the same level.

Modelled emissions

A second means to consider the implementation gap for the IED is through consideration of studies which have sought to model emissions from the industry sector. A key recent study was undertaken by IIASA et al (2023)[312]. This utilised the GAINS model to estimate emissions to air of key pollutants from IED sectors for several scenarios from 2020 to 2050. For this study, the analysis has not revisited reviews of individual permits already conducted under previous work. Instead, it utilised outputs of this more recent work to assess the impacts of potential foregone benefits from the setting of emission limit values in permits at the upper end of the BAT-AEL range (this is also of particular interest as a result of the focus of the revised IED requiring emission limit values to be set at the strictest achievable level). The modelling assessed the following scenarios of note for this work:

- The GAINS **baseline** scenario considers uptake of emissions abatement measures based on current legislation. It incorporates data on implementation of different emission controls from consultation with Member State experts undertaken over several studies, including work on the NEC Directive, UNECE Air Convention Gothenburg Protocol, and Clean Air Outlooks. As such, it assumes that most IED installations are performing at the upper BAT-AEL level, albeit with some Member States requiring lower levels for some installations / sectors. It also takes into account application of current derogations, for example Article 15(4) derogations.

- The **Maximum Technically Feasible Reduction (MTFR)** scenario assumes implementation of all feasible emissions control options while taking into account sector, technology and region-specific application constraints. As such, it is indicative of the maximum level of emissions abatement that could have been achieved if Member States had set emission limit values at the lowest achievable level.

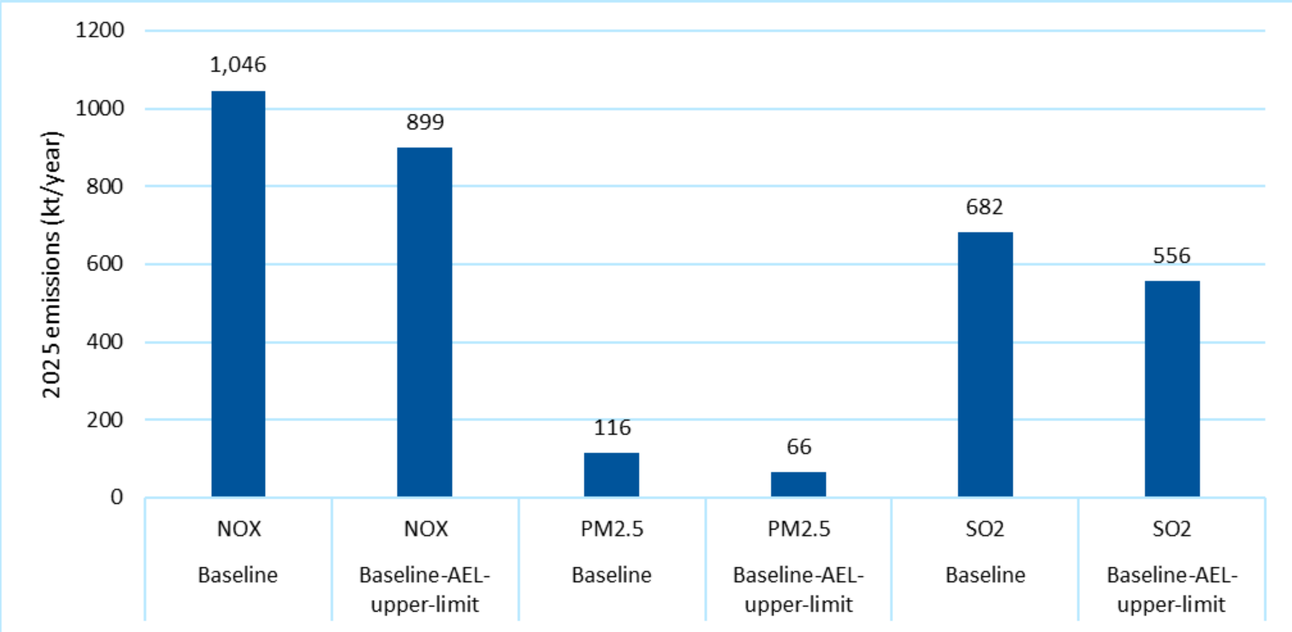
- The **Baseline-AEL upper limit scenario** was a sensitivity scenario based on the baseline, but with sectors with emissions higher than upper BAT brought down to upper-BAT levels (i.e. removing the impacts of any derogations being applied). This scenario includes also installations emitting below the upper BAT-AEL in the baseline, and which are kept at their baseline emission level - as such emissions from all installations are not associated purely with the upper BAT-AEL. $PM_{2.5}$ emissions are most affected by this sensitivity, and according to the report, differences are greater in non-combustion industrial activities, i.e. not LCPs/energy generation.

Comparison of 2025 modelling of the baseline scenario in GAINS with the Baseline-AEL upper limit scenario is shown in Figure 8-1 for NOx, $PM_{2.5}$ and SO_2. This shows the additional emissions that have taken place as a result of current implementation, compared with if all emission limits had been set at the upper BAT-AEL (for those sectors not already achieving at or below this level). In other words, this forces any plants emitting at concentrations over the BAT-AEL to be in line with the BAT-AEL.

In 2025, emissions in the baseline were 14% higher for NOx, 43% for $PM_{2.5}$, and 18% for SO_2 compared with the Baseline-AEL-upper-limit scenario. This includes the impact of derogations, but as the baseline also includes sectors that have achieved emission levels lower than the upper BAT-AEL range, it is not possible to equate the difference to derogations exactly.

[312] "Analysis of air pollutant emission trends for EU energy intensive industry sectors" - Specific Contract N° 090202/2022/881035/SFRA/ENV.C.4 under Framework contract FRA/C.3/ ENV/2021/OP/0017

Figure 8-1: 2025 Comparison of GAINS baseline (current implementation) and Baseline-AEL upper limit scenario



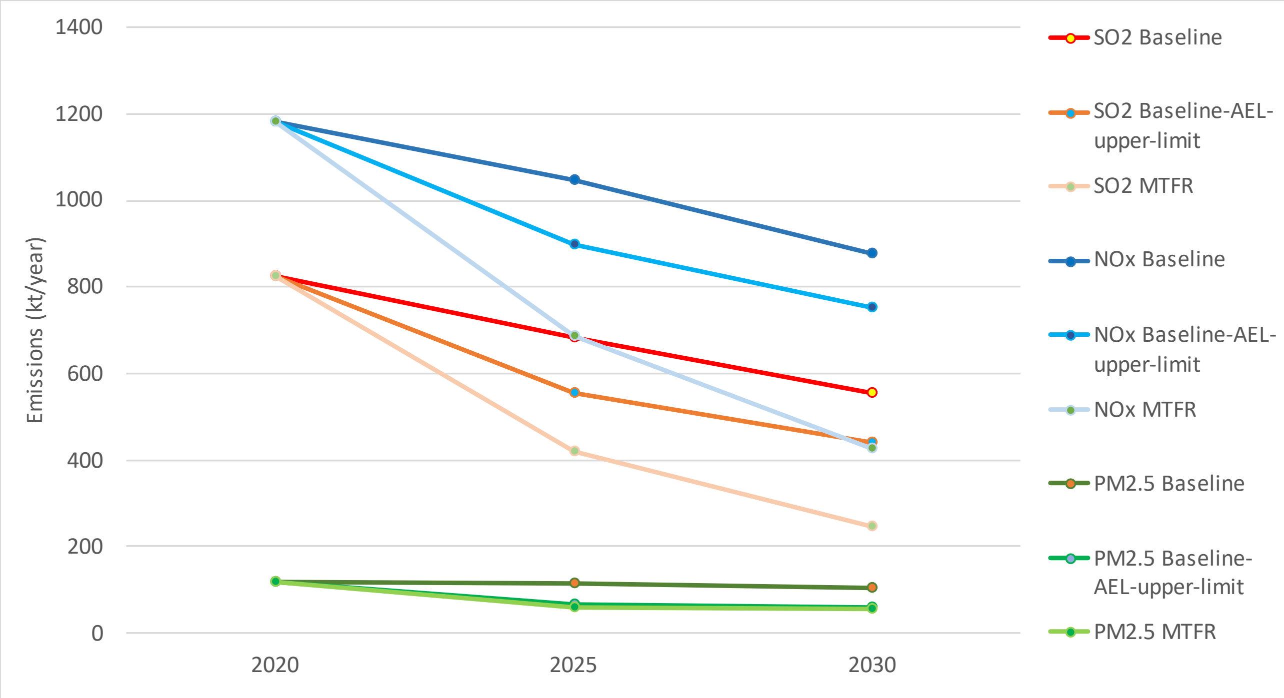
The MTFR scenario has been modelled only for 2030 (and beyond in 5-year increments to 2050). Hence detailed consideration of this scenario is presented in the forward-looking analysis, comparing the current trajectory of implementation in 2030, including with disaggregation by IED sector and Member State.

For 2025, the present study has made an interpolation between the 2020 baseline and 2030 MTFR scenario to estimate an illustrative 2025 MTFR scenario for comparison with the 2025 baseline. This interpolation is based on the step change in emissions observed in the 'Baseline-AEL-upper-limit' scenario in 2025 relative to the baseline in 2020. Based on this scenario:

- For NOx, there is an additional 356 kt/year emitted in the 2025 baseline compared with the MTFR scenario,
- For SO_2 there are 261 additional kt/year emitted in the baseline vs MTFR, and
- For $PM_{2.5}$ there are 55 additional kt/year emitted in the baseline vs MTFR.

This illustrative estimation shows that with current implementation (as modelled by the baseline scenario) there have been significant emissions benefits foregone by the setting of most permit limits for emissions to air at the upper end of the BAT-AEL ranges.

Figure 8-2: Comparison of Baseline and MTFR emissions for IED sectors, EU-27 totals. 2025 MTFR numbers represent an interpolation between the 2020 baseline and 2030 MTFR emissions



Note: 2025 year is resulting from interpolation of baseline 2020 and MTFR 2030 scenarios, based on the trend in emissions under baseline-upper-BAT scenario

Impact of Article 15(4) derogations

Article 15(4) of the IED allows competent authorities to set less strict emission limit values in permits where achieving BAT-AELs would lead to disproportionately higher costs compared to the environmental benefits. Although no data is available comprehensively mapping all derogations granted, several studies have explored this for specific sectors or Member States:

- A 2018 study[313] found that 75 out of 105 derogation requests were granted, with the highest number of requests being in the glass (40), cement, lime and magnesium oxide (CLM) manufacturing (30) and iron and steel (15) sectors.
- More recent analysis was conducted for the evaluation of the IED[314], which found that for the iron and steel and glass sectors, 15 Member States granted derogations for 82 installations out of 780 (i.e. just over 10% of installations).

In the 2021 report on implementation of the IED[315], it was found that 133 derogations were granted at 98 installations across 15 Member States. The largest number were granted by Sweden, the Czech Republic and Italy, with the manufacture of glass and the production of pulp, paper and board receiving the highest number. It found that more derogations have been granted for emissions to air than for emissions to water.

313 https://circabc.europa.eu/ui/group/06f33a94-9829-4eee-b187-21bb783a0fbf/library/e95a41c7-a4dd-4f58-9543-9693ba73e572?p=1&n=10&sort=modified_DESC
314 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1913-Industrial-emissions-evaluating-the-EU-rules_en
315 https://environment.ec.europa.eu/system/files/2021-12/implementation_report_IED_2013_2018.PDF

This analysis indicates that the number of derogations granted has increased over time, and are most prominent in the glass, CLM and pulp and paper sectors based on the existing literature.

Derogations result in delayed implementation of BATC and therefore foregone environmental benefits and are intended to be utilised when there would be disproportionately high costs to meet BAT-AELs. Comparison of the modelled upper-BAT-AEL baseline scenario (current implementation but with sectors with emissions above the upper BAT-AEL brought down to upper BAT-AELs) with the 2025 baseline gives some indication of the potential quantitative impacts of foregone benefits from the granting of derogations, as in most cases emissions above upper-BAT are the result of derogations (14% additional emissions for NOx, 43% for $PM_{2.5}$, and 18% for SO_2 in the 2025 baseline compared with the Baseline-AEL-upper-limit scenario).

Seveso-III Directive

The report on implementation of the Seveso-III Directive for the period 2015-2018[316] has been published and summarised Member State's implementation reports. It found that a total of 11,776 establishments fell in scope of the Directive in 2018, an increase of 479 from 2014. It also found some instances of non-implementation:

- While 4% of upper-tier establishments did not have an external emergency plan (EEP) due to invocation of Article 12(8) of the Directive i.e. assessment that an EEP is not necessary, a further 5% did not have an EEP indicating non-compliance. Note: in relation to this 5%, it has been noted in a communication by the European Commission that this may be an overestimate due to overlaps in reporting associated with article 12(8).
- It found non-compliance with respect to the Article 12(6) requirement to ensure EEPs are reviewed and tested, with 33% of EEPs not being tested (albeit with this being driven by a small number of non-compliant Member States).

The implementation report also analysed the number of major accidents. Between 2015 and 2018, there were 518 accidents registered in the eMARS database, of which 442 were identified as major accidents according to Appendix VI criteria of the Seveso-III Directive. Of these accidents, the most common sectors were chemicals manufacture (114 accidents) and refineries (105). Number of fatalities were also summarised, which included relatively high numbers in 2014 (25 fatalities), 2015 (18 fatalities) and 2016 (8 fatalities). Total fatalities for the reporting period 2015-2018 were 30, and for the period 2011-2014 there were 39.

In October 2024, the latest report assessing implementation reports for the period 2019-2022 was shared with the project team. It found a further small increase in the number of Seveso establishments (11,059 in the EU-27 compared with 10,836 for the EU-27). In terms of accidents for the period 2019-2022, it found that over half of major accidents were reported due to release of hazardous substances exceeding the threshold criteria. It also found 39 on-site fatalities and 22 incidents involving injury. 95% of upper-tier establishments had an external emergency plan.

In a presentation to the Seveso Expert Group[317], a more recent analysis of eMARS incidents was presented, with 42 incidents over two years (2022 and 2023), involving 21 deaths, more than 40 injuries, and greater than €2 million in property damage. Of these incidents, 7 were reported to be caused by a wrong procedure, 4 due to mechanical integrity failure, 4 from unexpected ignition, 4 from natural hazards, 3 from power failures and 3 due to process miscalculations.

8.3.2 Limitations and uncertainties of the analysis

The above analysis has a number of limitations and uncertainties. Firstly, in the case of analysis relating to non-implementation of the IED, there is a sole focus on emissions of selected pollutants to air. This is due to a lack of

[316] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0599
[317] https://circabc.europa.eu/ui/group/045e5d49-d835-4a1d-8cae-4b1ea23f8c80/library/09e8c3d7-7939-44bf-a9c6-c3c37f37a296?p=1&n=10&sort=modified_DESC

similar studies or data modelling emissions of water pollutants. Therefore, there are additional impacts of non-implementation on emissions to water, however it is not possible to quantify these due to lack of available information.

The modelling outputs of IIASA et al (2023) have been utilised to illustrate foregone benefits from current implementation. This therefore carries through assumptions, limitations and uncertainties involved in the modelling from the previous work. The MTFR scenario was used as the comparison against current implementation. This scenario represents the maximum technically feasible reduction and so is indicative of the maximum foregone benefits. In reality, while more strict limit values could have been set and achieved, it is unlikely that the full scale of reduction of the MTFR is possible to achieve as it represents the maximum of what is technically feasible, not considering financial constraints for example. For 2025 analysis, interpolation was used between the 2020 baseline and 2030 MTFR scenario, which includes the additional inherent assumption that there is a step-wise improvement in emissions from implementation of BAT between 2020 and 2030 similar to that observed under the baseline-upper-AEL scenario.

The impact of derogations is not possible to assess quantitatively in a rigorous manner due to lack of data on the number, scope and timescales of each one. As such, the scale of the impact of derogations has been assessed qualitatively, and an illustrative estimate of impacts has been presented based on wider air quality modelling.

8.4 Implementation gap cost

8.4.1 Analysis

Industrial Emissions Directive

Analysis focuses on the IED, considering the modelled emissions of different scenarios from the recent study undertaken by IIASA et al (2023)[318]. Two scenarios are considered relative to baseline emissions of NOx, $PM_{2.5}$ and SO_2 for industry:

- Baseline AEL-Upper 2025 and 2030, showing the cost of derogations permitting installations to emit above the BAT-ranges
- MTFR 2025 and MTFR 2030, showing the extra benefits that could have been achieved by now if emission limit values were set at the lowest achievable level.

As noted above, the analysis explores the difference between emissions from installations under current conditions and under stricter permit requirements. Hence the analysis does not strictly assess non-compliance, but instead explores what benefits could have been captured through greater ambition.

The method used is identical to that applied to assess the implementation gap cost under the NEC Directive (see section 2.4.1): the difference in emissions between scenarios is estimated and then multiplied by damage costs per tonne emission for each of the three pollutants based on estimates published by EEA (2023)[319], updated with new information on response functions and valuations in line with the positions adopted in CAO4[320]. Analysis accounts for chemical reactions transforming SO_2 and NOx into other pollutants that are harmful to health.

[318] "Analysis of air pollutant emission trends for EU energy intensive industry sectors" - Specific Contract N° 090202/2022/881035/SFRA/ENV.C.4 under Framework contract FRA/C.3/ ENV/2021/OP/0017

[319] EEA (2023) Estimating the external costs of industrial air pollution: Trends 2012-2021. Technical note on the methodology and additional results from the EEA briefing 24/2023. https://www.eea.europa.eu/publications/the-cost-to-health-and-the/technical-note_estimating-the-external-costs/view.

[320] IIASA (2025) Support to the Development of the Fourth Clean Air Outlook, under European Commission Framework FRA/C.3/ENV/2021/OP/0017. https://op.europa.eu/en/publication-detail/-/publication/4d746ab1-f7de-11ef-b7db-01aa75ed71a1/language-en

Impacts include both mortality and a variety of morbidity effects, drawing on recent research from WHO. Table 8-1 shows the total emission reduction across the EU27, relative to the baseline for each scenario and modelled year.

Table 8-1: EU27 total emission reduction relative to baseline under the scenarios investigated. Units: kt/year.

	NOx	$PM_{2.5}$	SO_2
AEL Upper 2025	147	50	126
AEL Upper 2030	128	45	115
MTFR 2025	356	55	261
MTFR 2030	454	51	311

The benefits for each of the three scenarios compared to baseline (current practice with emissions falling over time as shown in Figure 8-2) are shown in the following table (more detailed tables showing the gap cost by Member State are presented in Appendix 2). The columns represent alternative positions on quantification of health impacts. Columns headed 'VOLY' contain estimates where mortality is valued using the value of a life year, whilst those headed 'VSL' include mortality valued using the value of statistical life. For the CAO4 analysis impacts were grouped according to confidence ratings provided in earlier WHO reviews. Core estimates included effects in confidence bands 1 and 2 ('1&2 in the column headings). Sensitivity analysis brought in a third band ('123') that brought in impacts on dementia and diabetes. These were considered less robust than the results for impacts considering only confidence bands 1 and 2.

Results indicate substantial benefits across the three scenarios from reducing emissions to meet higher standards, with the following ranges at the EU27 level:

- AEL-Upper 2025, €15 to 56 billion/year
- AEL-Upper 2030, €13 to 49 billion/year
- MTFR 2025, €27 to 98 billion/year
- MTFR 2030, €30 to 112 billion/year.

Table 8-2: EU27 total emission changes relative to baseline under the 4 scenarios investigated. Units: € million/year.

	VOLY 1&2	VOLY 123	VSL 1&2	VSL 123
AEL Upper 2025	15,087	25,013	47,117	56,069
AEL Upper 2030	13,022	21,631	41,178	49,099
MTFR 2025	26,723	43,212	83,764	98,470
MTFR 2030	30,367	48,672	95,927	112,389

The share of the benefits across pollutants is as follows (Table 8-3). All three pollutants make a contribution in excess of 20% to all 4 scenarios. For the AEL Upper scenarios, $PM_{2.5}$ provides the highest share followed by SO_2 and then NOx. However this order is reversed for the MTFR scenarios. Table 8-4 then shows which countries have the greatest potential for emission reductions and associated benefits, with the 5 most populous Member States topping the list and accounting for about two thirds of the potential benefits.

Table 8-3: Benefits by pollutant for each scenario.

	AEL Upper 2025	AEL Upper 2030	MTFR 2025	MTFR 2030
NOx	27%	24%	38%	41%
$PM_{2.5}$	43%	43%	27%	22%
SO_2	30%	32%	35%	37%

Table 8-4: Benefits by country for each scenario.

	AEL Upper 2025	AEL Upper 2030	MTFR 2025	MTFR 2030
Germany	22%	12%	27%	24%
Italy	17%	21%	15%	15%
Spain	10%	14%	9%	10%
Poland	8%	4%	10%	9%
France	8%	8%	7%	7%
Portugal	7%	8%	5%	5%
Others	28%	33%	27%	30%

Seveso-III Directive

Case studies serve as an illustration of the potential impacts of Seveso-III provisions being improperly or not fully implemented:

- COWI et al. (2019) presented the case study of the 2001 ***Toulouse fertiliser incident***. This was an explosion in a storage hangar for ammonium nitrate, causing 29 deaths and thousands of wounded individuals, as well as damage to approximately 30,000 flats, 4,280 business premises, 29 high schools and 200 administrative buildings. With that said, COWI et al. (2019) did not assess the links with Seveso non-implementation associated with this accident.
- At the most recent Seveso Expert Group meeting[321], a further case study was presented of the ***Terpena accident*** of 2017, an upper-tier Seveso site. This incident involved a site for the manufacturing and processing of essential oils and derived products (used in the pharmaceutical industry), and involved an explosion followed by fire. This accident resulted in a hospitalised worker, destruction of site buildings, evacuation of 240 local people, and domino effect impacts including: disruption of electricity supply on a local railway, mechanical plant, and wastewater treatment plant. There was also discharge of pollutants to the Orăștie river causing visual pollution and small fish mortality and high temporary emissions of VOCs, SO_2 and particulates. Analysis of deficiencies leading to the disaster found insufficient staff training, inadequate equipment and preparation for fires, and insufficient procedures for emergency situations.

8.4.2 Limitations and uncertainties of the analysis

The following were considered to be the most important uncertainties associated with the quantification provided above:

[321] https://circabc.europa.eu/ui/group/045e5d49-d835-4a1d-8cae-4b1ea23f8c80/library/09e8c3d7-7939-44bf-a9c6-c3c37f37a296?p=2&n=10&sort=modified_DESC

- Quantification of the potential emission savings, which has had to draw on modelling work rather than more detailed appraisal of what is possible for industrial plant around Europe.
- Approach to valuation of mortality, which has been addressed through sensitivity analysis.
- Inclusion of impacts given a lower confidence rating in the EMAPEC study of WHO (dementia and diabetes), again addressed through sensitivity analysis.
- Analysis was restricted to the major air pollutants. The sources used for estimating emissions did not provide data on trace pollutants (e.g. toxic metals and dioxins). However, as shown in the COWI et al. (2019) report, these make only a small contribution to total damage from European industrial plant.
- No account was taken of discharges to water or land contamination,
- No account was taken of the Mercury Regulation or of the Seveso III Directive given a lack of data to support analysis.

Care must be taken when the estimates made here are presented alongside other estimates of the cost of inaction in this report, given that they deal with additional ambition rather than non-compliance.

The ranges given here are broad, roughly a factor 4 between the lowest and highest estimates. For the purposes of the present assessment, it is recommended to take the lower bound estimate for comparison with other sectors. This reflects a preference for valuation of mortality from air pollution using the VOLY amongst many European experts, and concerns over the reliability of the sensitivity function for dementia linked to $PM_{2.5}$. It is acknowledged that this is a conservative approach, for example in assigning a zero value to dementia and diabetes.

8.5 Forward looking assessment

Comparison of 2030 modelling from IIASA et al. (2023) of the baseline relative to the Baseline-AEL upper limit scenario illustrates the additional emissions that have taken place as a result of current implementation, compared with if all emission limits had been set at the upper BAT-AEL (for those sectors not already achieving at or below this level). As such, this broadly illustrates the impact of derogations.

In 2030, emissions in the baseline were:

- 17% higher for NOx, 74% higher for $PM_{2.5}$, and 26% higher for SO_2 compared with the Baseline-AEL-upper-limit scenario.
- 107% higher for NOx, 91% higher for $PM_{2.5}$, and 126% higher for SO_2 compared with the MTFR scenario.

Figure 8-3 and Figure 8-4 show the impact of lost emission reductions resulting from the current implementation trajectory (baseline scenario) in 2030 compared with the MTFR, by Member State and by sector respectively. When observing this difference by Member State:

- for SO_2 there are particularly large differences between the MTFR and baseline scenario in Cyprus (80%), Greece (80%), Italy (72%), Portugal (74%), Romania (73%) and Spain (73%). This indicates that on the current trajectory of implementation, the costs in these Member States from not implementing the maximum achievable BAT-AELs are the greatest. Member States with the lowest difference include Austria (13%), Denmark (26%), Hungary (30%) and Sweden (1%).
- For NOx, the largest differences between the baseline and MTFR is in Croatia (70%), Cyprus (71%), Luxemburg, (78%) and Spain (71%), with no Member States having less than a 30% difference.

- For $PM_{2.5}$, the largest differences between the baseline and MTFR is in Portugal (85%), Romania (73%) and Latvia (100%). Many Member States have less than a 30% difference between baseline and MTFR (Finland, Germany, Ireland, Luxemburg, the Netherlands, Slovakia and Sweden).

When considering sector level projections, the sectors with the largest difference in emissions between the baseline and MTFR scenario in 2030 are:

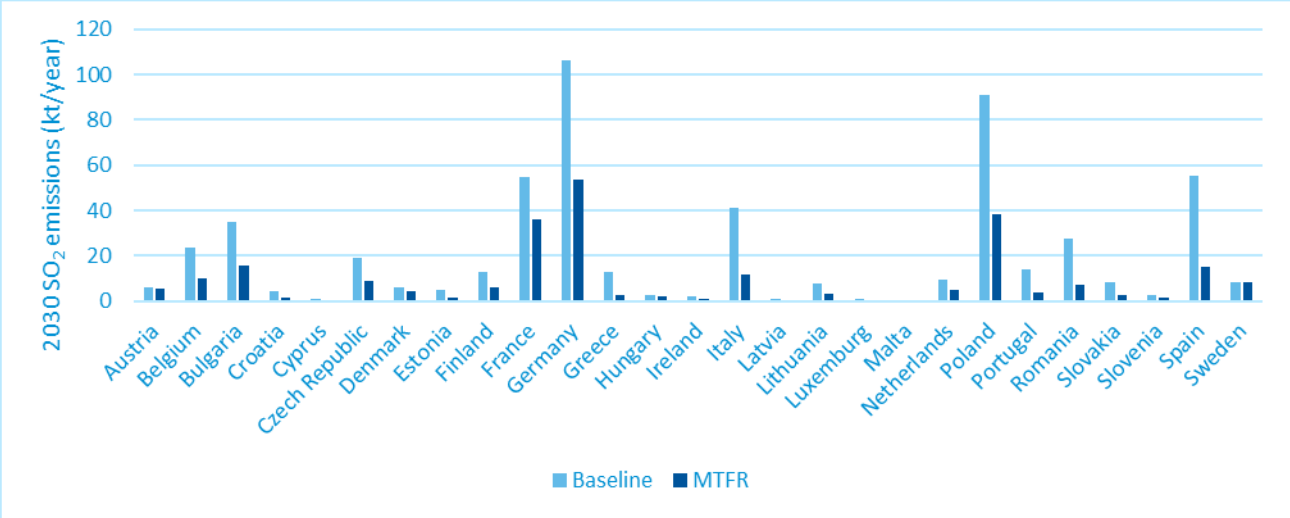
- the mineral industries (76% difference) and metal production (67% difference) sector for SO_2.
- For NOx this is also the case – 70% difference for mineral industries and 67% difference for metal production.
- For $PM_{2.5}$, the largest difference is the mineral industry sector (70%).

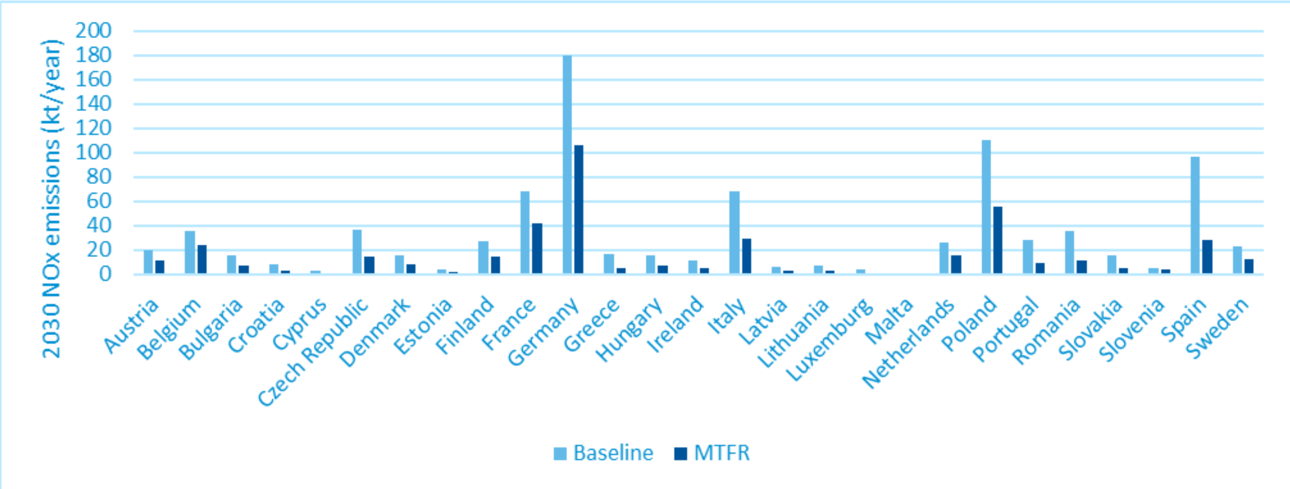
This analysis indicates that the current implementation of the IED and trajectory of implementation to 2030, where emission limits have been set mostly at the upper end of the BAT-AEL range, will lead to significantly higher emissions compared with the level of abatement that is technically feasible and within the BAT-AEL ranges.

Table 8-5: 2030 emissions (kt/year) of baseline scenario compared with MTFR

Pollutant	Baseline	MTFR	Difference
SO_2	556	246	311
NOx	879	425	454
PM2.5	106	56	51

Figure 8-3: 2030 comparison of GAINs baseline and MTFR emissions for all IED sectors, broken down by Member State





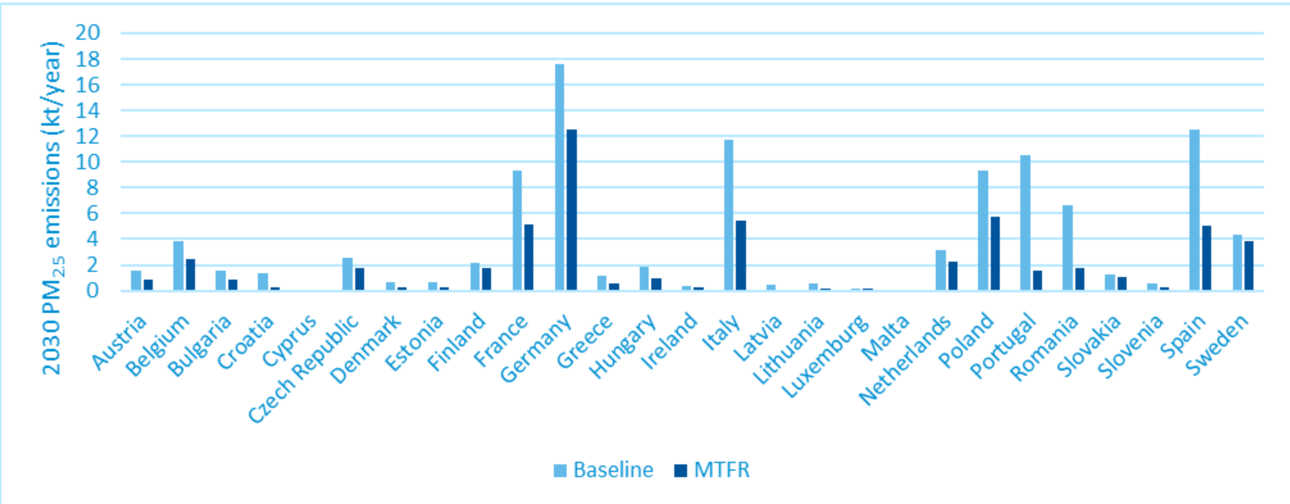
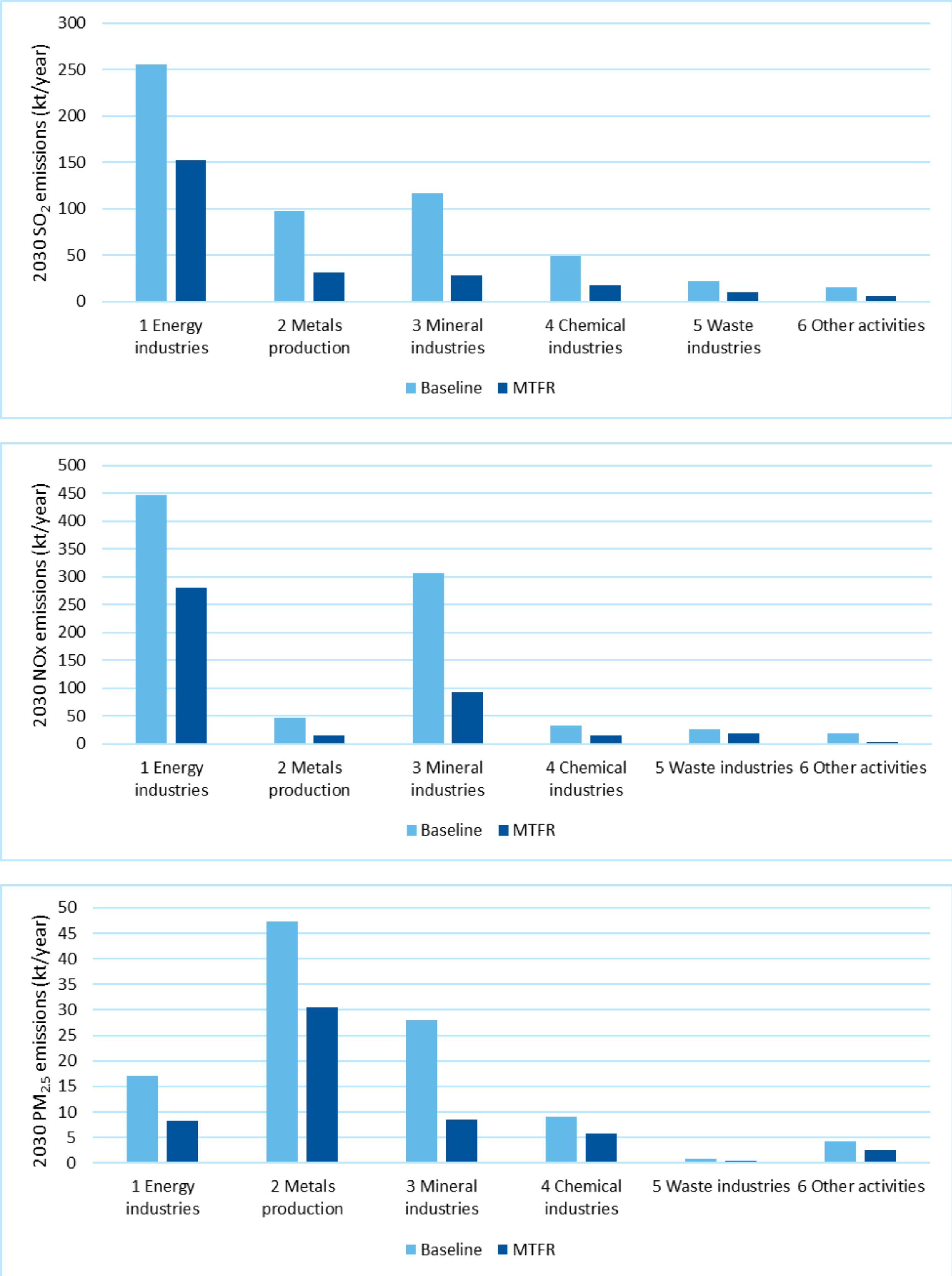


Figure 8-4: 2030 comparison of GAINS baseline and MTFR scenario emissions for EU27, broken down by sector



The revised Industrial Emissions Directive 2024/1785 (IED 2.0) contains a number of new provisions which should reduce the calculated discrepancies between the 2030 baseline and MTFR scenarios. Permits are required to be set at the "strictest achievable emission limit values", and as such when permits are updated following future BREF reviews, there should be a shift from current implementation (which is in most cases at the upper end of the BAT-AEL range) to lower values more in line with the MTFR scenario. Therefore, impacts presented above should reduce. Implementation of new aspects of IED 2.0, including binding energy efficiency/BAT-AEPLs, will be assessed in future IED implementation reporting. Indeed a recent JRC report "Delivering the EU Green Deal. Progress towards targets"[322] provided an estimation of some implementation gaps in achieving climate and environmental policy targets. According to the report, the revised IED should significantly cut industrial pollution and by 2050, it is expected to achieve up to a 40% further reduction in key air pollutants.

Forward looking for the Seveso-III Directive is uncertain due to challenges in assessing the current implementation gap quantitatively.

8.6 Lessons learnt and recommendations

Several of the conclusions from this section are similar to those from the COWI et al. (2019) study, particularly that it is difficult to quantify the extent of gaps and associated costs for the legislation specific to the industrial sector. However, analysis has shown that a stricter interpretation of BAT would generate significant emission savings in the EU, and provide large benefits to European society covering health, crops, forests ecosystems and materials. The lack of progress in assessment of this was noted as a problem in COWI et al. (2019).

Whilst analysis of Seveso was not possible, useful data were reported including recent analysis of eMARS incidents. 42 incidents occurred in 2022 and 2023, involving 21 deaths, more than 40 injuries, and more than €2 million in property damage. Of these incidents, 7 were reported to be caused by a wrong procedure, 4 due to mechanical integrity failure, 4 from unexpected ignition, 4 from natural hazards, 3 from power failures and 3 due to process miscalculations. This underlines the wide range of risks present at industrial facilities. It would be possible to place cost estimates on these data, including the health impacts as an indicator of the costs of failed implementation, though care would be needed in the use of the data.

[322] https://publications.jrc.ec.europa.eu/repository/handle/JRC140372

9. Horizontal instruments

- Horizontal instruments are legislative tools that aim to improve the overall environmental governance framework by creating systems to improve policy implementation and compliance across sectors. This captures a wide range of legislation, including the ELD, the ECD and the IEPR.
- Horizontal instruments do not define specific targets but contribute indirectly to the achievement of environmental targets within various policy areas. The ELD seeks to establish a common framework based on the 'polluter pays' principle across the European Union. The ECD criminalises serious violations of environmental law. Member States are required to transpose both the ELD and the ECD into national legislation, with some opting for more stringent provisions to ensure higher environmental protection. The IEPR aims to enhance transparency and public access to environmental data. Being a Regulation, it applies across the EU without the need of transposition. Nevertheless, some Member States have national registers with different scope and reporting thresholds.
- While some Member States have successfully applied the ELD, others have struggled due to varying interpretations of key provisions. Some Member States have narrowly interpreted certain ELD provisions, resulting in smaller scopes for their national legislations and less stringent measures for remediating water and biodiversity damages. One report concluded that Member States failed to enforce the relevant legislation and make the polluters pay, resulting in public money being spent instead. There is therefore a clear implementation (and enforcement) gap, which has resulted in complementary and compensatory remediation not always being achieved, however quantifying the gap is problematic.
- There have been significant disparities in implementation and enforcement of the ECD among Member States, due to a lack of clear definitions, which resulted in inconsistent application and interpretation of the Directive. Resources dedicated to its enforcement vary significantly across the EU, and so the penalties, which were found to be not sufficiently dissuasive or proportionate. Fragmented data collection on environmental crimes, prosecutions, and convictions further complicated efforts to assess and combat these offences effectively. Again, while there is clear implementation (and enforcement) gap, estimating its significance is problematic.
- While the European Environment Agency (EEA) — which maintained the European register – and Member State competent authorities have comprehensive procedures to check and verify reported data, resources dedicated to verifying and validating data reported to the E-PRTR/IEPR vary among Member States. This may lead to inconsistent data for some pollutants and/or industrial activities and varying accuracy of data across Member States.
- It has not been possible to estimate a cost as the impact of horizontal instruments is often indirect and preventive, supporting compliance with other sector-specific goals.

9.1 EU environmental policy and law

Horizontal instruments are legislative tools that aim to improve the overall environmental governance framework rather than setting specific environmental goals. They contribute indirectly to the achievement of environmental targets within various policy areas, such as water, air, and waste management. Unlike other types of environmental legislation that may focus on particular environmental media (e.g., the Water Framework Directive for water or Ambient Air Quality Directive for air), horizontal instruments work by creating systems to improve policy implementation and compliance across sectors.

The main directives categorised as horizontal instruments in this context include:

- **Environmental Liability Directive (ELD)** (Directive 2004/35/EC) establishes a framework of liability to prevent and remediate environmental damage, reinforcing the polluter-pays principle.

- **Environmental Crime Directive (ECD)** (Directive 2024/1203/EU) on the protection of the environment through criminal law, replacing Directives 2008/99/EC and 2009/123/EC (on ship-source pollution and on the introduction of penalties for infringements).
- **Environmental Impact Assessment (EIA) Directive** (Directive 2011/92/EU, amended by Directive 2014/52/EU) requires that environmental considerations are integrated into the planning and approval process for projects, ensuring that public and private projects with potentially significant environmental impacts are properly assessed.
- **Strategic Environmental Assessment (SEA) Directive** (Directive 2001/42/EC) mandates the assessment of environmental impacts for public plans and programmes likely to have significant environmental effects. It complements the Environmental Impact Assessment (EIA) Directive, which focuses on individual projects, by addressing broader strategic planning.
- **INSPIRE Directive** (Directive 2007/2/EC) aims to create a European spatial data infrastructure to improve the sharing of environmental data among public authorities.
- **Directive 2003/4/EC on Public Access to Environmental Information** aims to enhance transparency and public participation in environmental matters by obliging authorities to make environmental information available proactively and respond to specific requests.
- **Directive 2003/35/EC on Public Participation in Environmental Decision-Making** requires public authorities to provide relevant information early in the process and to allow sufficient time for the public to submit comments and observations.
- The **Industrial Emissions Portal Regulation** (Regulation (EU) 2019/1010) aims to enhance transparency and public access to information on the environmental performance of large industrial installations, including emissions to air, water, and land.
- **Regulation (EC) No 401/2009 on the European Environment Agency and the European Environment Information and Observation Network** establishes the legal framework for the collection, analysis, and dissemination of environmental data across Europe, tasking the EEA with coordinating the European Environment Information and Observation Network (EIONET) to provide accurate and timely information on environmental conditions.
- **Regulation (EU) 2021/783 establishing a Programme for the Environment and Climate Action (LIFE)** provides the framework for the EU's primary funding instrument dedicated to environmental and climate-related projects.

9.2 Environmental target

Horizontal instruments differ from media-specific environmental legislation in that they do not set quantifiable environmental targets, such as limits on air pollution or requirements for water quality. Instead, they establish procedures and frameworks that support better policy development, more effective enforcement, and enhanced decision-making across environmental policy areas. As a result, the impact of horizontal instruments is often preventive, fostering better compliance with sector-specific environmental goals. For illustrative purpose, this study qualitatively discusses the rationale and requirements of the Environmental Liability Directive, the Environmental Crime Directive and the Industrial Emission Portal Regulation (replacing the European Pollutant Release and Transfer Register Regulation).

Environmental Liability Directive

The Environmental Liability Directive (ELD) seeks to establish a common framework based on the 'polluter pays' principle across the European Union. The main objectives include preventing and remedying environmental damage by holding operators responsible for any harm caused to protected species and natural habitats, water, and land. Operators must implement preventative or remedial actions in case of imminent threat or actual environmental damage. The Directive also aims to encourage the development of financial security markets to cover the potential costs of environmental liabilities, ensuring that operators bear the remediation costs rather than the public. Member States are required to transpose the ELD into national legislation, with some opting for more stringent provisions to ensure higher environmental protection. Despite these measures, implementation across Member States has been inconsistent, with delays in transposition and variation in enforcement.

Environmental Crime Directive

The Environmental Crime Directive (Directive 2008/99/EC) aimed to strengthen environmental protection within the European Union by requiring Member States to criminalise serious violations of environmental law stemming from 72 pieces of EU legislation listed in its Appendices. These offences include unlawful conduct causing or likely to cause significant harm to the environment, wildlife, or human health. The Directive defined specific environmental offences and mandated liability for both natural and legal persons, with legal persons subject to either criminal or non-criminal liability. It also criminalised incitement, aiding, and abetting of such offences and requires penalties to be effective, proportionate, and dissuasive. However, it did not prescribe specific types or levels of penalties, nor did it address cooperation, data collection, training, or investigative tools. Some terms, such as “substantial damage” or “negligible impact,” were not further clarified, leading to varied interpretations.

The new Environmental Crime Directive was adopted on 11 April 2024 and entered into force on 20 May 2024. It replaces Directive 2008/99/EC and aims to enhance the legal framework for addressing environmental crime by clarifying ambiguous terms, such as “substantial damage,” that have previously allowed for inconsistent interpretation. It seeks to expand its scope to include new sectors of environmental crime and establish clear definitions for the types and levels of penalties to ensure consistency and proportionality. Additionally, the Directive aims to strengthen cross-border investigation and prosecution, improve the collection and sharing of statistical data through common standards across Member States, and enhance the effectiveness of national enforcement mechanisms to ensure a more robust response to environmental crime.

Industrial Emission Portal Regulation

Regulation 2024/1244 on reporting of environmental data from industrial installations, establishing an Industrial Emissions (the IEPR Regulation) is deeply rooted in both historical and contemporary environmental regulatory frameworks. The IEPR is an important tool for monitoring the effectiveness of the Industrial Emissions Directive (IED) and provide important information and context for the development and implementation of other EU initiatives such as the Green Deal and Chemicals Strategy.

The IEPR, which was adopted on April 12, 2024, serves as a modern replacement for the European Pollutant Release and Transfer Register (E-PRTR) Regulation. This new regulation establishes an integrated system at the European Union level for tracking pollutant releases and transfers, thereby fulfilling the requirements of the UNECE Kyiv Protocol. The first cycle of reporting under this updated regulation is scheduled for 2028, covering data from the 2027 reporting year.

The origins of this regulatory approach can be traced back to the E-PRTR Regulation (EC No 166/2006), which itself was a significant legislative effort to monitor and report emissions from industrial activities across Europe. The UNECE Kyiv Protocol, which was implemented in Europe via the E-PRTR Regulation, plays a crucial role in this context, as it mandates the creation of national pollutant release and transfer registers (PRTRs). These registers are designed to enhance public access to information about environmental pollutants, thereby supporting greater transparency and informed public participation in environmental decision-making. The IEPR goes beyond the requirements of the UNECE Kyiv Protocol and could serve as a benchmark should the Parties to the Protocol decide to modernise it.

9.3 Implementation gap

9.3.1 Analysis

Despite not being focused on specific environmental outcomes, the role of horizontal instruments is essential in ensuring the smooth functioning and enforcement of sectoral environmental legislation. Their non-implementation can lead to higher implementation gaps across other policy areas, which indirectly results in environmental harm.

Environmental Liability Directive

To illustrate the importance of the horizontal legislative instruments but also the challenges in estimating the implementation gap, the findings of the supporting study to the evaluation of the ELD[323] are discussed.

The evaluation of the ELD identified that progress had been made in some Member States in achieving its objectives, particularly in addressing biodiversity loss and remediating water damage. The ELD has introduced important environmental liability mechanisms across the EU, including obligations for in-kind remediation and public participation in environmental governance. Without the ELD, Member States would lack a cohesive framework for addressing transboundary environmental damage. However, implementation varies across the EU. Some Member States have made minimal progress or have not reported any ELD cases since 2007: five Member States have not reported a single ELD case since 30 April 2007; 13 further Member States have reported seven or less cases since that date. In total, in the span of 20 years, less than 2,000 confirmed cases of imminent threats of, and actual, environmental damage have been reported. The numbers, however, are imprecise. Figure 9-1 and Figure 9-2 shows the numbers of different types of environmental damage cases reported by the 27 Member States.[324]

While some Member States have successfully applied the ELD, others have struggled due to varying interpretations of key provisions, especially concerning biodiversity and water damage. The Commission's 2021 guidelines have helped to clarify these issues, but discrepancies remain. Importantly, due to these differing interpretations, what is considered an ELD occurrence in one Member State is not regarded as one in other Member States. While some Member States have narrowly interpreted certain ELD provisions, resulting in smaller scopes for their national legislations and less stringent measures for remediating water and biodiversity damages, other Member States have adopted more stringent provisions than those of the ELD, resulting in their national legislations having wider scopes and more stringent remediation measures, in particular for land damage.

In addition, *"[c]ompetent authorities in many Member States have tended to enforce only national non-ELD legislation, in particular legislation that transposed the Industrial Emissions Directive (IED) and national liability legislation, instead of also enforcing national ELD legislation"*[325].

A further obstacle to the functioning of the ELD is the absence of a mandatory EU-wide financial security system for ELD liabilities. Some operators have failed to internalise remediation costs, and the public has borne the financial burden. However, several Member States have introduced mandatory financial security measures, and voluntary environmental insurance has grown.

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[323] European Commission: Directorate-General for Environment and Fogleman, V., Study in support of the evaluation of the Environmental Liability Directive and its implementation – Final report, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2779/034934

[324] Figure 9-1 corresponds to the first reporting period. For the following reporting periods, the European Commission changed the reporting requirements, and did not require Member States to record or report ELD occurrences between 1 May 2013 and 26 June 2019. The Commission suggested 31 December 2021 as the cut-off date for reporting ELD occurrences in the article 18(1) reports. Some Member States reported cases after this date. Table 3 thus includes the reporting periods for individual Member States after 1 May 2013.

[325] European Commission: Directorate-General for Environment and Fogleman, V., Study in support of the evaluation of the Environmental Liability Directive and its implementation – Final report, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2779/034934

The ELD remains highly relevant, given ongoing biodiversity loss and environmental degradation. Nevertheless, its scope is limited by certain provisions, such as fault-based liability for biodiversity damage in some cases, and the lack of liability for air damage. Although the ELD is generally coherent with other EU legislation, there are overlaps and inconsistencies with the Industrial Emissions Directive (IED) and Seveso III Directive. These overlaps have sometimes led to underuse of the ELD.

Figure 9-1: Number of different types of environmental damage cases up to 30 April 2013[326]

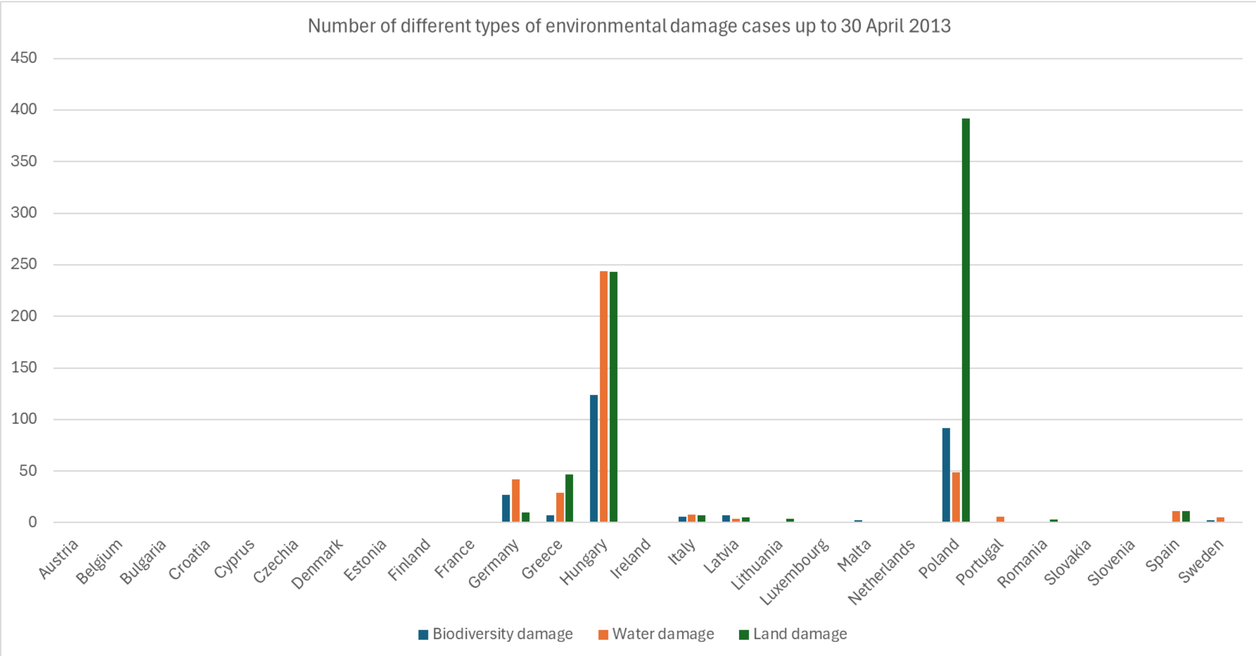
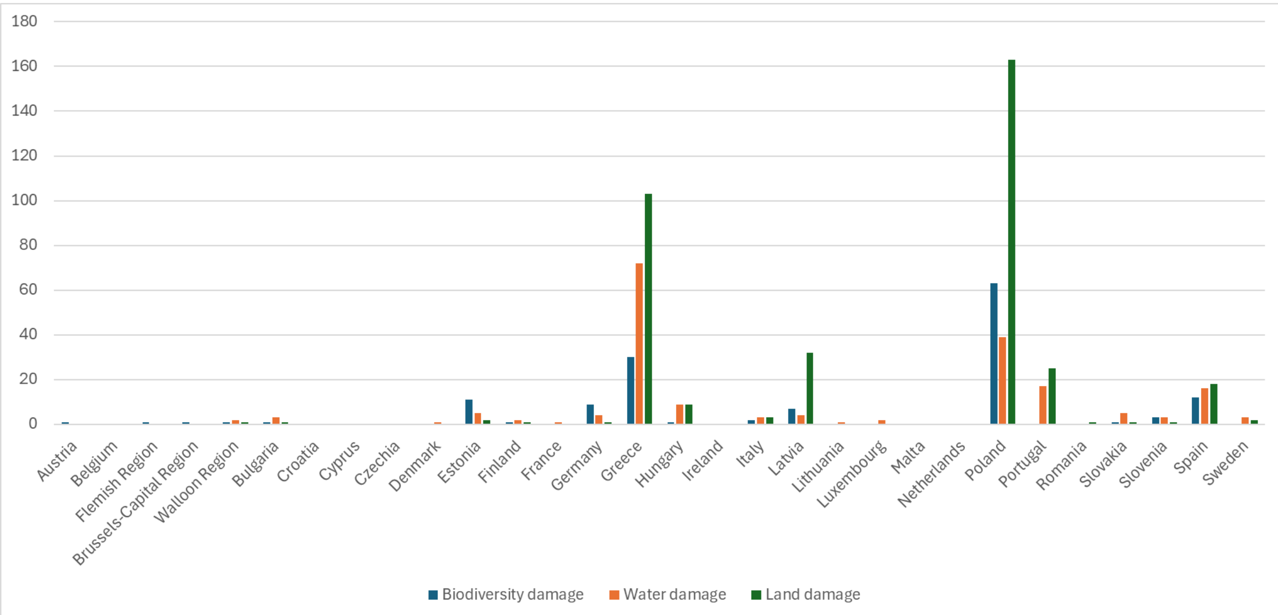


Figure 9-2: Number of different types of environmental damage cases after 1 May 2013[326]



326 Source: European Commission: Directorate-General for Environment and Fogleman, V. (2024)

The European Court of Auditors in its 2021 special report "The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions"[327] concluded that EU funds were used for environmental remediation projects of pollution that occurred when relevant environmental legislation was already in place. Member States failed to enforce the relevant legislation and make the polluters pay, resulting in public money being spent instead. Indeed, the supporting study to the ELD evaluation identified a number of ELD occurrences that were not treated as such by Member States, competent authorities and national courts, which preferred to enforce only national non-ELD legislation.

There is therefore a clear implementation (and enforcement) gap, which has resulted in complementary and compensatory remediation not always being achieved. However, estimating the gap is problematic, as there are no definite figures on the number of cases that should have been identified and dealt with by the Member States under the ELD but have not. In addition, some Member States require monetary compensation for environmental damage to be paid to the State, but the ELD requires remediation in kind.

Environmental Crime Directive

Environmental crimes, encompassing activities like illegal waste disposal, wildlife trafficking, and the destruction of protected habitats, represent one of the most severe threats to global ecological stability and public welfare. Globally, such crimes are estimated to generate economic losses of $91–259 billion annually, making them the fourth largest criminal activity after drug trafficking, counterfeiting, and human trafficking. These activities not only degrade ecosystems, water, air, and soil but also undermine public health, legal trade, and economic stability. In the EU alone, estimates of annual revenues from illegal non-hazardous waste trafficking range between €1.3 billion to 10.3 billion, highlighting the transnational nature and scale of these crimes. The involvement of organised criminal networks in environmental crimes amplifies their impact, linking them to other illicit activities like money laundering and terrorist financing.

The Environmental Crime Directive (ECD), adopted in 2008, was a pivotal step toward addressing these crimes within the EU. It criminalises specific environmentally harmful activities and mandates effective, proportionate, and dissuasive penalties. The 2020 evaluation of the ECD[328] highlighted that while the Directive had established a legal framework for addressing environmental crimes across the EU, its effectiveness was undermined by significant disparities in implementation and enforcement among Member States. The lack of clear definitions for key terms, such as "substantial damage" and "negligible impact," resulted in inconsistent application and interpretation of the Directive. Penalties in some Member States were not sufficiently dissuasive or proportionate, and enforcement efforts were hindered by limited resources, insufficient training, and a lack of specialisation among authorities. Fragmented data collection and a lack of comprehensive statistics on environmental crimes, prosecutions, and convictions further complicated efforts to assess and combat these offences effectively. While cross-border cooperation had improved, it remained inconsistent due to varying legal definitions and enforcement capacities. The Directive had added value in establishing a baseline for criminalising environmental offences across the EU, but its impact was constrained without clearer guidelines, stronger enforcement mechanisms, and better harmonisation. Organised criminal groups continued to exploit legal discrepancies, emphasising the need for greater cohesion and cooperation. Although the Directive remained relevant given the rising severity of environmental crimes, its coherence with other EU policies and international obligations could have been improved.

Furthermore, the Directive's limited scope – focusing on significant damage and certain hazardous activities – excludes many instances of environmental harm. The requirement to identify liable operators, coupled with practical challenges such as insolvency or lack of resources, further constrains its application. Many Member States report inadequate training, resources, and specialisation among enforcement authorities, resulting in

[327] ECA (2021). The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions. Special report. Available at:
https://www.eca.europa.eu/lists/ecadocuments/sr21_12/sr_polluter_pays_principle_en.pdf
[328] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020SC0259

weak implementation of sanctions. Inconsistent data collection and the absence of standardised statistics across the EU further hinder monitoring and evaluation of the Directive's effectiveness.

As for the ELD, while there is clear implementation (and enforcement) gap, estimating its significance is problematic, as there are no data on the number of cases that should have been dealt with through the ECD and were not.

European Pollutant Release and Transfer Register Regulation

The review of the E-PRTR Regulation implementation and related guidance[329] revealed several key shortcomings. One significant issue was incomplete data coverage, as high reporting thresholds exclude many small and medium-sized facilities, which collectively contribute a substantial portion of industrial emissions. The lack of alignment with other environmental legislation, such as the IED, resulted in inconsistencies in reporting requirements and definitions, complicating data integration and reducing its overall utility.

The register also fell short in terms of transparency and accessibility, as it lacked the contextual information needed for the data to be fully understood and effectively utilised by the public and policymakers. Reporting inconsistencies among Member States, outdated methodologies, and inaccurate emission estimation factors further undermined the reliability of the data. Additionally, delays in reporting and reviewing processes hindered the timeliness of the information, limiting its effectiveness as a tool for decision-making and immediate action.

The E-PRTR's scope did not evolve to keep pace with new environmental challenges and scientific advancements. Emerging pollutants, new industrial activities, and more nuanced pollution metrics were not adequately addressed, leaving gaps in its ability to respond to current and future issues. Moreover, outdated emission estimation methods and insufficient stakeholder engagement, combined with limited resources for enforcement and compliance monitoring in Member States, exacerbated these challenges.

These shortcomings have led to the need for development of the Industrial Emissions Portal Regulation, which requires – from 2028 – reporting of pollutant releases and transfers but also of resource use and contextual information. Three additional substances were added to the list of pollutants. Moreover, the IEPR changed the reporting level from a facility[330] to a single installation. The implementation of the Regulation must be reviewed every five years and, in this context, the Commission – in collaboration with Member State competent authorities and other stakeholders – may revise the list of pollutants, the reporting thresholds and related guidance.

It is important to note that the shortcomings identified during the review of the implementation of the E-PRTR Regulation and related guidance, and which has led to the establishment of the IEPR, cannot be considered an implementation gap *per se*. In the context of this exercise, the implementation gap of the E-PRTR Regulation (and considering the coming years, of the IEPR) is defined as the difference between the reporting requirements and the actual data reported. The estimation of the implementation gap therefore would require a thorough assessment of the quality of the reporting. While the European Environment Agency (EEA) — which maintained the European register – and Member State competent authorities have comprehensive procedures to check and verify reported data, the accuracy of the data varies across Member States.[331]

[329] ICF et al (2020): Review of E-PRTR implementation and related guidance. Final report prepared for the European Commission DG Environment.
[330] Defined in IEPR Art 3(2) as "one or more installations, or parts thereof, on the same site that are operated by the same natural or legal person".
[331] ICF et al (2020): Review of the E-PRTR implementation and related guidance. Report prepared for the European Commission DG Environment.

9.3.2 Limitations and uncertainties of the analysis

Environmental Liability Directive

The numbers of ELD cases reported by Member States are imprecise, with differences even within the same Member State. For example, between 2010 and 2020 the German Insurance Association (*Gesamtverband der Deutschen Versicherungswirtschaft*; GDV) recorded 3,265 environmental damage claims. However, Germany reported a total of 207 ELD cases for the periods 2007-2013 and 2019-2021 combined. In Italy, the Italian co-reinsurance Pool, *Pool per l'Assicurazione e la Riassicurazione della Responsabilità per Danni all'Ambiente*, informed the Commission to have handled 870 ELD cases between 2006 and 2018, but Italy reported only seven cases to the Commission for the period 2019-2021. Other differences in the number of perceived ELD cases reported by Member States competent authorities and recorded by other stakeholders are known. Any tentative attempt to measure the implementation gap more accurately would therefore be very difficult.

Environmental Crime Directive

The baseline defined in the evaluation of the ECD[332] is considered weak due to several limitations in data and methodology. Before the ECD's adoption, there was a lack of comprehensive and reliable statistical information on environmental crimes, including their detection, investigation, prosecution, and the sanctions imposed. Member States did not consistently collect or maintain comparable data, which made it difficult to establish a unified picture of the extent of environmental crime or the effectiveness of enforcement. Furthermore, there was no uniform definition of environmental crimes across the EU at the time, leading to significant variations in how Member States interpreted and applied environmental laws. This inconsistency hindered efforts to compare data or derive meaningful conclusions.

Another major challenge was the underreporting of environmental crimes, with many incidents going undetected or unrecorded, making it difficult to assess the true scale of the issue. Specific categories of environmental crime, such as wildlife and waste trafficking, were particularly under-documented, and existing data often failed to distinguish between trade-related offences and other environmental violations. Cross-border dimensions of environmental crime were also poorly understood, as cooperation between Member States was limited, and agencies like Europol and Eurojust had minimal involvement in these areas. The variability in the severity of sanctions for environmental crimes among Member States further complicated the establishment of a consistent baseline for enforcement practices or outcomes.

Historical data before the ECD's transposition deadline in 2010 was sparse, with little information available on trends in illegal activities, convictions, or sanctions. Instead, the baseline relied heavily on studies, reports, and anecdotal evidence, which differed widely in their focus and methodology. This patchwork approach left significant gaps in understanding the scale and impact of environmental crimes across the EU. As a result, the baseline provides only a limited foundation for evaluating the ECD's effectiveness, highlighting the need for improved data collection, standardisation, and monitoring in future assessments.

European Pollutant Release and Transfer Register Regulation

All Member States are parties to the UNECE Kyiv Protocol and therefore required to implement national industrial emissions registers. The E-PRTR Regulation sets minimum requirements, and some Member States operate registers with broader scopes compared to the E-PRTR. These national systems frequently include a wider range of pollutants and require reporting from a larger set of industrial activities, often using lower reporting thresholds. By capturing emissions from smaller facilities and additional pollutants, these portals provide a more comprehensive picture of industrial environmental impacts within their jurisdictions.

The divergence in scope between national portals and the E-PRTR reflects varying priorities and resources among Member States. Some countries have chosen to go beyond the minimum requirements of the E-PRTR to address specific national environmental concerns or to align with more stringent domestic policies. For instance,

[332] https://commission.europa.eu/news/evaluation-environmental-crime-directive-2020-11-05_en

national portals might include emerging pollutants not yet covered by the E-PRTR, reflecting advances in scientific understanding and changes in industrial practices or different national priorities.

Another area of variation lies in the thresholds for reporting emissions. Many national systems adopt lower thresholds, enabling them to account for emissions from smaller facilities that, when aggregated, can significantly impact local and regional environmental quality. This contrasts with the higher thresholds of the E-PRTR, which tend to focus on large-scale industrial emitters, potentially underestimating the cumulative effects of smaller contributors.

While the EEA verifies data quality centrally, Member States employ different levels of resources and procedures for verifying the quality of data reported to their portals, leading to varying levels of data accuracy and reliability across the EU.

Finally, industrial operators can apply different methodologies (measurements / calculations / estimations) which have different levels of accuracy. This impacts the comparability of data reported by operators even within the same Member State and industrial activity.

9.4 Implementation gap cost

9.4.1 Analysis

Environmental Liability Directive

Economic valuation of environmental damage within the framework of the ELD relies on equivalency methods to assess and quantify damage and determine appropriate remediation measures. These methods, such as resource-to-resource, service-to-service, value-to-value and value-to-cost analyses, aim to estimate the extent of environmental harm and the cost or effort required to restore damaged natural resources and services to their baseline condition.[333] The ELD emphasises restoration costs as the primary measure of damages while also accounting for interim losses – the loss of natural resource services during the period of recovery. These economic valuation techniques are crucial for aligning remediation efforts with the "polluter pays" principle, ensuring that responsible parties adequately compensate for both the direct and indirect impacts of environmental harm. The methods are designed to ensure proportionality and fairness while addressing the complex and site-specific nature of environmental damage. Even with regard to the obligation of preventive action to be taken in case of imminent threat of damage, the cost of non-implementing this requirement is again the cost of damage remediation.

Unfortunately, there are no recent data on these aspects, as the reporting requirements for Member States do not include the valuation of the damage and/or remedial process. The 2016 ELD evaluation estimated the EU average costs of remedial action but based on very limited data. Twelve Member States provided cost data for 140 cases, representing only 10% of all reported cases at the time. However, 98 of these cases were from a single Member State (Hungary), which skewed the representativeness of the dataset. The average cost of remedial action was estimated at €350,000, but this figure included a few large-scale cases with excessive costs. Excluding cases exceeding €1 million, the average cost dropped to €42,000, which aligned with data from Greece, where the average was €60,000 per case. The cost range varied widely, from €600 to several million euros, reflecting inconsistencies in the application of the Directive. While some Member States appeared to include minor cases, others applied the Directive only to severe instances of damage, underscoring the need for a coherent

[333] There are many economic valuation methods applied to nature and ecosystem services. These depend on availability of data, contextual framework, objectives, etc. For example, the EU Forum of Judges for the Environment (EUFJE), the EU Network for the Implementation and Enforcement of Environmental Law (IMPEL), and the European Network of Prosecutors for the Environment (ENPE) are developing an indicative tool to value damage to nature in court, i.e. to help legal professionals calculate a financial compensation for damage to nature when restoration *in natura* is not possible (without prejudice to the ELD): https://biovaltool.eu/

interpretation of the significance threshold. These figures may therefore not fully capture the diversity of cases or the true costs of remediation across the EU.

Also, the monetisation of remedial and preventive processes presented in some of the case studies included in the supporting study to the most recent evaluation of the ELD (EC and Fogleman, 2024) points to substantial variability depending on the nature and scale of environmental damage, as well as the specificities of Member State implementation. Case studies reveal that remedial costs range widely, from minor interventions costing a few hundred euros to large-scale damage requiring millions. For example, high-profile incidents involving severe environmental harm resulted in substantial costs for restoration measures, often exceeding €1 million. Conversely, smaller cases focused on preventive measures or less significant damage typically incurred costs in the lower thousands.

A way to approach the assessment of the costs of non-implementation of the ELD would be to estimate the annual marginal change (increase or decrease) in environmental damage in the EU, with environmental damage comprising damage to water, land and nature/biodiversity only[334]. This would require:

- Establishing a baseline, i.e. the status of water, land and nature/biodiversity before the entry into force of the ELD, and its evolution without the entry into force of the ELD
- Measuring the changes in the status of water, land and nature/biodiversity since the entry into force of the ELD
- Comparing the statuses of water, land and nature/biodiversity in the baseline ("no ELD") vs the ELD scenario
- Monetising the difference in the amount of environmental damage to water, land and nature/biodiversity.

Even considering damage to land only, and the number of contaminated sites as an indicator, this approach would require gathering data on the number of contaminated sites being remediated per year before the entry into force of the ELD and how this number has evolved after its entry into force[335]. Moreover, as noted in the explanatory memorandum accompanying the proposal for the ELD[336], already in 2006, all Member States had laws or programmes in place to deal with liability for contaminated sites. This approach would also require estimating the average EU cost of site remediation (costs can vary significantly depending on the nature of the pollution, its extension and the necessary clean-up or restoration techniques). Finally, even with perfect information, this approach would not capture precisely the costs of non-implementation of the ELD, as the Directive allows in practice to address a relatively limited scope of environmental damage:

- as regards the nature/biodiversity, only significant damage to species and habitats protected under EU law is within the scope;
- as regards water and land, only significant damage and only in cases the liable operator qualifies as carrying out a potentially hazardous (listed in Appendix III) activity is within the scope;

[334] Therefore, excluding damage to air, human health, properties and economic activities resulting indirectly from environmental damage to water, land and nature/biodiversity.
[335] The impact assessment of the Soil Health Law (SWD(2023) 417 final) reports that between 1 to 2.5% of non-agricultural land is contaminated, although the surface area with contaminated sites is not accurately quantified. In 2016, it was estimated that around 390,000 sites in the EU would require remediation (14% of 2.8 million potentially contaminated sites). The document specifies that progress in the management of contaminated sites varies considerably, from 20 sites per year to 3,000 sites per year per Member State, and that at that rate of remediation, it would have taken some 47 years to remediate all estimated existing contaminated sites.
[336] EC (2000). White paper on environmental liability. COM(2000) 66 final.

- for land damage, moreover, only damage resulting in risk to human health qualifies;
- for damage to nature/biodiversity, in case the liable operator does not qualify as carrying out a potentially hazardous (listed in Appendix III) activity, damage is within the scope only if the operator was at fault or negligent;
- moreover, the ELD requires to identify the liable operator and for him to carry out preventive or remedial measures. So, for example, if the operator is insolvent, the fact of non-remediating the damage cannot be attributed to the non-implementation of the ELD.

An alternative assessment framework would require analysing what happens if the ELD is not implemented or is not implemented correctly. This would require assessing three categories of cases as follows, but in each case data limitations prevent analysis and quantification:

- *The damage or imminent threat of the damage occurrence exists, is identified as such, and fulfils the criteria to be addressed under the ELD, but is instead addressed under other liability rules, such as permitting legislation and national liability rules existing in parallel to the ELD (rules qualified by Member States as 'more stringent' and thus maintained by the virtue of Article 16 ELD)*. The 2024 ELD evaluation shows that there are many cases dealt with national liability schemes. No statistical data are available, but the 2024 ELD evaluation provides some circumstantial data, in terms of a comparison between the number of ELD and non-ELD environmental damage proceedings in some Member States. The consequence of applying national liability rules instead of the ELD is very often that only primary remediation of the damage is carried out, with no complementary or compensatory remediation being applied, which are the main characteristics differentiating the ELD from national liability regimes. To note that the complementary and compensatory remediation are not required in all ELD cases either, but only where primary remediation cannot return the affected resource to its original state (complementary remediation) or does so with a delay, and thus ecosystem services are not available during that time (compensatory remediation). There are no comprehensive data on the total or average cost of complementary and compensatory remediation, but some evidence points to complementary and compensatory remediation being more costly than primary remediation.
- *The ELD is implemented but not correctly.* This means usually that the ELD implementation is limited to primary remediation, and complementary or compensatory remediation is not applied. This may be due to the economic limitations of the liable operators and/or insufficient expertise of the competent authorities. There are no data on how many cases fall within this category, but the 2024 ELD evaluation shows that complementary and compensatory remediation is applied very rarely.
- *The damage or imminent threat of the damage occurrence exists but remains not identified and/or no liability rules are applied. As a result, the cost of the damage is shifted to the society as a whole.* This can happen for many reasons, and only some of them could qualify as no implementation of the ELD. For example, if the damage is not remediated because the liable operator cannot be identified or is insolvent, there is quantifiable damage to the environment, but it cannot be attributed to the non-implementation of the ELD. However, if the damage is not remediated because the competent authority has not identified the damage or the liable operator, then the damage and the costs of remediating it should be attributed to the non-implementation of the ELD. The cost of non-implementation of the ELD with regard to such cases is the total loss of species and habitats protected under the ELD, as well as loss of other environmental resources concerned, i.e. clean water and land, and of the services they provide, insofar as the loss occurs through significant damage cases. There are no data on how many cases fall within this category.

Environmental Crime Directive

The assessment of the costs of non-implementation of the ECD would require evaluating the financial, ecological, and social impacts of unaddressed environmental crimes. The analysis would focus on environmental damage to water, land, and biodiversity, which fall within the Directive's remit, while excluding indirect costs such as impacts on human health or economic activities not directly linked to environmental harm. A baseline would be necessary to establish the current level of environmental damage across Member States to be compared with a counterfactual scenario reflecting the benefits of full implementation of the Directive.

The assessment would have to consider direct environmental costs, such as ecosystem degradation and the loss of biodiversity, as well as economic costs, including the diminished value of ecosystem services and losses from illegal activities. Social impacts, such as reduced quality of life and health issues associated with environmental degradation, would also have to be examined alongside the administrative burden on institutions resulting from gaps in enforcement. Opportunity costs, representing the benefits foregone due to insufficient environmental protection, would have to be accounted for as well.

Key data that would be required include quantitative measures of environmental damage, enforcement statistics, and economic valuations of ecosystem services and remediation efforts. Information on health and social impacts, as well as the effectiveness of enforcement mechanisms, would be equally important. Analytical methods would involve quantifying the scale of unaddressed harm, monetising impacts using recognised valuation techniques, and comparing the costs of non-implementation to the potential benefits of full enforcement. Scenario modelling could further illustrate the incremental gains from improving compliance. Unfortunately, the required data is not available.

European Pollutant Release and Transfer Register Regulation

The E-PRTR Regulation and the IEPR now offers several important benefits that enhance environmental protection and public awareness. By providing transparent access to detailed information about pollutant releases and transfers from industrial facilities across the EU, it empowers citizens, policymakers, and researchers to better understand and address the environmental impacts of industrial activities. The E-PRTR supports policymaking by supplying reliable emissions data, which aids in evaluating and refining environmental regulations and monitoring progress toward targets. It also promotes accountability among industries, encouraging them to adopt cleaner technologies and reduce their emissions through mandatory reporting requirements.

Furthermore, the harmonisation of emissions reporting across Member States facilitates cross-border comparisons and cooperation in tackling transnational environmental issues. By increasing public awareness, the register enables communities to advocate for improved environmental practices and policies. For industries, it serves as a benchmarking tool, allowing operators to compare their environmental performance with peers and identify areas for improvement. The E-PRTR also supports international commitments, such as those under the UNECE Protocol, aligning the EU with global efforts to combat pollution.

These benefits can be evaluated in economic terms through various monetisation methods. Increased transparency and public access to information can be valued by assessing the societal willingness to pay for access to information about industrial pollution. The register's role in policy development and enforcement can be monetised by calculating the cost savings from more efficient regulatory interventions and avoided environmental damages. For industries, the adoption of cleaner technologies can be measured in terms of operational cost savings or increased competitiveness, and this is partially also the result of transparency and access to information by the public. Cross-border cooperation facilitated by the register can be valued by examining the economic benefits of shared environmental improvements, such as healthier ecosystems and reduced remediation costs.

The difficulty is in disentangling the effects of this horizontal instrument from other environmental legislation and in particular the IED. Consequently, the focus of the analysis for such instruments differs from other policy areas.

9.4.2 Limitations and uncertainties of the analysis

As acknowledged in the previous reports on the costs of non-implementation of environmental legislation, the costs and benefits of the implementation of horizontal instruments are difficult to define and measure. While horizontal instruments play fundamental roles within the environmental regulatory framework, their nature makes it extremely difficult to disentangle their positive and negative impacts from those of the legislative instruments they aim to support.

As for other horizontal instruments, instead of addressing explicit environmental targets, the objectives of the ELD, ECD, and IEPR are examined to understand their broader roles in strengthening environmental protection. The analysis also considers their implementation status and challenges rather than attempting to measure a definitive implementation gap.

Foregone benefits associated with the non-implementation of these instruments are discussed primarily in qualitative terms. For instance, under the ELD, failure to implement robust liability frameworks may result in unremedied environmental damage, loss of biodiversity, and diminished ecosystem services, which are difficult to quantify precisely. Similarly, gaps in implementing the ECD could lead to inconsistent prosecution of environmental crimes, allowing significant harm to remain unaddressed, while the IEPR’s non-implementation might limit public access to critical emissions data, weakening both transparency and policy effectiveness.

Indicators such as the number of reported ELD incidents, environmental crime prosecutions under the ECD, or the availability and quality of IEPR data can provide qualitative insights into the level of implementation across Member States. However, these indicators alone are insufficient for determining the precise size of implementation gaps due to data availability issues and the conceptual challenges posed by the absence of specific environmental targets.

9.5 Forward looking assessment

Environmental Liability Directive

With regard to the ELD, in 2021 the Commission published guidelines on environmental damage. There is evidence that the broad definitions of biodiversity damage and water damage provided in the guidelines have been applied by courts in some Member States. Moreover, the Commission will organise ELD training events in some Member States. These actions are expected to increase implementation and enforcement of the ELD across the EU27 to 2030. It is however not possible to estimate how the implementation gap will evolve in the future.

Environmental Crime Directive

The new Environmental Crime Directive, adopted on 11 April 2024 and effective from 20 May 2024, replaces Directive 2008/99/EC and aims to improve the legal framework for tackling environmental crime. It addresses issues of inconsistent interpretation by providing clearer definitions for terms like “substantial damage.” The Directive broadens its coverage to include additional sectors of environmental crime and introduces precise guidelines for the types and severity of penalties, promoting consistency and fairness. Furthermore, it seeks to enhance cross-border cooperation in investigations and prosecutions, standardise the collection and exchange of statistical data among Member States, and strengthen national enforcement systems to deliver a more effective and coordinated approach to combating environmental crime.

Industrial Emission Portal Regulation

Following a comprehensive evaluation in 2017, the European Commission proposed revising the E-PRTR Regulation, resulting in the adoption of the new Industrial Emissions Portal Regulation (IEPR) on 12 April 2024, which came into force on 22 May 2024. Over the next two years, the Commission will develop implementing rules, including a standardised reporting format for resource use and for new sectors. The first data reported under the new framework, covering releases and resource use in 2027, will be published in 2028.

The revised Regulation will now include data on energy, water, and raw material consumption alongside contextual information about operators' activities. The Regulation aligns the scope and detail of reporting with the updated Industrial Emissions Directive (IED 2.0) to better support its implementation. It also introduces flexibility to update the list of pollutants in response to scientific advancements and changes in the EU environmental laws. Measures to improve data quality include harmonising the quantification methods used by operators, ensuring more reliable reporting. Additionally, the Regulation simplifies reporting requirements for the aquaculture and livestock sectors, reducing administrative burdens while maintaining transparency and accountability.

9.6 Lessons learnt and recommendations

Future work should build on such qualitative assessments while incorporating more comprehensive and updated evidence as it becomes available. For example, examining quantifiable benefits from specific Member States or cases, such as the economic value of biodiversity restoration under the ELD or improved compliance rates following the IEPR's implementation, could provide more nuanced insights.

10. Cross-cutting analysis and conclusions

Although the eight policy areas are somewhat distinct, there are key interactions between them in terms of the environmental outcomes that might arise as a result. For example, action on industrial emissions inherently contributes to the achievement of air pollutant concentration targets, and achievement of air pollution targets contributes to effects on nature and biodiversity. To aggregate the impacts into a total cost of non-implementation it is important to consider and account for any interactions between different policy areas to avoid double counting.

In the sections above, the implementation gap and cost in each policy area have been assessed in isolation (i.e. not considering interactions with other areas). To address this, challenge, interdependencies and links between the policy areas were mapped forming a clear representation of the interactions between the policy areas and environmental outcomes. Then, taking into account the map of interdependencies and the typology of costs, adjustments were applied to the costs for individual policy areas where necessary to mitigate the risk of overlap such that they can be aggregated into a total cost estimate.

The table below presents the key interactions identified, their nature, and any remedial action taken underpinning the aggregate estimate of costs.

Table 10-1: Identification and discussion of interactions in cost estimates between (and within) policy areas

Interaction	Description and steps taken to avoid double counting
Selection of policies within policy area	Many of the policy areas capture multiple policies. In many cases, there are strong links and interactions between policies within each policy area. For example, the air policy area considers the three key components of the EU's Clean Air Policy: the revised AAQ Directive the NEC Directive, and a cohort of so-called 'source-specific' legislation. In such cases, the analysis has considered the potential for overlaps and has carefully selected legislation for more detailed analysis to avoid the risk of double counting. In the example of air, analysis is only performed for the AAQ Directive and NEC Directive, with source-specific legislation not assessed.
Combination of targets in different years	In many of the policy areas, the legislation may set multiple targets to be achieved in different years. For example, the Waste Framework Directive sets targets on the preparation for re-use and recycling of municipal waste for 2020, 20205, 2030 and 2035. In these cases, the analysis considers the same impacts, just to different levels of ambition. Where legislation may set multiple targets to be achieved in different years, the total analysis only takes costs associated with targets for a single selected year. The aggregate cost analysis presents the gap for 'current' targets (that apply in 2025), and 'future' targets (defining the gap to the most ambitious targets set in legislation).
Air – interactions between the AAQ Directive and NEC Directive and impacts between pollutants.	Within air, analysis is performed for the AAQ Directive and NEC Directive separately. However, there is potential for interaction and overlap between the costs estimated. The analysis has carefully considered the results of the estimation for each, and based on this recommends: • For current targets: it is concluded the risk of double-counting is small, given that only six countries (Austria, Bulgaria, Cyprus, Hungary, Portugal and Romania) have an implementation gap against both Directives. Also, because of some of the patterns in the results (e.g. Bulgaria exceeds the NEC Directive commitment for NH_3, but only the AAQ Directive target for ozone), clear potential for double counting was identified only for Cyprus and Romania. To eliminate the possibility of significant double counting, for Cyprus and Romania only results for the legislation with the greater damage estimate are used (NEC Directive for Romania, AAQ Directive for Cyprus). • For future targets: given the extent of forecast exceedance of NEC Directive 2030+ ERCs, it is concluded that there is scope for a more significant level of double counting if combined with the implementation gap cost for AAQ Directives. On that basis, with respect to 'future' targets, only damage related to the 2030+ ERCs under the NEC Directive are presented. There is also the potential for interactions and risk of double counting between the analysis of effects associated with different pollutants. The analysis has followed practice elsewhere (e.g. CAO4) and

Interaction	Description and steps taken to avoid double counting
	assumes that: (a) ozone impacts are independent of damage from $PM_{2.5}$ and NO_2 but, (b) does not combine impacts associated with $PM_{2.5}$, PM_{10} and NO_2 where there is exceedance of a target for more than one of these pollutants in a given Member State, instead taking the highest individual pollutant cost.
Water – interactions between WFD and MSFD	There is likely to be some overlap between the foregone benefits estimated with respect to the WFD and the MSFD. The central estimate of total annual cost of non-implementation for coastal waters under WFD is €2.6bn per year. However, such interactions are hard to quantify precisely and as such no adjustment has been made to the estimated cost for either regulation in the aggregate cost.
Air, water and industrial emissions	Action on industrial emissions inherently contributes to the achievement of air pollutant concentration and emission targets as industry emits pollutants directly to air. Furthermore, industry also emits pollutants directly to water, and pollutants emitted to air can also end up in water bodies. As such there is significant potential for overlap in the cost estimates. The potential for overlap will depend on the nature of the implementation gap assessed for air (i.e. which Member States see concentrations of air pollutants above standards and for which pollutants) and water (i.e. which water bodies in which Member States are not achieving good status), and additional potential under industrial emissions across Member States and pollutants. Against 'current' air legislation targets (i.e. those that apply from 2020 under the AAQ Directive and 2020-29 NEC Directive), there are fewer exceedances and hence the additional benefits estimated from further reduction in industrial emissions may be somewhat additional. However, for targets for air which apply in the future (i.e. 2030+ ERCs under the NEC Directive), the implementation gap is larger and many more Member States have a deficit for many more pollutants. For water, in 2022 the majority of surface water bodies are failing to achieve good ecological status or good chemical status however Member States have applied time limited Article 4(4) exemptions to a large proportion of these waterbodies. That said, in 2027, time limited exemptions under WFD Article 4(4) expire (except for "natural conditions") and all measures to achieve good status must be in place. Under both air and water, the implementation gap is greater looking forward, increasing the risk of double counting should these costs be combined with the foregone benefits estimated for industrial emission reductions. One must also consider that the implementation gap cost for industrial emissions is of a slightly different nature – the analysis does not strictly assess non-compliance but illustrates the benefits of greater ambition. In summary, to avoid the risk of overlap and maintain a consistent approach, only the cost estimates for air (AAQ Directives and NEC Directive) and water are included in the aggregate estimate. Costs estimates for industrial emissions are not included.
Air and nature	The achievement of air pollution targets contributes to effects on nature and biodiversity as deposition of air pollutants is associated with several detrimental environmental effects, including acidification and eutrophication. However, the contribution of ecosystem impacts to estimated air pollutant damage here is small, in the order of 1% or less overall, and the potential for double counting is therefore negligible.
Air and waste	For several waste policies the implementation gap costs include impacts on air quality, associated with changes in energy use. Including these also in the total cost risks double counting, and hence these air pollution effects of waste policy are excluded from the overall estimate.
Air and noise	Transport is a key source of both air and noise pollution, and several recent studies have explored the potential for interaction (and overlap) between the effects of each, in particular as both lead to consequences primarily for human health. These studies suggest some independence between the effects of air and noise pollution[337] and do not define a methodology to account for overlaps. Hence for this study, given lack of methodology to adjust estimates for overlap, and initial evidence to suggest

[337] See for example: Eminson et al. (2023). Does air pollution confound associations between environmental noise and cardiovascular outcomes?-a systematic review. Environmental Research, 232, p.116075; and Héritier et al. (2019). A systematic analysis of mutual effects of transportation noise and air pollution exposure on myocardial infarction mortality: a nationwide cohort study in Switzerland. European heart journal, 40(7), pp.598-603.

Interaction	Description and steps taken to avoid double counting
	there may not be a strong interaction between these effects, no adjustment has been made as part of this study to account for any interaction.
Nature and water	The nature and biodiversity area considers the EU BDS target to: *Legally protect a minimum of 30% of the EU's land area.* Around 11% of the existing land area which is currently protected is classified as 'rivers and lakes'. A benefit associated with protecting (and restoring) these habitats was included in the NRR impact assessment. However, these benefits have not been included in the estimation of costs in the nature policy area, to avoid overlap with the benefits estimated under the water area associated with achieving 'good' status under the WFD across surface waterbodies. Achieving 'good' ecological status (regardless of whether this is achieved through protection of habitats or otherwise) will likely capture the benefit of improved biodiversity and ecosystem services.

Table 10-1 demonstrates that care has been taken to avoid double counting in aggregated estimates across the different policy areas. However, the approach taken is conservative in this aspect, for example implicitly assuming that all air pollution related waste sector costs would be double counted against NEC Directive and AAQ Directive costs. As such it provides some bias to underestimation in aggregated impacts.

The following table presents the analysis undertaken individually in each policy area. Where multiple targets are defined for different years, it presents the implementation gap as it stands at the last historic year for which data was available against (a) 'current' targets, and (b) 'future' targets (i.e. targets defined in legislation, which need to be met in a future year). It also summarises the 'forward-looking' analysis, which captures anticipated trends and changes which will influence how the implementation gap may evolve to 2030. The table then also presents the total cost estimate, drawing on the discussion of interactions presented above.

In summary, the total implementation gap cost is estimated to be:

- **€180 billion per year** (range from €154 billion to 208 billion per year) comparing the gap between status of the environment based on the last historical year for which data is available, and environmental targets which currently apply.
- This estimate increases to **€325 billion per year** (range from €294 billion to 408 billion per year) when comparing the gap between the status of the environment based on the last historical year for which data is available, to environment targets which will apply in the near future.

Table 10-2: Analysis for each policy area and assessment of total implementation gap cost. Notes: Rows coloured blue show the alternative assessment against future targets for particular policy areas where this is applicable (i.e. where there are different targets that currently apply and will apply in the future). Accordingly, numbers in white cells were counted in the current gap, and in blue cells in the future gap totals at the bottom of the table.

Policy area *(year of data used for assessment)*	**Targets**	**Annual implementation gap cost (€, 2023 prices)**	**Forward look**
Air *(2022 data)*	AAQ Directives (standards applying until 2029) and NEC Directive 2020-29 ERCs	€3.5 billion (range up to €4.6 billion)	Implementation gap to 2030+ ERCs anticipated to fall as emission reductions continue. More ambitious air quality standards will, nominally, increase the number of people living in areas or exceedance (although this does not capture additional action which will be put in place to work towards these new targets).
	NEC Directive 2030+ ERCs	€85 billion (range up to €137 billion)	
Noise *(2017 data)*	ZPAP 2030 target	€20 billion (range from €12.9 billion to 27.1 billion)	Most recent evidence suggest it is unlikely that the 2030 ZPAP target will be achieved, and the implementation gap could even increase.
Nature & biodiversity *(data varies from 2018 to 2024 depending on target)*	EU Biodiversity Strategy 2030 targets	€72 billion across targets assessed (range from €62 billion to 81 billion)	Based on historical trends some targets may be met by 2030, but for many, it is uncertain whether ambitions will be achieved based on current trends. That said, this does not capture the potential impact of the recently adopted NRR, which expected to result in strengthened restoration efforts.
Water *(2021 data for surface and ground water bodies; 2018 data for marine)*	Target under WFD and MSFD to achieve 'good' status for all waters	€63.7 billion for all water bodies (range from €54.6 billion to 73.0 billion)	To note, time limited exemptions under WFD Article 4(4) expire in 2027 and hence all measures to achieve good status must be in place by then. Attaining 'good 'status of surface waterbodies (rivers, lakes, transitional and coastal waters) covered by Article 4(4) exemptions could achieve benefits of around €57.2 billion per year. The study has not estimated the equivalent foregone benefits for groundwater bodies.
Circular economy and waste *(data varies from 2019 to 2022 depending on target)*	Targets under several policies that currently apply	€20.6 billion (range up to €22.6 billion)	The new Batteries Regulation, new Waste Shipment Regulation and Single Use Plastics Directive have only recently been adopted – the analysis captures the full gap to their targets but if successful these policies will reduce the gap. In addition, proposed changes to the Waste Framework Directive, Packaging and Packaging Waste Directive and End of Life of Vehicles Directive have been proposed to drive further progress in closing the implementation gap.
	Targets under several policies that will apply in the future (e.g. 2030, 2035)	€79 billion (range up to €90 billion)	
Chemicals	N/a – Legislation does not have specific and quantifiable environmental protection or improvement targets.	Not quantified. CLP Regulation considered effective, but some implementation challenges were identified in a 2019 fitness check. The REACH Regulation is working as intended and has delivered significant	The revised CLP regulation, in force since December 2024, is expected to address any substantive implementation gaps. A proposal for a targeted revision of REACH is expected in 2025. Such revisions may encompass changes to several processes. Collectively these changes

Policy area *(year of data used for assessment)*	Targets	Annual implementation gap cost (€, 2023 prices)	Forward look
		benefits, but some elements and processes are not working as efficiently as they could, potentially creating a gap in the level of protection for human health and the environment.	have the potential to accelerate the rate at which benefits are realised, perhaps significantly
Industrial emissions and major accident hazards *(modelled 2025 data)*	Stricter permit requirements under IED(greater ambition) – Seveso III does not set quantitative targets	€27 billion (range up to €98 billion)	The IED 2.0 contains new provisions which require permits to be set at the strictest achievable level. This will drive emissions reductions which will capture these available benefits, as industrial sites will be required to take action to meet stricter permit requirements.
Horizontal	N/a - Horizontal instruments do not define specific targets but contribute indirectly to the achievement of environmental targets within various policy areas	Not quantified. For ELD and ECD, analysis highlights a clear implementation (and enforcement) gap, which has resulted in complementary and compensatory remediation not always being achieved (under ELD), and financial, ecological, and social impacts of unaddressed environmental crimes (related to ECD).	New guidelines and training on environmental damage, the new Environmental Crime Directive, adopted on 11 April 2024, and new IEPR should all work to reduce gaps in implementation and their associated costs.
TOTAL COST	*Air targets to 2029 and current circular economy & waste targets, plus noise, nature & biodiversity and water*	**€180 billion** **(range from €154 billion to 208 billion)**	Most significant costs are in nature & biodiversity and water areas, hence implementation gap likely to reduce to 2030 as implementation of NRR begins to work towards targets in the EU BDS 2030, and expiry of WFD Article 4(4) exemptions pushes a greater attainment of 'good'.
	Air targets from 2030 and future circular economy & waste targets, plus noise, nature & biodiversity and water	**€325 billion** **(range from €294 billion to 408 billion)**	Most significant costs are in: nature & biodiversity, water, air and circular economy & waste areas. Implementation gap likely to reduce to 2030 as further air pollutant emission reductions are anticipated and new legislation and changes to existing policies in circular economy & waste drive further progress in closing the implementation gap.

A1 Appendix 1 – Comparison to COWI et al. (2019)

Overall comparison

In 2019, the European Commission published a study[338] by COWI et al. (2019) which estimated the costs and benefits foregone for the EU of not achieving environmental targets across seven environmental policy areas: (i) air and noise; (ii) nature and biodiversity; (iii) water; (iv) waste; (v) chemicals; (vi) industrial emissions and major accident hazards; and (vii) horizontal instruments. This followed a previous study conducted in 2011[339]. This report builds on these preceding studies and updates the estimates of the costs and foregone benefits of the lack of implementation of EU environmental law in the EU-27 Member States.

The present study used as a starting point the approaches used in COWI et al (2019) to allow for comparability of its results with the previous assessment but included several improvements across different elements of the approach. These improvements aimed to address weaknesses in the original study and to reflect scientific and analytical advances in the underlying evidence base, data and appraisal methods since it was published. Furthermore, there have been significant developments in the environmental acquis since the 2019 study, in particular reflecting the multiple developments stemming from the EU Green Deal and publication of the 8th Environmental Action Program, which are captured in this study.

The following table presents a high-level comparison of the overall results of the study to those presented in COWI et al. (2019). It presents the results as reported in that study, and adjusted to a 2023 price base for comparability with the estimates of the present study. The table also reports the key differences in approach between the two studies which have led to the change in outcomes. The nature of the differences varies between policy area, and the impact of different changes also varies by the type of change and policy area. It is not possible to undertake a full quantitative comparison between the results of the two studies (as the full details of the approaches taken in COWI et al. (2019) were not available). Further description of the changes and their influence on the results is discussed for each policy area in turn in the following sections.

[338] https://op.europa.eu/en/publication-detail/-/publication/2c05c9e6-59aa-11e9-a8ed-01aa75ed71a1
[339] https://op.europa.eu/en/publication-detail/-/publication/c1ea3ac1-ed7f-4abb-a06b-41b8f515991c/language-en/format-PDF/source-search

Table A1-10-1: High-level comparison of key results from COWI et al. (2019) to present study (all values € billion)

Policy area	COWI et al. (2019) (2018 prices)	COWI et al. (2019) (2023 prices)	Present study (2023 prices)	Key differences in approach of present study (relative to COWI et al. (2019)
Air	***Current:*** 24.6 (8.7 – 40.4)	***Current:*** 29.0 (10.2 – 47.6)	***Current:*** 3.5 to 4.6 ***Targets from 2030:*** 85 to 137	• Updated emissions and concentrations data for 2022 • Updated and expanded the health functions used for quantification • Updated (higher) costs per health outcome • Analysis of targets from 2030.
Noise	30.7* (24.6 – 36.8)	36.1* (29.0 – 43.3)	20 (12.9 to 27.1)	• Dataset with greater coverage • Updated (higher) costs per health outcome • Comparison to ZPAP 30% reduction target rather than full burden estimation • Inclusion in study totals.
Nature & Biodiversity	13.1 (10.5 – 15.7)	15.4 (12.4 – 18.5)	71.5 (62 to 81)	• Different targets (COWI et al. (2019) included illustrative cost assuming Habitats and Birds Directive captured 5% of benefits of Natura 2000 network. Present study assesses two EU BDS 2030 targets and IAS Regulation). • Uses new quantitative data against BDS targets. • New appraisal methods developed to monetise gap.
Water	9.3 (4.3 – 14.3)	10.9 (5.4 – 16.8)	63.7 (54.6 to 70.3)	• Updated values for waterbody status (NWEBS). • Inclusion of chemical status in monetisation. • Inclusion of gap cost for marine. • Updated dataset for 3rd RBMP.
Circular economy & waste	***Current:*** 4.0 (3.2 – 4.8) ***Targets from 2030:*** 107**	***Current:*** 4.7 (3.8 – 5.7) ***Targets from 2030:*** 126**	***Current:*** 21.6 (20.6 – 22.6) ***Targets from 2030:*** 84.5 (79 to 90)	• More targets now monetised (in particular Ecodesign) • Updated prices for raw materials and energy. • Updated data on implementation gap.
Chemicals	-	-	-	-
Industrial emissions and major accident hazards***	3.7 (3.0 – 4.4)	4.4 (3.5 – 5.2)	27 to 98	• Change in approach (COWI et al. (2019) monetised total burden from industrial emissions, present study consider gap to greater ambition). • Updated and expanded the health functions used for quantification • Updated (higher) costs per health outcome.
Horizontal	-	-	-	-
TOTAL	54.7*,** (29.7 – 79.6)	64.4*,** (35.3 – 93.7)	***Current:*** 180 (154 to 208) ***Targets from 2030:*** 325 (294 to 408)	

Notes: *COWI et al. (2019) estimate for noise was not included in the total assessment; **COWI et al. (2019) estimate for waste considering targets that apply from 2030 was not captured in the total nor the executive summary; ***Estimates for Industrial emissions and major accident hazards are not included in the total estimate to avoid double counting with costs assessed under Air.

Air

Most of the indicators and data used for the purposes of this analysis are comparable to COWI et al (2019), using the same sources with updated data. The previous study only presents data for four pollutants covered by the

AAQ Directives ($PM_{2.5}$, PM_{10}, O_3 and NO_2). This study uses data published by the EEA on exceedances including, but not limited to, pollutants previously out of scope such as lead, carbon monoxide, benzene and arsenic. Furthermore, only one population exposure indicator was used in 2019 (the number of urban population in exceedance), which this study both replicates and broadens, also including an analysis of the number of total population in exceedance.

There are several differences in the cost estimation between the current estimates and those made by COWI et al (2019). There have been significant updates to the health functions used for quantification, drawing on literature published in the last decade that has now been reviewed by WHO. For the AAQ Directive standards, the ranges for $PM_{2.5}$ are sharply down with those published previously (COWI et al (2019): €3.6 to 23.8 billion/year for 2016; this study €34 to 134 million/year for 2022). Damage costs for NO_2 under the AAQ Directive are of a broadly similar magnitude (€63 to 105 million/year from COWI et al. (2019) to €34 to 161 million/year this study), although there is a substantial reduction in the estimated population living in areas where limit values are exceeded (34 million vs 1 million). COWI et al. (2019) made substantial estimates of ozone impacts (€4,739 to 15,048 million/year) against those made here of €971 million/year with a different approach being taken to quantifying and valuing the implementation gap.

COWI et al. (2019) did not quantify the costs associated with non-compliance with the NEC Directive through concern over the potential for double counting against the AAQ Directive estimates. For the present study these concerns were reviewed, and it was concluded that there would be very limited potential for overlap if estimates for the AAQ Directive and NEC Directive were combined. There was limited overlap between the countries with exceedance of the AAQD and those with exceedance of the NEC Directive: where such overlap existed analysis here selected the larger of the estimates from either AAQ Directive or NEC Directive. It could be said of course that this is of limited relevance given the transboundary nature of air pollutants, but inspection of the data suggests that this would be of limited importance. This addresses a recommendation from the earlier work.

Noise

In the COWI et al. (2019) study, the data reported under the third round of the END were used to quantify the implementation gap. Since the study publication in 2019, more data related to agglomerations and major noise sources have been reported to the European Commission in relation to the third round of END which were not available at the time of the 2019 study. By using the most recent data, it is therefore possible to provide a more complete estimate of the total population exposed to noise and the implementation gap without having to widely rely on gap filling data.

COWI et al. (2019) defined the implementation gap as the number of people across the EU exposed to 'high noise levels' in 2017'', defined in the 7th EAP (aligned with reporting thresholds under END). However, such an approach is a somewhat mis-leading illustration of the implementation gap of the END given that the END neither states that population exposed to noise is to be reduced to these thresholds nor provides quantitative targets to be achieved through its implementation. Achieving such reduction also might not be feasible in all cases even with significant mitigations and investments. Instead, this study adopts the target defined in the ZPAP which, although not legislative, provides a clearer and more relevant reference that can be used to quantify an actual implementation gap.

Furthermore, the present study adopts a different monetary value per DALY. COWI et al (2019) based their valuation on expected annual income per capita, taken from Eurostat (range €8,400 – 67,000 per year depending on the Member State, 2017 prices). The present study has adopted a value consistent with the VOLY used to assess impacts of air pollution exposure, fixed at €117,000 (2023 prices), also applying an 8% uplift following best practice guidance for the appraisal of noise impacts in the EU[340]. The present study also does not vary the valuation of impact by Member State, as undertaken by COWI et al. (2019) – again this was adopted

[340] https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

for consistency with the valuation of impacts associated with air pollution, although this change is only likely to have a negligible effect on estimates at EU-level.

Nature and biodiversity

COWI et al (2019) aimed to measure the implementation gap with respect to the Habitats and Birds Directives, which overall aims to halt the loss of biodiversity and ecosystem services and ensure species and habitats recovery but noted that these contain no measurable quantitative targets. COWI et al. (2019) considered at 'the State of Nature in the EU'[341] report to assess the status and trends of protected habitats and species. The report concluded that the overall objective had not been met and that it was not possible to predict when the target would be achieved. COWI et al. (2019) also analysed the achievement of four specific objectives concerning different articles of the Habitats Directive and the Birds Directive spanning 13 indicators. However, they concluded that the objectives do not provide measurable targets for nature and biodiversity and therefore not feasible to measure an implementation gap. COWI et al. (2019) also considered the outputs of the mid-term review of the EU Biodiversity Strategy. However, at that stage there were no concrete measurements against the target but rather a statement regarding the progress made towards the target.

The present analysis has been able to go much further in terms of assessing the implementation gap as the EU biodiversity strategy dashboard now contains specific indicators for measurement against the target. Where COWI et al. (2019) provided a qualitative consideration of the objective outlined, this assessment has been able to assess three specific quantitative indicators: Targets 1, 8 and 9 of the EU BDS concerning legally protected land and sea areas, agricultural land under organic farming and trees planted as part of the three billion trees initiative. The study has also looked at forward projections to 2030 of grassland butterfly pollinator species and common birds as part of targets 4 and 5.

The COWI et al. (2019) study measured the implementation gap by assuming that the full implementation of the Habitats and Birds Directives would prevent the annual loss of ecosystem services by 5%. This percentage was applied to the value calculated by the Brink et al (2008) study[342] which estimated that the Natura 2000 network provides €200 – 300 billion per year in ecosystem service benefits. Therefore, the implementation gap cost was calculated at €10.5-15.7 billion per year, and a central estimate of €13.1 billion per year (2018 prices). Converting the central estimate into 2023 prices using the latest GDP deflators[343] would equate to €15.4 billion per year.

This estimate is similar but lower than the estimate calculated for target 1.1 which estimates that the implementation gap could equate to €11 - 30 billion. However, the two values cannot be compared for two key reasons. Firstly, the value used in COWI et al. (2019) only looks at the loss in ecosystem service benefits from the Natura 2000 network which is only one way to protect an area, there are other designations for example National and Regional Protected areas i.e. National Parks, Nature Reserves, Landscape Protected Areas, Marine Protected Areas. Whereas in this study, the value looks at the loss in benefits from all protected areas in Europe.

Secondary, the per hectare values used in this study are from the NRR impact assessment[344] which were derived from a wide-ranging evidence review of the benefits of ecosystem restoration for different habitat types. For most ecosystems it was possible to identify two-unit values, one for each of carbon storage/sequestration benefits and one for increases in total ecosystem values. Whereas, for COWI et al. (2019) the values were calculated for Natura 2000 sites rather than individual habitats.

[341] https://www.eea.europa.eu/publications/state-of-nature-in-the-eu
[342] https://www.researchgate.net/publication/260657684_The_costs_and_socio-economic_benefits_associated_with_the_Natura_2000_network
[343] https://data.ecb.europa.eu/data/datasets/MNA/MNA.A.N.I9.W2.S1.S1.B.B1GQ._Z._Z._Z.IX.D.N
[344] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022SC0167&qid=1686750707844

Water

Inland surface, transitional and coastal water bodies – magnitude of the implementation gap and estimates of cost

The cost of the WFD implementation gap for water bodies in COWI et al. (2019) uses the same method as the 2011 report by the same authors. Both reports applied the percentage of waters below 'good ecological status' in the EU and a transfer of a 2007 willingness-to-pay estimate for England and Wales to arrive at an estimate of the overall benefits of the achieving 'good ecological status' in EU waters of between €12 billion and €44 billion per year. The resulting implementation gap cost on EU-28 level was thus estimated to be between €3.2 billion and €13.0 billion per year in COWI et al. (2019) based on the results of the 2nd RBMP from 2016. **It is important to note that the COWI et al. (2019) estimates focussed only on good ecological status and did not seek to account for chemical status (which has been accounted for in this study).**

Notably, the COWI et al. (2019) report recognises that not accounting for Article 4 exemptions would overestimate the implementation gap cost, but nevertheless they did not manage to come up with an estimate of the implementation gap taking account of exemptions, owing to challenges regarding the interpretation of the data. The present study has thus gone further than the previous studies in producing such an estimate.

As regard the comparison of the actual estimates from COWI et al. (2019) with those produced in the current study, Section 5.4.1 notes that the 2007 E&W WTP values underpinning both COWI et al. (2011 and 2019) were actually updated in 2012 to provide the much more detailed series of National Water Environment Benefit Survey (NWEBS) values for E&W. The updated values have been applied to the results of the 3rd RBMP (of 2021) in this study to provide the updated estimate of the costs of non-implementation. **As such, the estimates in this (current) report are not directly comparable to those provided in the COWI et al. (2019) report as the valuation methods used have been updated.**

Groundwaters

As described earlier, the COWI et al. (2019) estimates have been updated by applying data on the percentage change in chemical status of groundwaters between the 2nd RBMP data (2016) and the 3rd RBMP (2021) to adjust values. These suggest that forgone benefits have reduced from the €648.6 million per year from the 2nd RBMP data (2016) to €636.7 million per year in the 3rd RBMP (2021).

Marine Waters

Owing to inconsistency and lack of coherence in status assessments identified by the Commission's report of the first phase (2012) of implementation of the MSFD and the lack of available data from the 2018 MSFD status assessment (the timing of which coincided with the 2019 study), the environmental gap under the MSFD was not assessed in COWI et al. (2019).

Circular economy and waste

There have been numerous changes and proposals to the circular economy and waste legislation since COWI et al. (2019), with several of the policies now including new or additional targets. This report building upon the information in COWI et al. (2019) and used the same methods and data sources for most of the legislative targets. Below is a summary of the key differences.

Implementation gap

Waste Framework Directive (EU) 2018/851

In COWI et al. (2019), the implementation gap for recycling rates of Member States against the municipal waste target was calculated using data from a 2018 Eunomia study. At the time of COWI et al. (2019), Member States used one of four methods to calculate their recycled municipal waste amounts, thereby making comparisons between Member States impossible. A 2018 amendment to the WFKD updated the calculation methods for Member States and, according to Eurostat, between 2019 and 2022, Member States adopted their data collection system based on new definitions set out in the 2018 WFKD amendment[345]. For this study, the same method in the EEA's Early Warning Report was used to calculate the recycling rate which used Eurostat as the data source[346].

For the implementation gap for the SDG reduction in food waste target, COWI et al. (2019) used data from an IVL Swedish Environmental Research Institute report[347]. The data provided an estimate of food waste generated in each sector based on data from a variable number of countries, including the UK. Member State data in Eurostat was not yet available at the time; 2020 was the first year for which data on food waste collection was available in Eurostat and subsequently Eurostat data was used for calculating the implementation gap in this report. The implementation gap from COWI et al. (2019) to the SDG target based on 2012 levels which includes the EU-28, whereas the updated estimation in this report includes only the EU-27.

COWI et al. (2019) also did not provide a breakdown of the implementation gap of each Member State against the CDW target, instead noting that all Member States except for Cyprus, Slovakia and Sweden met the target. COWI et al. (2019) focused on the quality issues of the data.

WEEE Directive 2012/19/EU

The WEEE Directive targets changed with the latest revision because the Commission added a division in categories for the EEE products, and each category has specific targets for recovery, preparation for re-use, and recycling. Hence the data shown for this Directive are different than in COWI et al. (2019).

Batteries Directive 2006/66/EC and New Batteries Regulation (EU) 2023/1542

The calculation method for the collection rate of waste portable batteries has changed since COWI et al. (2019) report. COWI et al. (2019) used the calculation method laid out in Appendix I of the Batteries Directive[348], whereas this report used the updated calculation method laid out in Appendix XI of the New Batteries Regulation[349] because the new Regulation will repeal the Directive in 2025.

Implementation gap costs

The 2019 report estimated that the total non-implementation gap cost against current targets was €4 billion. Since 2019, this value has nearly doubled with the current non-implementation gap cost against current targets now around €5.7-7.8 billion (€19.7-21.8 billion including costs associated with non-compliance with the Ecodesign Directive). This increase can be attributed to the larger costs associated with non-implementation of the major waste directives and WEEE. The cost associated with the implementation gap to the 2025 MSW target is nearly double the value in the 2019 report which considered the gap to the 2020 MSW target because more Member States not meeting the 2025 target and there is a larger implementation gap to the 2025 target than the 2020 target. The larger value associated with non-implementation of the WEEE existing targets can be attributed to a higher estimated weight of precious metals lost per tonne of WEEE and a larger implementation gap against the 2019 collection target.

Furthermore, considering the developments to the circular economy and waste policies since 2019, this report has also gathered additional information on the economic and environmental costs associated with waste

[345] https://ec.europa.eu/eurostat/cache/metadata/en/env_wasmun_esms.htm
[346] https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-products/methodology-for-the-early-warning-assessment-related-to-certain-waste-targets
[347] https://www.researchgate.net/publication/301216380_Estimates_of_European_food_waste_levels
[348] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006L0066-20180704#tocId36
[349] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02023R1542-20240718#tocId899

streams that were not monetised in the 2019 report, specifically batteries, waste shipments and single use plastics.

In contrast to the increase in the cost of non-implementation against existing targets, the cost of non-implementation against future targets has decreased since the 2019 report. The 2019 report estimated that the total non-implementation gap cost against future targets was €107 billion against future targets and is now currently estimated at €64-77 billion per year (€78-89 billion per year including costs associated with non-compliance with the Ecodesign Directive). This value is smaller despite including the costs from non-implementation of targets from three additional policies and future costs from asbestos waste. Since 2019, the EU has made noticeable progress in reducing its food waste. The environmental and economic costs associated with not meeting the SDG for food was reduction was estimate at €92 billion in 2019 and has since decreased by 40%. Furthermore, a different modelling technique was used in this report for estimating the foregone material value against future targets in the major waste directives.

Considering the overall historical trends, the EU has seen a steady increase in MSW recycling and a decrease in GHG emissions from waste management, despite waste generation also increasing. If these trends continue, especially in light of recent policy proposals targeting major waste streams, the costs associated with lost material value and GHG emissions could continue to decline. While not included in the total costs, the proposed changes to the Waste Framework Directive, Packaging and Packaging Waste Directive and ELV Directive will also impact the implementation gap and costs in the future. Based on the impact assessments for each policy, the proposed targets could bring an additional €93-107 billion per year in future economic and environmental benefits.

Chemicals

COWI et al. (2019) focussed on the same pieces of legislation in their previous assessment – REACH and CLP – and also noted that neither piece of legislation provides specific environmental targets. They conclude that REACH and CLP are not subject to an implementation gap and therefore there are no associated implementation gap costs. Our assessment looks in more detail at the changes to CLP which have now been implemented and the implementation of specific processes taking place under REACH. The qualitative discussion presented in this analysis examines the implications of Restriction, Authorisation and enforcement processes under REACH not being implemented as quickly and as cost effectively (for both authorities and industry) as intended in the legislation. Unlike COWI et al. (2019), we conclude that there is likely an implementation gap cost but quantification is not appropriate.

Industrial emissions and major accident hazards

With respect to analysis of non-implementation of the IED, COWI et al. (2019) focused on analysis of a small subset of individual permits to assess stringency in relation to where emission limits are set in the BAT-AEL range. Since 2019, a number of studies have been conducted which have analysed permits, including the evaluation of the IED and subsequent impact assessment for its revision, assessment of implementation reports, and specific permit analysis studies including analysis of permits of ex-TNP plants. This study therefore presents a broader analysis drawing on the assessment of literature which has identified that permits have mostly been set at the upper end of the BAT-AEL range. The present analysis utilises the modelling outputs of IIASA et al (2023) to illustrate the gap in achieved emission reductions compared with the strictest possible reductions that could have been achieved (MTFR scenario), and as such has a different focus to COWI (2019) which looked only at the stringency of permits.

With regard to the Seveso-III Directive, it found that the Directive has been well implemented in Member States, with impacts on the reduction in risk of major industrial accidents and associated monetary value. However, assessment of cost of non-implementation was deemed to be not possible due to not being able to establish how many accidents would have occurred in the Directive's absence. As such, assessment of the implementation gap was not undertaken, but rather a case study approach was used to illustrate potential impacts. A similar approach is adopted here but referencing a wider evidence base made available since the preceding study.

With regard to cost impacts, COWI (2019) provided estimates of the total costs of emissions to air from IED activities, rather than seeking to understand the benefits of a stricter implementation of BAT. However, their analysis supports the conclusion provided here that despite being the subject of regulation over many years, industry in Europe still generates emissions capable of causing significant harm to the population.

Horizontal instruments

As concluded in COWI et al. (2019), no quantification and monetisation of the implementation gaps for horizontal instruments is possible. This report chose to assess qualitatively three horizontal instruments other than those that were covered in COWI et al (2019).

A2 Appendix 2 – additional policy context, detail on approach, and results tables

Air

AAQD implementation gap data tables

Table A2-10-3: Number of recorded instances where concentrations are above relevant limit or target values, per Member State in 2022 (number of sampling point locations)

Member State	$PM_{2.5}$	PM_{10}	NO_2	SO_2	Lead	Carbon Monoxide	Benzene	Ozone	Arsenic	Cadmium	Nickel	BaP	Total	Total (excl. Ozone)
Austria	0	0	0	0	0	0	0	36	0	0	0	1	37	1
Belgium	0	0	2	0	0	0	0	0	2	0	0	0	4	4
Bulgaria	0	0	1	0	0	0	0	1	0	1	0	3	6	5
Croatia	1	0	1	0	0	0	0	2	0	0	0	2	6	4
Cyprus	0	1	0	0	0	0	0	2	0	0	0	0	3	1
Czechia	0	0	0	0	0	0	0	23	0	0	0	19	42	19
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0	2	0	1	2	5	5
France	0	1	10	0	0	0	0	79	0	0	1	1	92	13
Germany	0	0	3	0	0	0	0	65	0	0	1	0	69	4
Greece	0	0	3	0	0	0	0	8	0	0	0	0	11	3
Hungary	0	0	0	0	0	0	0	6	0	0	0	6	12	6
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	6	3	16	0	0	0	0	197	0	0	1	18	241	44
Lavia	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Member State	$PM_{2.5}$	PM_{10}	NO_2	SO_2	Lead	Carbon Monoxide	Benzene	Ozone	Arsenic	Cadmium	Nickel	BaP	Total	Total (excl. Ozone)
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Malta	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland	1	0	3	0	0	0	0	6	2	0	0	144	156	150
Portugal	0	0	2	0	0	0	0	8	0	0	0	0	10	2
Romania	0	1	2	0	0	0	0	6	0	0	0	0	9	3
Slovakia	0	0	0	0	0	0	0	3	0	0	0	10	13	10
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	1	20	1	0	0	0	0	47	0	0	0	1	70	23
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total with exceedances	**4**	**5**	**11**	**0**	**0**	**0**	**0**	**17**	**3**	**1**	**4**	**11**		
Total number of exceedances	**9**	**26**	**44**	**0**	**0**	**0**	**0**	**491**	**6**	**1**	**4**	**207**	**788**	**297**

Source: EEA, 2024. AQ eReporting – Annual Statistics. Available at: https://www.eea.europa.eu/en/analysis/maps-and-charts/air-quality-statistics-dashboards.

Table A2-10-4: Instances where concentrations are above relevant limit or target values over time (number of sampling point locations across EU27)

Year	$PM_{2.5}$	PM_{10}	NO_2	SO_2	Lead	Carbon Monoxide	Benzene	Ozone	Arsenic	Cadmium	Nickel	PAHs
2015	78	83	350	2	1	1	4	561	8	7	0	212
2016	56	40	311	0	0	1	5	204	8	3	3	212
2017	88	73	308	3	0	1	3	267	7	2	4	225
2018	49	48	266	1	3	2	4	580	9	0	2	210
2019	14	15	184	2	0	2	2	302	7	1	2	221
2020	12	10	41	2	0	1	1	139	7	1	2	211
2021	14	10	52	1	0	2	1	150	6	1	2	220
2022	9	26	44	0	0	0	0	270	6	1	4	208

Source: EEA, 2024. AQ eReporting – Annual Statistics. Available at: https://www.eea.europa.eu/en/analysis/maps-and-charts/air-quality-statistics-dashboards.

Table A2-10-5: Percentage of urban population exposed to air pollutant concentrations above selected EU air quality standards, EU-27

Year	$PM_{2.5}$	PM_{10} (Daily limit value)	O_3	NO_2
2000		51	19	27
2001		35	34	20
2002		40	23	22
2003		48	64	32
2004		33	23	19
2005		40	25	20
2006	21	44	54	16
2007	12	35	23	19
2008	10	28	18	11
2009	9	26	17	13
2010	11	27	19	11
2011	15	33	18	11
2012	12	24	18	7
2013	9	22	19	8
2014	8	18	9	6
2015	7	23	36	8
2016	5	12	14	6
2017	8	19	19	7
2018	3	16	42	3
2019	0	11	25	3
2020	0	10	12	1
2021	0	10	10	1
2022	1	9	19	1

Source: EEA, 2024. Exceedance of air quality standards in Europe. Available at: https://www.eea.europa.eu/en/analysis/indicators/exceedance-of-air-quality-standards

Table A2-10-6: Percentage of total population exposed to air pollution > EU limit values

	NO_2	Ozone	PM_{10} (Annual average limit value)	$PM_{2.5}$
Austria	0	12	0	0
Belgium	0	0.1	0	0
Bulgaria	0	0.4	0	0
Croatia	0	28.1	0	0
Cyprus	2.6	11	54	0
Czechia	0	16.4	0	0
Denmark	0	0	0	0
Estonia	0	0	0	0
Finland	0	0	0	0
France	0.5	20.1	0	0
Germany	0	19.4	0	0
Greece	3.3	16.3	1.1	0
Hungary	0	32.4	0	0
Ireland	0	0	0	0
Italy	0.5	24.9	0	0.3
Latvia	0	0	0	0
Lithuania	0	0	0	0
Luxembourg	0	0	0	0
Malta	0	1.4	0	0
Netherlands	0	0	0	0
Poland	0	1.4	0	1.5
Portugal	0	8.2	0	0
Romania	0.2	0	0	0
Slovakia	0	10.9	0	0
Slovenia	0	56.1	0	0
Spain	0	5.3	0	0
Sweden	0	0	0	0

Source: Horálek, J. et al. (2024). ETC HE Report 2024/4: Air quality maps of EEA member and cooperating countries for 2022. PM10, PM2.5, O3, NO2, NOx and BaP spatial estimates and their uncertainties. Eionet Portal. Available at: https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-reports/etc-he-report-2024-4-air-quality-maps-of-eea-member-and-cooperating-countries-for-2022-pm10-pm2-5-o3-no2-nox-and-bap-spatial-estimates-and-their-uncertainties

NEC Directive implementation gap data tables

Table A2-10-7: Emissions by pollutant and change compared to 2016 (EU-27)

Emission type	2016	2017	2018	2019	2020	2021	2022
Ktonnes							
SO_2	1,978	1,926	1,789	1,549	1,327	1,349	1,290
NOx	6,974	6,810	6,592	6,204	5,541	5,583	5,384
NMVOC	6,859	6,886	6,762	6,602	6,508	6,474	6,291
NH_3	3,683	3,679	3,633	3,536	3,494	3,422	3,267
$PM_{2.5}$	1,504	1,482	1,517	1,414	1,334	1,373	1,279
Change relative to 2016 values							
SO_2	n/a	3%	10%	22%	33%	32%	35%
NOx	n/a	2%	5%	11%	21%	20%	23%
NMVOC	n/a	0%	1%	4%	5%	6%	8%
NH_3	n/a	0%	1%	4%	5%	7%	11%
$PM_{2.5}$	n/a	1%	-1%	6%	11%	9%	15%

Source: EEA, Air pollution in Europe: 2024 reporting status under the National Emission reduction Commitments Directive: https://www.eea.europa.eu/publications/national-emission-reduction-commitments-directive-2024#:~:text=The%20National%20Emission%20reduction%20Commitments%20Directive%20(NEC%20Directive)%20sets%20obligations,)%20(EU%2C%202016

Table A2-10-8: EU-27 annual tonnages and annual percentage emission change

Emission type	2016	2017	2018	2019	2020	2021	2022
Ktonnes							
SO_2	1,978	1,926	1,789	1,549	1,327	1,349	1,290
NOx	6,974	6,810	6,592	6,204	5,541	5,583	5,384
NMVOC	6,859	6,886	6,762	6,602	6,508	6,474	6,291
NH_3	3,683	3,679	3,633	3,536	3,494	3,422	3,267
$PM_{2.5}$	1,504	1,482	1,517	1,414	1,334	1,373	1,279
Annual percentage reduction							
SO_2	n/a	-3%	-8%	-15%	-17%	2%	-5%
NOx	n/a	-2%	-3%	-6%	-12%	1%	-4%
NMVOC	n/a	0%	-2%	-2%	-1%	-1%	-3%
NH_3	n/a	0%	-1%	-3%	-1%	-2%	-5%
$PM_{2.5}$	n/a	-1%	2%	-7%	-6%	3%	-7%

Source: EEA, Air pollution in Europe: 2024 reporting status under the National Emission reduction Commitments Directive: https://www.eea.europa.eu/publications/national-emission-reduction-commitments-directive-2024#:~:text=The%20National%20Emission%20reduction%20Commitments%20Directive%20(NEC%20Directive)%20sets%20obligations,)%20(EU%2C%202016

Table A2-10-9: Assessment of the implementation gap between 2022 emissions and ERCs (%)

Member State	2020-29+ ERCs					2030+ ERCs				
	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$
Austria	-44	-39	-78	4	-39	29	-13	-42	15	6
Belgium	-54	-55	-222	-20	-57	-7	-28	-92	-7	-20
Bulgaria	-25	-6	-257	8	-14	11	22	-95	17	16
Croatia	-29	-41	-375	-46	-36	19	-11	-80	-11	26
Cyprus	-8	-24	43	-5	-17	13	-13	76	7	35
Czechia	-35	-13	-77	-3	-10	25	31	-10	14	47
Denmark	-22	-6	-110	-2	-28	12	-3	-33	-2	14
Estonia	-63	-23	-255	-3	-43	-39	2	-67	-3	1
Finland	-44	-39	-115	-6	-36	-17	-12	-102	-6	-28
France	-29	-21	-133	-15	-47	20	-2	-19	-5	14
Germany	-7	-36	-46	-16	-17	38	-12	22	13	10
Greece	-48	-19	-247	-16	-20	3	2	-60	-12	7
Hungary	-31	-18	-64	6	2	33	29	18	29	49
Ireland	-16	-22	-175	4	-43	30	-11	-18	8	-3
Italy	-27	-10	-203	-30	-14	26	9	-35	-15	24
Latvia	-5	-22	-114	0.5	-34	-2	-4	-25	0	9
Lithuania	27	8	-10	19	-20	31	29	3	19	4
Luxembourg	-201	-28	-285	-6	-107	10	-5	-192	16	-46
Malta	-22	-20	-1556	-14	-49	56	-14	-259	10	1
Netherlands	-34	-22	-149	-11	-26	5	-12	-63	-1	-10
Poland	-18	-6	-42	-19	-3	-3	-5	-4	0	48
Portugal	-41	-11	-125	4	-9	18	16	-3	12	40
Romania	3	-14	-198	-13	19	29	16	-55	3	53
Slovakia	-33	-35	-183	-7	-31	-4	-12	-19	12	-4
Slovenia	-38	-41	-331	-15	-27	21	14	7	2	32
Spain	-44	-13	-267	-9	-10	7	12	-33	6	35
Sweden	-18	-24	-81	5	-75	37	-6	-81	7	-75

Source 2020-29 values: See Aether (2024), 'Final horizontal review report - Review of National Air Pollutant Emission Inventory Data 2024 under Directive 2016/2284': https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/8c979d9e-7c23-4b30-ba1e-4c9a58e3e754/details?download=true. 2030+ values are derived based on 2022 emissions from Aether (2024).

AAQ Directive – cost calculation additional tables

Table A2-10-10: Population in 2022 in areas exceeding limit values for $PM_{2.5}$, PM_{10} and NO_2. For ozone, required reduction in national population weighted annual average SOMO35 averaged from 2018 to 2022, assumed to apply to the whole population in each country, is shown. Includes only countries showing exceedance for at least one limit/target.

	$PM_{2.5}$ % of population in areas >25 µg.m^{-3}	PM_{10} % of population in areas >40 µg.m^{-3}	NO_2 % of population in areas >40 µg.m^{-3}	*O_3 SOMO35 - Required average SOMO35 reduction (ppb.hours)*
Austria				*455*
Belgium				*132*
Bulgaria				*105*
Croatia				*485*
Cyprus		54	2.6	*538*
Czechia				*359*
France			0.5	*612*
Germany				*626*
Greece		1.1	3.3	*979*
Hungary				*421*
Italy	0.3		0.5	*2,425*
Luxembourg				*286*
Malta				*267*
Netherlands				*60*
Poland	1.5			*187*
Portugal				*380*
Romania			0.2	*150*
Slovakia				*228*
Slovenia				*696*
Spain				*674*

Source: Horálek, J. et al. (2024). ETC HE Report 2024/4: Air quality maps of EEA member and cooperating countries for 2022. PM10, PM2.5, O3, NO2, NOx and BaP spatial estimates and their uncertainties. Eionet Portal. Available at: https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-reports/etc-he-report-2024-4-air-quality-maps-of-eea-member-and-cooperating-countries-for-2022-pm10-pm2-5-o3-no2-nox-and-bap-spatial-estimates-and-their-uncertainties

Table A2-10-11: Damage costs, EUR/person/year/µg.m^{-3} for $PM_{2.5}$ and NO_2 and EUR/person/ppb.hour for O_3. 2023 prices.

	$PM_{2.5}$ 1&2 VOLY	$PM_{2.5}$ 1,2&3 VOLY	NO_2 1&2 VOLY	$PM_{2.5}$ 1&2 VSL	$PM_{2.5}$ 1,2&3 VSL	NO_2 1&2 VSL	O_3 1&2 VOLY
Austria	113.09	187.66	20.43	339.40	413.97	77.46	0.0032
Belgium	108.93	187.13	20.04	328.84	407.04	75.46	0.0028
Bulgaria	142.20	208.88	26.41	576.45	643.13	135.75	0.0059
Croatia	123.59	197.97	22.99	469.87	544.25	110.19	0.0040
Cyprus	109.86	183.12	20.33	253.27	326.53	56.51	0.0020
Czechia	122.91	188.16	22.42	398.54	463.79	91.86	0.0036
Denmark	110.46	162.52	20.80	326.09	378.15	75.15	0.0028
Estonia	116.52	189.21	21.60	414.56	487.25	96.67	0.0039
Finland	112.80	192.34	20.70	380.35	459.89	88.10	0.0038
France	103.02	166.82	19.09	317.10	380.90	73.03	0.0028
Germany	117.79	225.27	20.70	405.24	512.72	93.10	0.0037
Greece	112.56	204.09	20.33	412.46	503.98	95.86	0.0035
Hungary	131.19	197.41	24.86	480.89	547.10	112.93	0.0043
Ireland	106.59	156.85	20.19	237.00	287.26	53.10	0.0020
Italy	107.08	215.87	19.40	382.48	491.27	88.77	0.0034
Latvia	130.34	206.51	24.39	526.92	603.10	124.25	0.0046
Lithuania	128.41	201.82	23.71	499.66	573.07	117.19	0.0047
Luxembourg	105.00	148.30	19.76	236.81	280.11	53.02	0.0023
Malta	102.12	168.21	19.76	260.84	326.92	59.79	0.0024
Netherlands	111.36	184.11	20.77	317.87	390.62	72.82	0.0027
Poland	122.74	184.80	23.51	404.73	466.79	94.55	0.0038
Portugal	108.25	200.05	20.04	394.29	486.09	92.08	0.0034
Romania	134.33	198.09	25.50	483.63	547.39	113.48	0.0047
Slovakia	125.80	177.55	23.65	372.89	424.64	85.93	0.0034
Slovenia	111.79	183.87	20.62	359.20	431.28	82.96	0.0031
Spain	103.67	172.68	18.74	317.58	386.59	72.64	0.0028
Sweden	109.19	194.01	19.76	303.44	388.26	68.72	0.0027

Notes: "1&2" and "1, 2&3" refer to the confidence bands used in the CAO4 analysis, band 3 including dementia and diabetes.

NEC Directive – cost calculation additional tables

Table A2-10-12: Gap between 2022 emissions and 2022-2029 NEC Directive ERCs (kt/year). Only countries with excess emissions are shown.

	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$
Austria				2.6	
Bulgaria				5.1	
Cyprus			4.8		
Hungary				4.7	0.8
Ireland				5.0	
Latvia				0.1	
Lithuania	10.8	3.0		7.8	
Portugal				1.9	
Romania	5.0				20.7
Sweden				2.4	
Total	**15.8**	**3.0**	**4.8**	**29.6**	**21.5**

Table A2-10-13: Damage costs, € k/tonne emission, for country/pollutant pairs. Data show sensitivity to valuation of mortality using the VOLY and VSL, and to inclusion of $PM_{2.5}$ morbidity functions in CAO4 confidence group 3 covering dementia and diabetes. 2023 prices.

	NOx		NMVOC		SO_2		NH_3		$PM_{2.5}$	
	VOLY	VSL	VOLY	VSL	VOLY	VSL	VOLY	VSL	VOLY	VSL
Damage cost € k per tonne. lower bound: confidence bands 1 and 2; upper bound: confidence bands 1, 2 and 3										
Austria	43 - 62	137 - 155	4 - 6.3	11 - 13	72 - 120	217 - 265	30 - 49	89 - 108	202 - 335	594 - 724
Belgium	38 - 52	133 - 149	4.3 - 7	13 - 15	60 - 102	192 - 237	62 - 106	200 - 248	223 - 383	715 - 884
Bulgaria	19 - 23	67 - 70	1.1 - 1.5	2.4 - 2.7	25 - 37	71 - 79	21 - 31	63 - 70	80 - 118	254 - 284
Croatia	27 - 37	93 - 102	2.3 - 3.4	6.2 - 7.1	44 - 69	137 - 159	20 - 32	64 - 74	81 - 130	268 - 311
Cyprus	7 - 9	6 - 7	0.6 - 0.9	1 - 1.2	9 - 15	11 - 15	0.8 - 1.3	2.4 - 3.1	5.8 - 10	18 - 24
Czechia	30 - 42	96 - 106	2.9 - 4.2	7.5 - 8.7	42 - 64	122 - 142	40 - 61	116 - 134	119 - 182	337 - 392
Denmark	15 - 19	48 - 52	1.3 - 1.7	3 - 3.4	24 - 35	67 - 77	17 - 24	46 - 53	65 - 95	181 - 210
Estonia	7 - 8	28 - 29	0.8 - 1.1	2 - 2.3	4.4 - 7	15 - 17	5.8 - 9.3	16 - 19	27 - 43	62 - 72
Finland	8 - 9	30 - 31	0.6 - 0.9	1.6 - 1.9	10 - 16	29 - 35	6.6 - 11	20 - 24	50 - 86	156 - 189
France	34 - 46	105 - 117	2.5 - 3.8	6.5 - 7.8	49 - 79	142 - 170	19 - 31	55 - 66	135 - 218	395 - 474
Germany	41 - 63	140 - 158	3.7 - 6.6	9.4 - 12	56 - 107	161 - 204	37 - 71	107 - 136	226 - 432	662 - 838
Greece	16 - 18	66 - 68	1.7 - 3	4.8 - 5.8	17 - 31	51 - 62	16 - 29	55 - 67	70 - 126	245 - 299
Hungary	30 - 38	108 - 115	1.9 - 2.6	5.1 - 5.8	38 - 57	122 - 138	25 - 37	80 - 91	101 - 153	339 - 386
Ireland	17 - 23	49 - 56	1.2 - 1.7	3.5 - 4.2	34 - 50	96 - 116	8.6 - 12	25 - 30	39 - 57	95 - 116
Italy	44 - 73	155 - 180	5 - 9.5	14 - 18	47 - 94	146 - 187	32 - 63	99 - 127	204 - 412	652 - 838
Latvia	11 - 13	50 - 51	0.7 - 1	1.6 - 1.9	11 - 17	36 - 41	6.1 - 10	19 - 22	39 - 62	134 - 154
Lithuania	10 - 12	40 - 42	0.5 - 0.7	1.2 - 1.4	10 - 16	32 - 36	6.7 - 10	21 - 24	66 - 104	222 - 255
Luxembourg	36 - 48	93 - 108	3.5 - 4.8	8.7 - 10.1	76 - 107	202 - 239	34 - 48	86 - 101	104 - 146	246 - 291
Malta	10 - 10	9 - 9	0 - 0	0 - 0	1.7 - 2.5	3.2 - 3.9	0 - 0	0 - 0	13 - 21	35 - 44

	NOx		NMVOC		SO_2		NH_3		$PM_{2.5}$	
Netherlands	46 - 60	146 - 161	4.6 - 7.2	12 - 14	60 - 99	166 - 204	55 - 91	153 - 187	227 - 376	617 - 758
Poland	19 - 25	61 - 66	1.6 - 2.2	3.8 - 4.3	26 - 39	73 - 84	28 - 42	79 - 91	136 - 205	380 - 438
Portugal	15 - 19	58 - 62	1.2 - 2.1	3.3 - 4	18 - 33	56 - 69	13 - 24	42 - 51	96 - 177	316 - 389
Romania	26 - 32	92 - 98	1.2 - 1.7	3.1 - 3.5	30 - 44	94 - 106	16 - 24	50 - 57	73 - 108	240 - 272
Slovakia	25 - 31	83 - 89	1.6 - 2.1	4.6 - 5.2	31 - 44	100 - 113	29 - 41	91 - 103	77 - 109	232 - 264
Slovenia	31 - 44	120 - 136	2.7 - 4.2	10 - 11	41 - 68	161 - 193	21 - 34	79 - 95	87 - 143	323 - 387
Spain	18 - 22	60 - 64	1.7 - 2.7	4.7 - 5.7	32 - 54	99 - 121	10 - 16	28 - 34	79 - 132	242 - 295
Sweden	11 - 14	36 - 39	0.8 - 1.4	2.3 - 2.9	11 - 19	33 - 43	10 - 18	30 - 38	34 - 61	102 - 130

Source: Damage costs per tonne of pollutant were calculated adjusting those reported by EEA (2023) with updated assumptions from the CAO4 analysis. EEA (2023), Estimating the external costs of industrial air pollution: Trends 2012-2021. Technical note on the methodology and additional results from the EEA briefing 24/2023.

Table A2-10-14: Gap between 2022 emissions and 2030+ ERCs (ktonnes/year). Only countries with excess emissions are shown.

	NOx	NMVOC	SO_2	NH_3	$PM_{2.5}$
Austria	30.4			9.9	0.8
Bulgaria	8.8	13.8		10.3	4.5
Croatia	8.2				6.7
Cyprus	1.4		8.6	0.5	0.3
Czechia	35.1	79.2		9.7	26.1
Denmark	7.9				1.6
Estonia		0.4			0.1
France	113.1				23.2
Germany	323.4		57.4	67.3	8.3
Greece	7.5	2.3			2.6
Hungary	26.7	26.6	2.5	23.7	17.7
Ireland	17.6			10.0	
Italy	148.7	61.2			34.3
Latvia				0.1	1.6
Lithuania	12.4	10.3	0.3	7.8	0.2
Luxembourg	1.1			1.0	
Malta	2.5			0.2	0.0
Netherlands	8.1				
Poland				1.3	126.6
Portugal	21.0	22.0		6.0	17.5
Romania	51.1	29.3		4.5	57.0
Slovakia				3.3	
Slovenia	4.9	3.1	0.2	0.3	3.1
Spain	35.5	49.3		26.4	46.0
Sweden	36.7			3.6	
Total	901.9	297.4	69.0	185.6	378.2

Noise

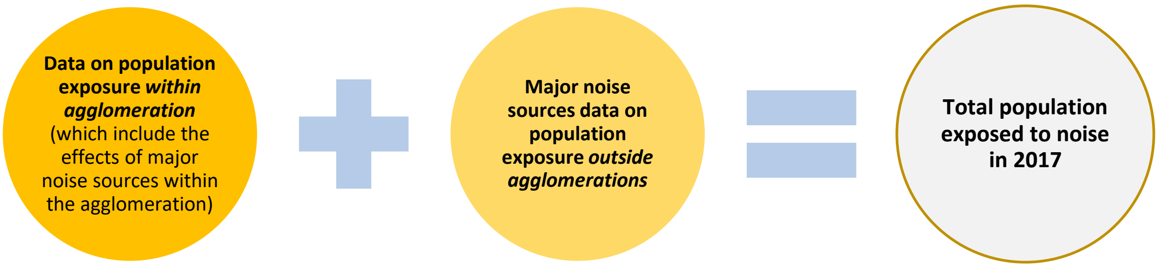
Implementation gap assessment

As the first step for the implementation gap assessment, the total number of people exposed to each noise source has been calculated from L_{den} 55 dB and L_{night} 50 dB.

In this context, each of the noise sources considered in the END (i.e. road, rail, airports and industrial) has been considered individually, as a single person may or may not be exposed to multiple noise sources and the data as current reported to the European Commission do not allow this kind of considerations.

In counting the total population exposed to noise, when considering the END data relative to agglomerations, the effects of major noise sources within the agglomeration have been also taken into account. With regard to the data relative to major noise sources data, only the population outside the agglomerations have been considered for the population count. This is to avoid any population double counting in the assessment from the agglomeration and major noise sources data (Figure A2-10-1).

Figure A2-10-1: Data considered for the calculations of the total population exposed to noise



For those agglomerations and major noise sources for which data are yet to be reported under the END third round, gap filling data provided by the EEA and ETC/HE have been used.

Table A2-10-15 Total population exposed to >55dB L_{den} across different sources, 2017

Number of people exposed >55dB L_{den}	Road	Rail	Air
Inside Agglomeration (Reported)	63,446,200	8,373,500	1,637,700
Inside Agglomeration (Gap filling)	6,156,300	727,500	533,900
Outside Agglomeration (Reported)	18,994,600	10,003,900	1,368,200
Outside Agglomeration (Gap filling)	40,600	6,100	32,700
Total population	88,637,700	19,111,000	3,572,500

As the second step for the quantification of the implementation gap, a reduction of 30% in the population exposed to noise has been calculated for each individual noise source, which corresponds to the ZPAP noise target. Being the population within the 55 dB L_{den} noise exposure levels inclusive of the population exposed to 50 dB L_{night}, the calculation of the of 30% reduction in population exposure only considers the L_{den} exposures to avoid any double counting of the population in setting the 2030 noise target. As the ZPAP refers only to transport noise, population exposed to industrial noise sources have been excluded from the calculations.

Finally, the difference between the total population exposed to noise and the ZPAP target for each noise source corresponds to the implementation gap. These are presented in the table below.

Table A2-10-16 Implementation gap against the ZPAP target for population exposed to >55dB L_{den} across different sources, 2017

Number of people exposed >55dB L_{den}	Road	Rail	Air
Total population	88,637,700	19,111,000	3,572,500
ZPAP Target	62,046,390	13,377,700	2,500,750
Implementation gap	26,591,310	5,733,300	1,071,750

The following tables and figures are additional detailed results, referenced in the main body of the report.

Table A2-10-17 Trend of change in noise exposure between 2017 and 2022 based on agglomerations and major noise sources for which noise exposure data have been consistently reported between END Third Round and END Fourth

Number of people exposed >55dB L_{den}	Road	Rail	Air
Agglomerations and major sources consistently reported, 2017	61,446,900	16,269,200	2,364,700
Agglomerations and major sources consistently reported, 2022	65,830,400	14,240,800	1,739,200
% of difference	7%	-12%	-26%

Table A2-10-18 Forward looking assessment on change of noise based on an identified trend[350]

Years	Road	Rail	Air
2017	0%	0%	0%
2018	1%	-2%	-5%
2019	3%	-5%	-10%
2020	4%	-7%	-16%
2021	6%	-10%	-21%
2022	7%	-12%	-26%
2023	8%	-14%	-31%
2024	10%	-17%	-36%
2025	11%	-19%	-42%
2026	13%	-22%	-47%
2027	14%	-24%	-52%
2028	15%	-26%	-57%
2029	17%	-29%	-62%
2030	18%	-31%	-68%

[350] Based on data have been consistently reported between END Third Round and END Fourth

Figure A2-10-2: Percentage of total reported data between END Third Round and END Fourth Round for agglomerations

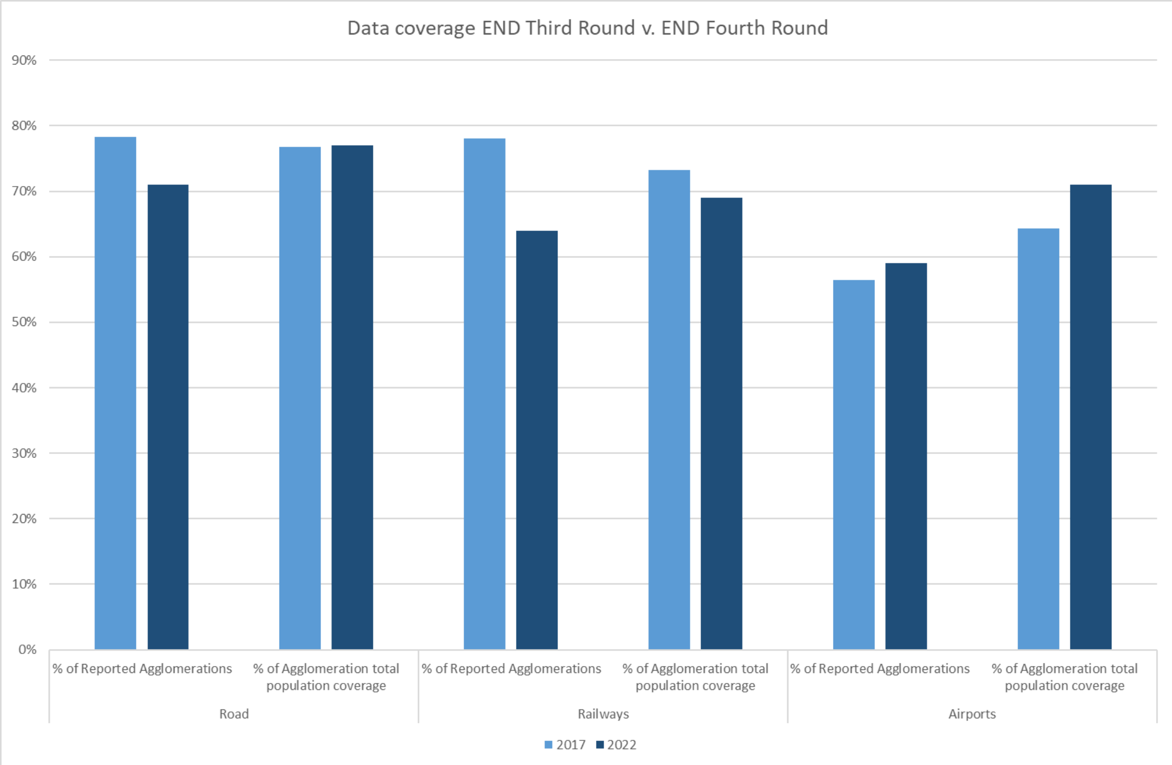


Figure A2-10-3: Percentage of total reported data between END Third Round and END Fourth Round for major noise sources

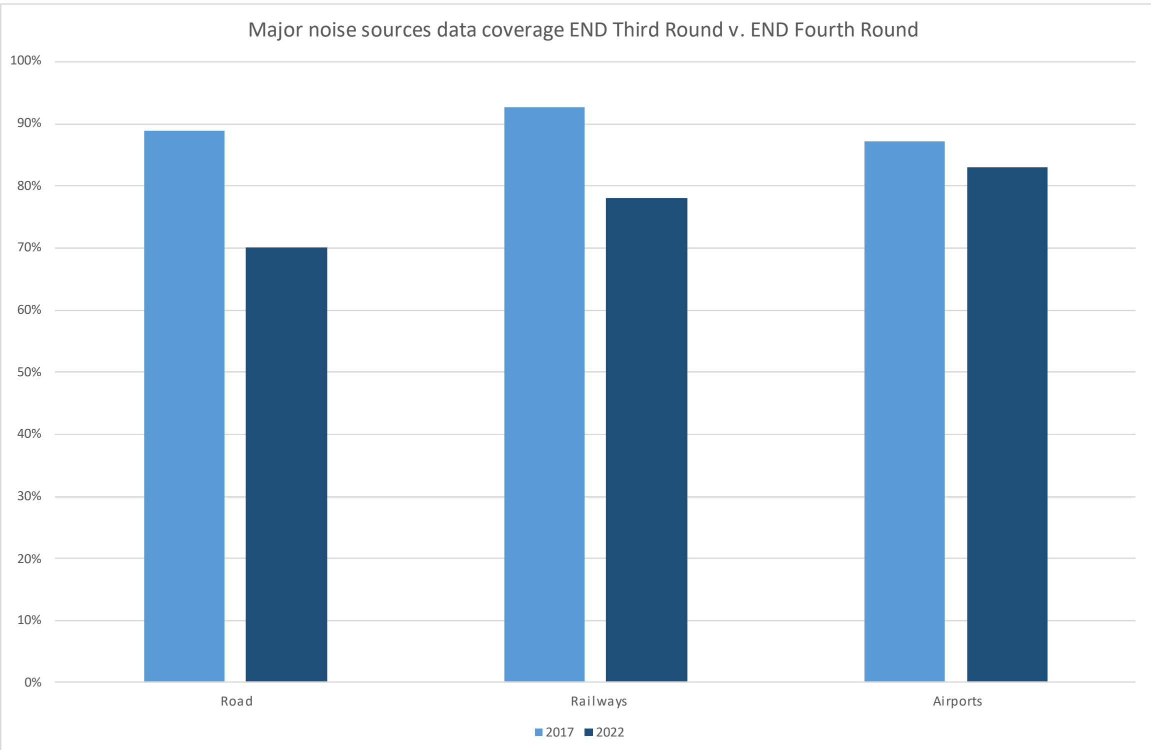


Figure A2-10-4: Total number of agglomerations with reporting obligations between END Third Round and END Fourth Round

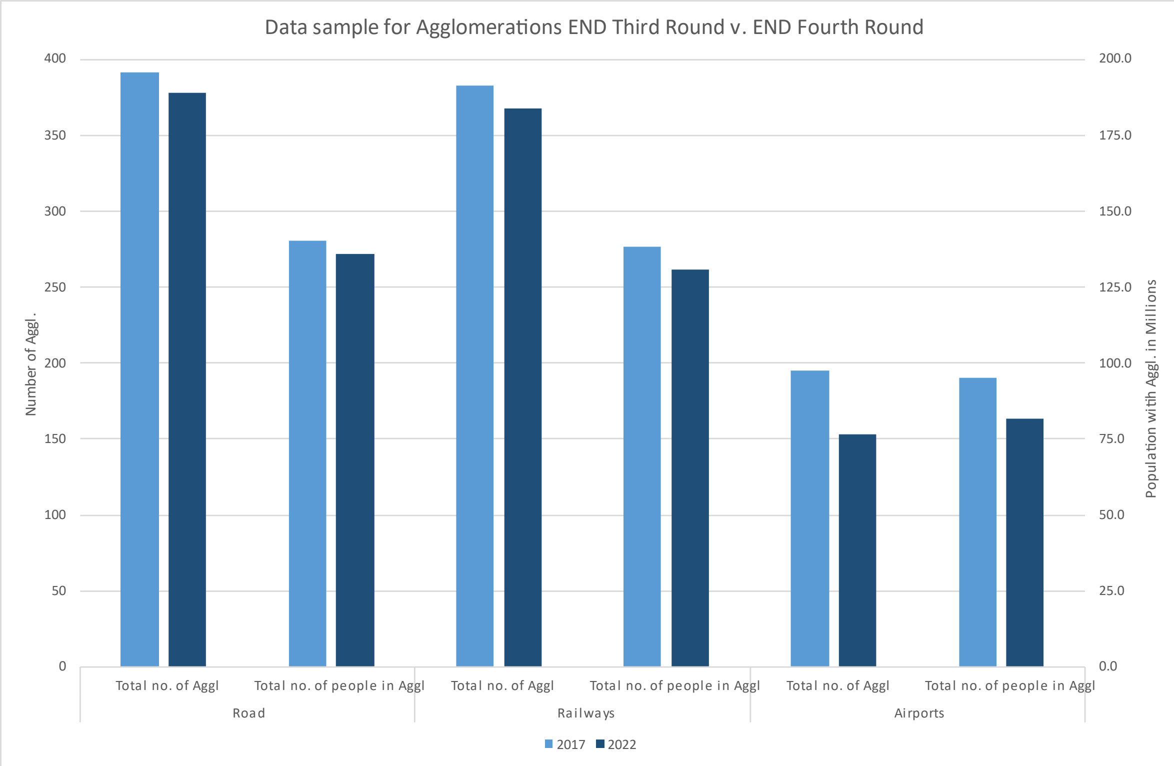


Figure A2-10-5: Total number of Member States or major airports with reporting obligations for major noise sources between END Third Round and END Fourth Round

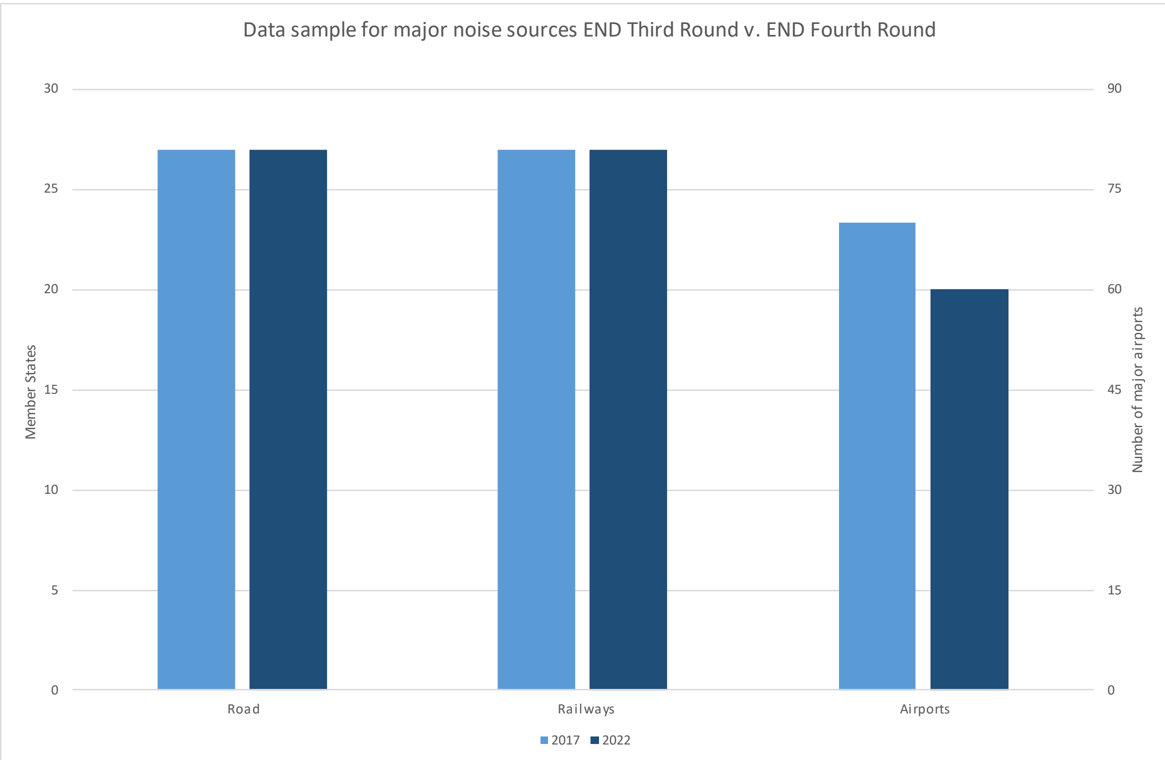


Figure A2-10-6: Percentage of agglomeration data reported under the third round of END to-date

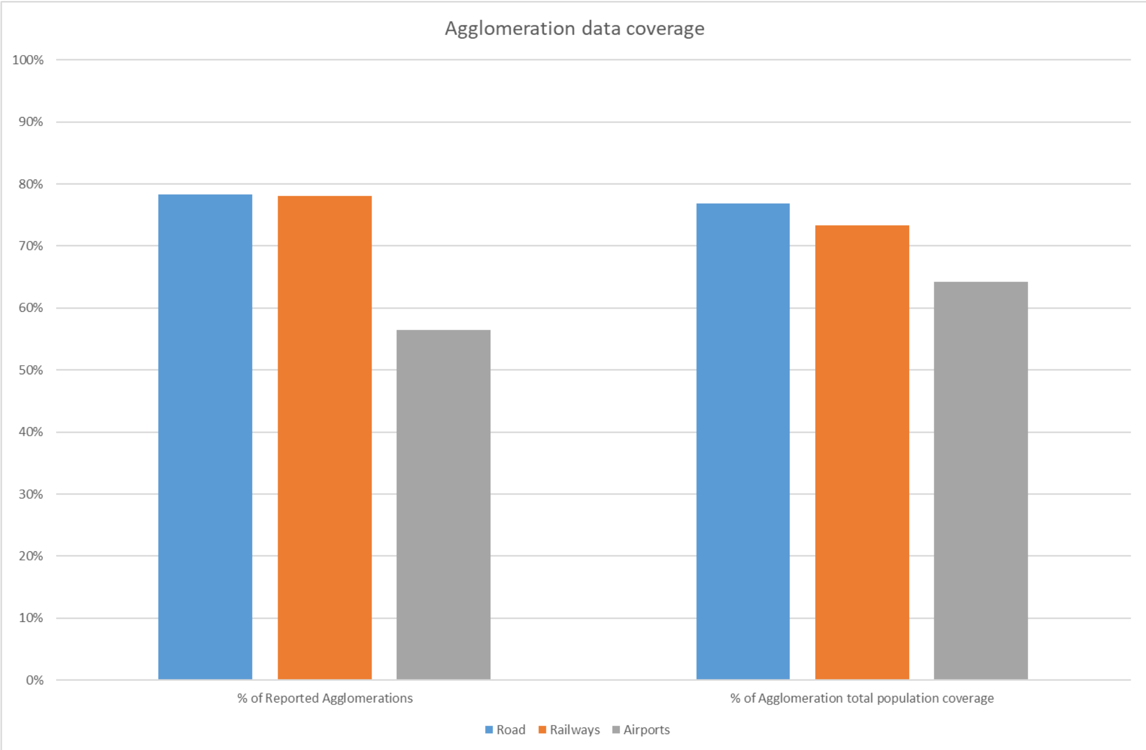


Figure A2-10-7: Percentage of major noise sources data reported under the third round of END to-date

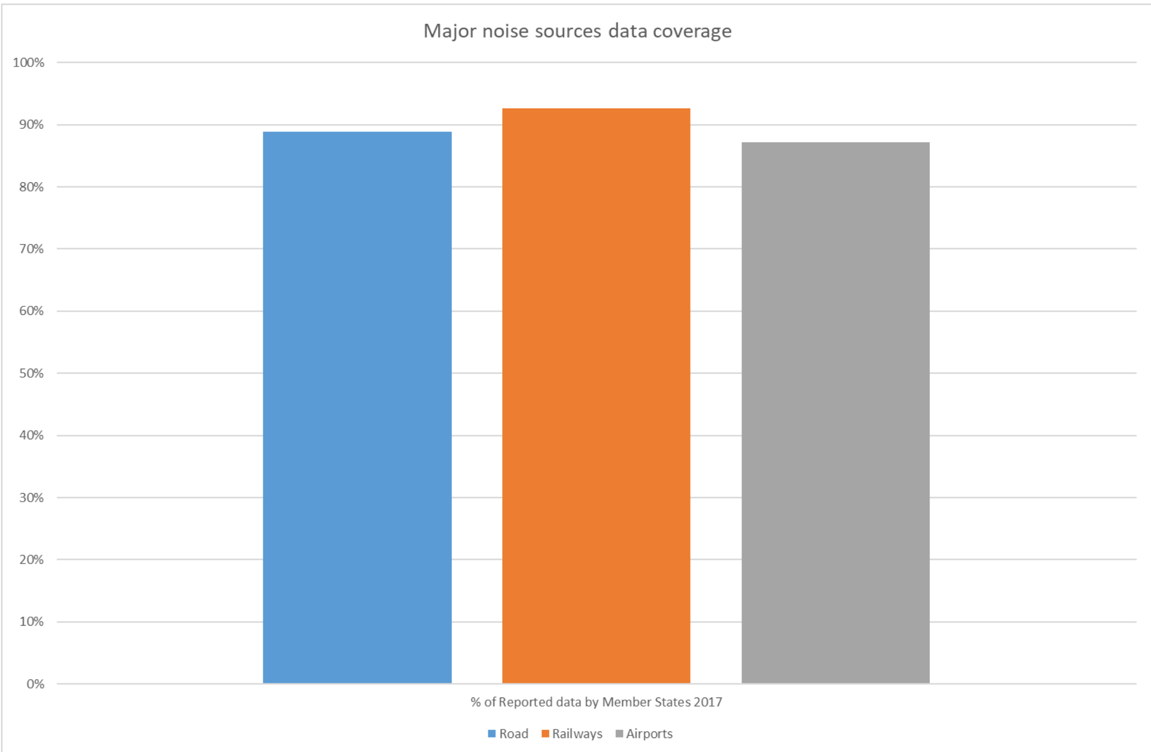
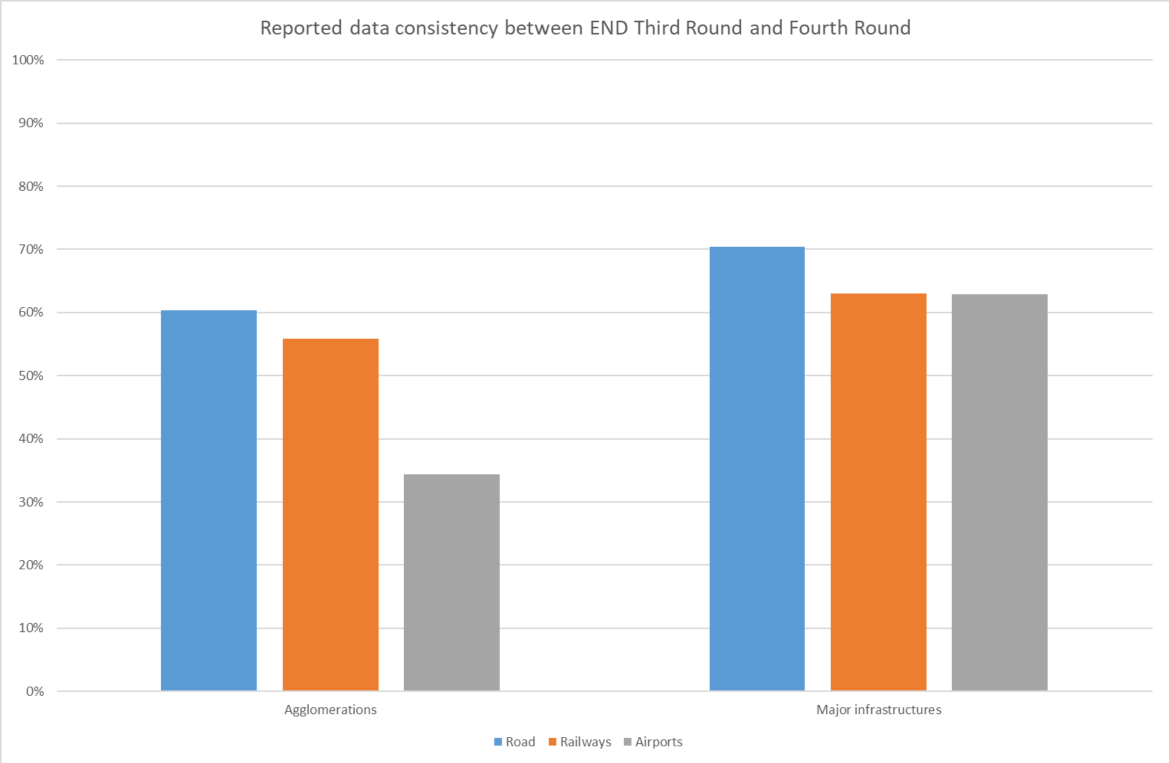


Figure A2-10-8: Percentage of agglomerations and major noise sources for which noise exposure data have been consistently reported between END Third Round and END Fourth Round



Nature

Implementation gap cost methodology

Nature Restoration Law impact assessment values

All the values used below are from the Nature Restoration Law impact assessment[351]. According to the paper, the unit benefits estimates were derived from a wide-ranging evidence review of the benefits of ecosystem restoration. For most ecosystems it was possible to identify two-unit values, one for each of carbon storage/sequestration benefits and one for increases in total ecosystem values. In each case the analysis used the median value per hectare from the range of estimates available, converted where necessary to EURO and updated to 2023 prices from 2020 prices using the lates GDP deflators[352].

Table A2-10-19 Summary of benefit estimates from ecosystem restoration of steppe, health and scrub habitats, 2023 prices

Ecosystem	Service valued	Range (€/ha/year) min	Range (€/ha/year)	Median estimate (€/ha/year)
Heathland and scrubland	Carbon sequestration and storage	264	1,520	396
	Multiple ecosystem services	634	10,892	2,410

Table A2-10-20 Summary of benefits estimates from the restoration of inland wetlands, 2023 prices

Ecosystem	Service valued	Range (€/ha/year) Min	Range (€/ha/year) Max	Median estimate (€/ha/year)
Marshes and other inland wetlands	All ecosystem services	468	11,837	1,430

Table A2-10-21 Summary of benefits estimates from the restoration of forests, 2023 prices

2023 prices	Service valued	Benefits (€/ha/year)
Ecosystem	Carbon storage and sequestration	44
Forests	Total ecosystem services	2,356

*likely to underestimate true carbon benefits

351 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022SC0167
352 https://data.ecb.europa.eu/data/datasets/MNA/MNA.A.N.I9.W2.S1.S1.B.B1GQ._Z._Z._Z.IX.D.N

Table A2-10-22 Summary of benefits from the restoration of HD Appendix I agricultural habitats, 2023 prices

Ecosystem	Service valued	Range (€/ha/year) min	Range (€/ha/year) max	Median estimate (€/ha/year)
HD Appendix I agricultural habitats	Carbon sequestration	0	196	196
	Multiple ecosystem services	49	5,812	2,630
Favourable/secure status of EU protected species & reversal of farmland bird & biodiversity decline	No monetary estimates available			
Increasing semi-improved and semi-natural vegetation	No monetary estimates available			
Cessation of ploughing of grasslands	No monetary estimates available			

Table A2-10-23 Benefits from the restoration of freshwater habitats

Ecosystem	Service valued	€/ha/year
Freshwater	Multiple ecosystem services	109,877

Bioval values and calculation of cost

Bioval values look at the total amount of compensation and also applies:

- Extinction risk – The IUCN Red List Status captures the risk of extinction of species. This contains 5 relevant statuses which are translated to levels in our methodology (Least concern, Vulnerable, Near Threatened, Threatened and Critically endangered). The most local status is prioritised.
- Ecological importance - All native species contribute to the normal functioning of the ecosystem and therefore have ecological value (level 1). A certain number of species have functions in the ecosystem that cannot be replaced by other species and therefore have a more important role in the functioning of the ecosystem (level 2). Some species play a key role in the ecosystem (keystone species) and their disappearance would lead to a disproportionate change in the ecosystem (level 3).
- Cultural significance - Species either have a normal cultural significance (level 1) or a high cultural significance (level 2). High cultural significance is demonstrated by either: the species' occurrence in culturally significant literature; occurrence on flags and emblems; dedicated species protection plans based on cultural motivations; attraction of significant numbers of tourists.
- Contribution to welfare - Some species can be responsible for extensive damage to welfare (level 0). Most species contribute to human welfare through indirect processes such as supporting the normal functioning of the ecosystems from which we derive our welfare (level 1). Species that are highly contributing to human welfare can also be identified (level 2) such as beavers which help restore water cycles or squirrels who are crucial to rejuvenation of oak forests but also some iconic species that attract a high number of tourists which fuel the local economy.

The criteria are scaled to an acceptable maximum amount, negotiated in the stakeholder workshops. Integrating all of the above elements, the formula yields for the small or short-living species the lowest possible compensation of €83 and the highest €1,000, with the most common species requiring €100. For middle sized or medium long living species this is between €833 and €10,000 with the most common species requiring €1000. Large or long-living species require a compensation between €4,166 and €50,000. In this category it is more probable that the species are scoring high on multiple criteria as these are often the ecosystem engineers and culturally significant species.

Table A2-10-24 shows the population change for 78 bird species using the available data. The population unit is predominately reported in number of pairs (p), whereas two species are defined as either number of breeding females (bfemales) or number of calling males (cmales). When the unit is pairs, the population change has been multiplied by two before applying the Bioval tool.

Table A2-10-24 Changes in population between the reporting years 2008-2012 and 2013-2018 the potential economic cost using the Bioval value

Common name	Technical name	Population change	Population unit	Bioval Value (€)	Potential economic cost (€ million)
Eurasian Blackcap	Sylvia atricapilla	5,350,000	p	100	-
Bohemian Waxwing	Bombycilla garrulus	15,000	p	100	-
Snow Bunting	Plectrophenax nivalis	2,500	p	100	-
Eurasian Siskin	Spinus spinus	-810,000	p	100	162
Common Quail	Coturnix coturnix	-310,000	cmales	100	31
Song Thrush	Turdus philomelos	-950,000	p	100	190
European Golden Plover	Pluvialis apricaria	-27,000	p	100	5
Twite	Linaria flavirostris	N/A	p	100	N/A
Rosy Starling	Pastor roseus	N/A	p	100	N/A
Great Tit	Parus major	1,850,000	p	100	-
Brambling	Fringilla montifringilla	-425,000	p	100	85
Common Blackbird	Turdus merula	850,000	p	100	-
Dunnock	Prunella modularis	-560,000	p	100	112
European Greenfinch	Chloris chloris	N/A	p	100	N/A
Common Redpoll	Acanthis flammea	N/A	p	100	N/A

Common name	Technical name	Population change	Population unit	Bioval Value (€)	Potential economic cost (€ million)
Two-barred Crossbill	Loxia leucoptera	-	p	136	-
Hawfinch	Coccothraustes coccothraustes	455,000	p	100	-
Common House Martin	Delichon urbicum	655,000	p	136	-
Coal Tit	Periparus ater	N/A	p	139	N/A
Common Reed Bunting	Emberiza schoeniclus	- 305,000	p	139	85
Eurasian Bullfinch	Pyrrhula pyrrhula	225,000	p	139	-
Mistle Thrush	Turdus viscivorus	-135,000	p	139	38
Bearded Reedling	Panurus biarmicus	4,500	p	208	-
Sand Martin	Riparia riparia	-155,000	p	175	54
Redwing	Turdus iliacus	-465,000	p	208	194
Common Linnet	Linaria cannabina	N/A	p	208	N/A
House Sparrow	Passer domesticus	-2,000,000	p	208	832
Spotless Starling	Sturnus unicolor	-	p	250	-
Red Crossbill	Loxia curvirostra	128,500	p	244	-
Common Chaffinch	Fringilla coelebs	-2,000,000	p	250	1,000
European Robin	Erithacus rubecula	-4,150,000	p	250	2,075
European Goldfinch	Carduelis carduelis	400,000	p	250	-
Common Starling	Sturnus vulgaris	-850,000	p	250	425
Northern Lapwing	Vanellus vanellus	-185,500	p	331	123
Eurasian Skylark	Alauda arvensis	-3,000,000	p	358	2,149
Eurasian Tree Sparrow	Passer montanus	1,160,000	p	331	-
Barn Swallow	Hirundo rustica	-5,150,000	p	544	5,605

Common name	Technical name	Population change	Population unit	Bioval Value (€)	Potential economic cost (€ million)
Crested Lark	Galerida cristata	-750,000	p	550	825
Lesser Redpoll	Acanthis cabaret	N/A	N/A	550	N/A
Corn Bunting	Emberiza calandra	N/A	p	550	N/A
Ortolan Bunting	Emberiza hortulana	-57,500	p	550	63
European Serin	Serinus serinus	-3,250,000	p	550	3,575
European Turtle Dove	Streptopelia turtur	-485,000	p	736	714
Fieldfare	Turdus pilaris	405,000	p	550	-
Stock Dove	Columba oenas	49,000	p	1,000	-
Little Owl	Athene noctua	-69,500	p	1,360	189
Common Wood Pigeon	Columba palumbus	-250,000	p	28	14
Eurasian Woodcock	Scolopax rusticola	-21,000	cmales	1,389	29
Eurasian Sparrowhawk	Accipiter nisus	-15,500	p	1,360	42
Long-eared Owl	Asio otus	-6,000	p	1,360	16
Carrion Crow	Corvus corone	-1,120,000	p	83	187
Eurasian Magpie	Pica pica	-275,000	p	83	46
Western Jackdaw	Corvus monedula	145,000	p	83	-
Rook	Corvus frugilegus	-1,135,000	p	2,860	6,493
Common Kestrel	Falco tinnunculus	5,500	p	2860	-
Barn Owl	Tyto alba	-39,050	p	2860	223
Tawny Owl	Strix aluco	36,500	p	2,860	-
Grey Partridge	Perdix perdix	- 491,500	p	3,581	3,520
Western Marsh Harrier	Circus aeruginosus	-8,000	bfemales	3,672	29
Canada Goose	Branta canadensis	N/A	p	139	N/A
Eurasian Jay	Garrulus glandarius	-685,000	p	4,000	5,480

Common name	Technical name	Population change	Population unit	Bioval Value (€)	Potential economic cost (€ million)
Great Egret	Ardea alba	N/A	p	5,000	N/A
Black Kite	Milvus migrans	7,250	p	5,000	-
Yellowhammer	Emberiza citrinella	-1,150,000	p	5,000	11,500
Common Buzzard	Buteo buteo	31,000	p	5,000	-
Common Snipe	Gallinago gallinago	51,500	p	5,500	-
Peregrine Falcon	Falco peregrinus	1,100	p	5,172	-
Grey Heron	Ardea cinerea	- 64,000	p	5,000	640
Great Cormorant	Phalacrocorax carbo	3,500	p	5,969	-
Red Kite	Milvus milvus	4,300	p	6,946	-
Common Pheasant	Phasianus colchicus	-4,484,925	p	462	4,141
Common Raven	Corvus corax	45,000	p	14,302	-
Common Crane	Grus grus	34,200	p	12,500	-
Northern Goshawk	Accipiter gentilis	7,550	p	16,248	-
Eurasian Curlew	Numenius arquata	-10,500	p	25,860	543
Snowy Owl	Bubo scandiacus	N/A	p	20,000	N/A
White Stork	Ciconia ciconia	3,000	p	24,059	-
Eurasian Spoonbill	Platalea leucorodia	2,400	p	29,302	-
				Total	51,435

Forward-looking assessment – detailed analysis

Target 1: Legally protect a minimum of 30% of the EU's land area and a minimum of 30% of the EU's sea area, and integrate ecological corridors, as part of a true Trans-European Nature Network.

From 2011 to 2021, the rate of designation of terrestrial areas has seen an average annual increase of 0.7%. If this rate were to continue, this would lead to 27.7% of land being protected (1.1 million km^2 of land) by 2030 (Figure A2-10-9). This would mean the 30% target set for the year 2030 would not be met, falling short by a gap of around 2.3% (93,000 km^2).

The average annual rate of increase in marine protected areas was 0.7% per year between 2012 to 2021 (MPA coverage 5.9% in 2012 to 12.1% in 2021) (Figure A2-10-10). If this rate continued to 2030, overall, 18.3% of EU seas would be protected by 2030 (additional 6.21% between 2021 and 2030), therefore not reaching the 30% target.

The gap to achieving the target set for 2030 would be 11.7% based on historical trends. In order for the target to be met, between 2021 and 2030 the rate of designation would have to increase from 0.7% per year to 2.0% per year.

Figure A2-10-9: Line graph of percentage of EU land designated as a terrestrial protected areas with projections to 2030 using historical trend and the rate needed to reach the 2030 target.

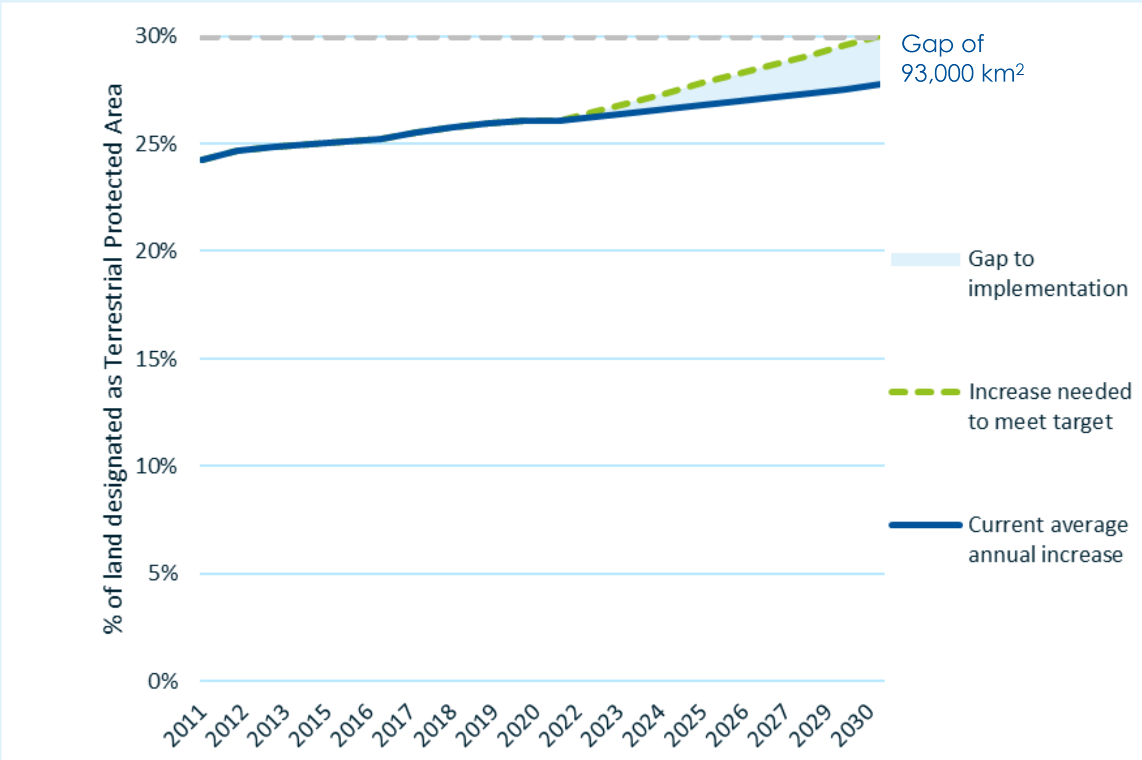
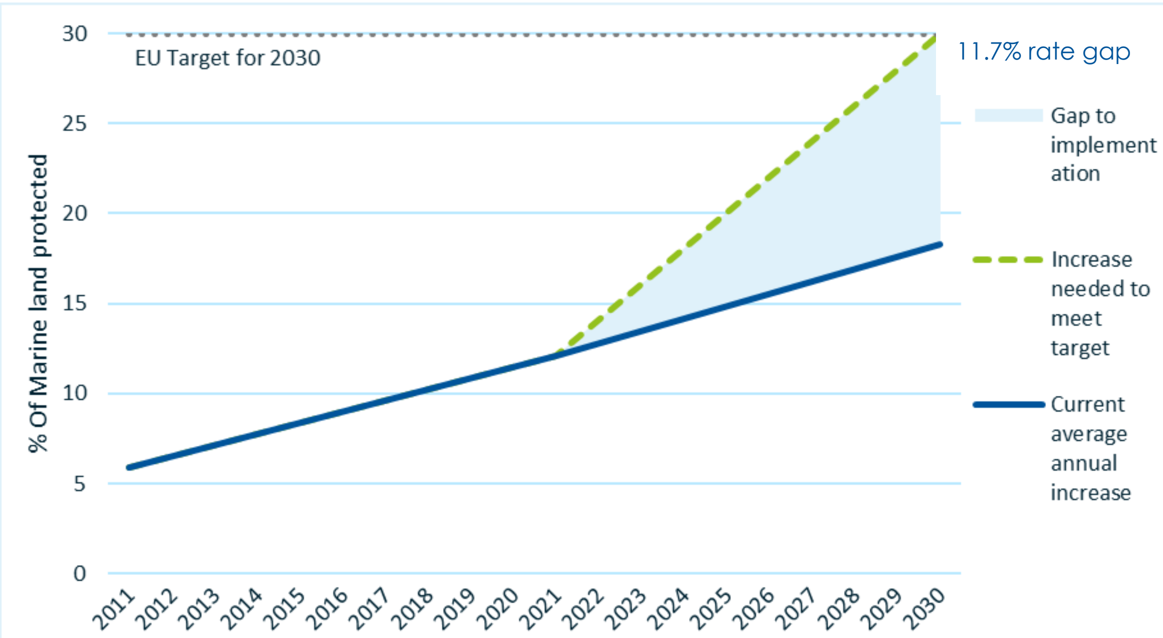


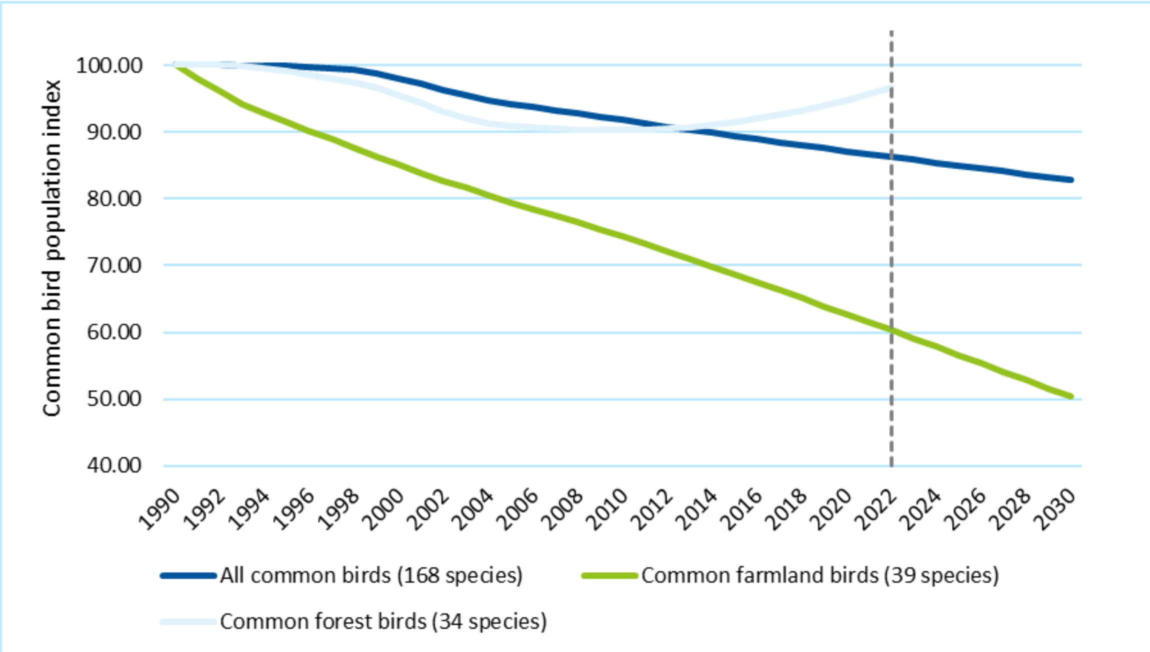
Figure A2-10-10: Line graph of percentage of EU seas designated as a marine protected areas with projections to 2030 using historical trend and the rate needed to reach the 2030 target.



Target 4: Legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment. By 2030, significant areas of degraded and carbon-rich ecosystems are restored. Habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.

The index of 168 common birds showed that between 1990 and 2022 common birds decreased by around 14%, common forest birds (34 species) decreased by 4%, and the greatest decline was observed in farmland birds (39 species) which reduced by 40% within the EU (Figure A2-10-11). Projections of bird population index to 2030 have been calculated using historical trends from 1990 to 2022 (Figure A2-10-11). The target of species showing a positive trend by 2030 is highly unlikely to be reached without Member States implementing conservation and restoration measures (for all common birds and the common farmland birds' indexes – as mentioned in section 4.3.1, the common forest birds started to show a positive trend in 2013). The projections show that without Member State intervention, the index of all common birds would fall to 82.8 (average annual decline of 0.4%) and common forest birds would decline to 95.9 (average annual decline of 0.1% per year).

Figure A2-10-11: Index of common bird species (all common birds, forest birds and farmland birds) within the EU from 1990 to 2022 with projections to 2030 using historical population trends.



The target set out in the EU BDS dashboard is that at least 30% of habitats and species assessed under the Habitats Directive reach favourable conservation status (good status). As shown previously in section 4.3.1, data from the EEA[353] shows the conservation status of species and habitats at the EU level. As there is only two data points over 10 years of data, an implementation gap in 2030 was not calculated as it is challenging to robustly extrapolate from two data points. That said, it is notable that the proportion of species in 'good' condition was already close to the target under the last reporting cycle, and if the upward trend continues the target could be met. However, the trend for habitats is moving in the wrong direction, with a decline in habitats in 'good' condition between the two reporting periods (see Figure 4-5).

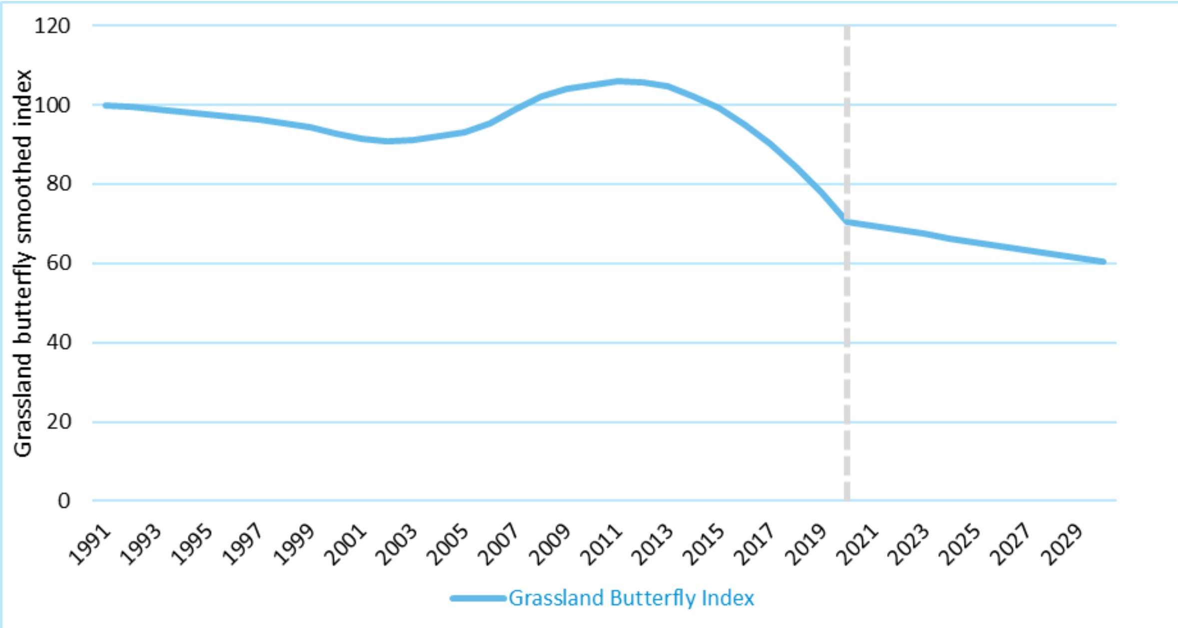
Target 5: The decline of pollinators is reversed

The smoothed trend of 15 grassland butterfly species showed that between 1991 and 2020, populations declined by 29.5% and by an average of 1% a year. If this rate of decline were to continue to the year 2030 the population index would reach 60.3 (Figure A2-10-12) which compared to the 1990 population is 40% lower. As the target

[353] https://www.eea.europa.eu/en/analysis/indicators/conservation-status-of-habitats-under

does not have a number to reach and in theory only needs to show a reversal in decline, it is not possible to anticipate how the implementation gap may change going forward based on historical trends.

Figure A2-10-12: Index of common grassland butterfly species within the EU from 1990 to 2021 with projections to 2030 using historical population trends.



Target 8: At least 25% of agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased

Of the utilised agricultural area (UAA) within the EU as of 2020, 9.10% (14.7 million ha) was under organic farming. The average annual increase in organic farming between 2012 and 2020 was 6% per year. If this annual increase were to continue to 2030, 15.9% (26 million ha) of UAA would be used for organic farming. This presents a gap of 9.1% (14.7 million ha) to reaching the 2030 target of 25% of UAA used for organic farming. In order to reach the 2030 target, the rate of uptake would have to increase by an average of 2.5 million ha per year totalling approximately 40 million ha (Figure A2-10-13).

Target 9: Three billion additional trees are planted in the EU, in full respect of ecological principles

The MapMyTree dashboard[354] shows that the latest cumulative count of trees planted in 2024 is 22.6 million[355]. To project the estimated number of trees that will be planted by 2030, the average annual percentage change from 2020 to 2024 (82%) was used. Using this annual average increase, 0.8 billion trees would be planted to 2030 (Figure A2-10-14). This would mean that based on the current rate, by the year 2030 the EU Member States collectively would be off target by 73.1% (2.2 billion trees).

[354] https://mapmytree.eea.europa.eu/#/dashboard
[355] Viewed (01/10/2024, 11:00)

Figure A2-10-13: Utilised agricultural area (UAA) used for organic farming in the EU 27 from 2012, with projections to 2030 using historical trend and the rate needed to reach the 2030 target

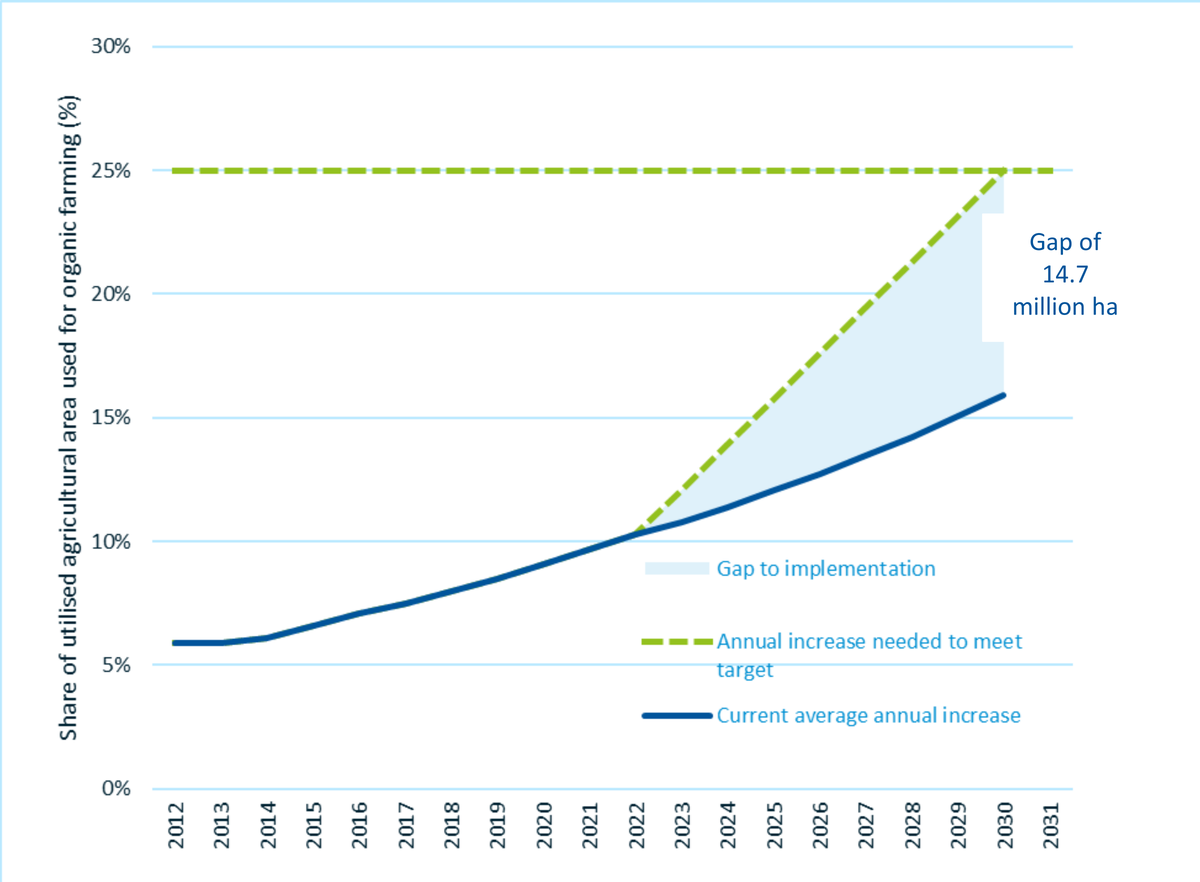
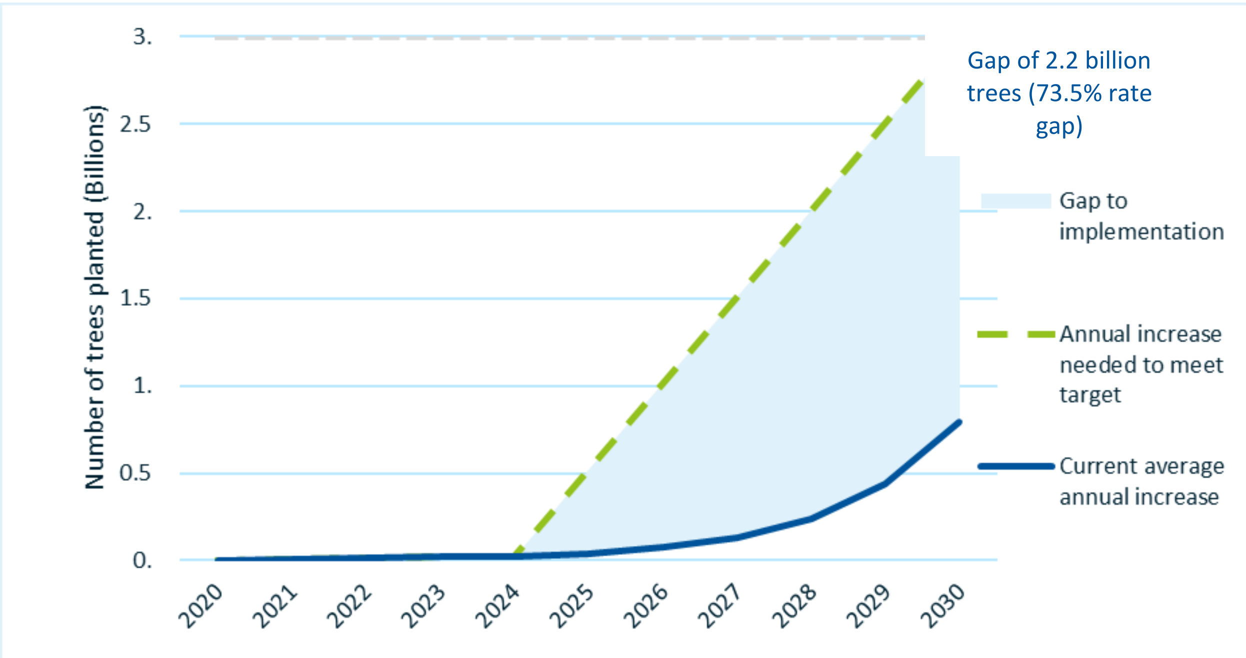


Figure A2-10-14: Number of trees planted within the EU as part of the 3 Billion trees initiative. Projections to 2030 using historical trend rate and the rate needed to reach target are plotted.



Invasive Alien Species

The 2024 report on informing spatiotemporal trends of IAS of Union concern[356] looked at the range of expansion of 55 IAS of UC. The trend in the range of expansion was calculated as the percentage increase between the number of cells of occurrences between the periods of time. Due to the variability of available occurrences, not all IAS of UC could be looked at in this assessment, as well as variability in the date ranges of available occurrences. The range of expansion is presented across all Member States rather than per Member State individually. The analysis was presented across two time frames depending on the data available (further detail is presented in Table A2-10-25 and Table A2-10-26 below):

- For the 26 species with data from 2011 to 2020, almost all (25) showed an increase in occurrences over the time frame, with 20 showing an increase of more than 100%, and 4 showing an increase of more than 1000%.
- For the 29 species with data from 2002 to 2022, almost all (26) showed an increase in occurrences over the time frame, with 15 showing an increase of more than 100%, and 3 showing an increase of more than 1000%.

The analysis highlights that the trend of IAS is likely to continue increasing in the future without further action to management and eradicate IAS. That said, the baseline data used I the assessment of the implementation gap can support Member States in establishing a surveillance system for the targeted species in accordance with Article 14 of the IAS Regulation, while also promoting cooperation and coordination among Member States across borders or within shared biogeographical regions, as outlined in Article 22. The distribution data for the targeted species could facilitate discussions among Member States regarding suitable management measures to be implemented (Article 19). Furthermore, the data provided can help Member States and the European Commission (EC) monitor the changes in IAS distribution across Europe and assess the effectiveness of measures taken by Member States Competent Authorities in implementing the IAS Regulation. Analysing this data may eventually lead to reconsidering or adjusting implementation activities and provide valuable input for updating the list of IAS of Union concern.

Table A2-10-25: The occurrence of Invasive Alien plant Species and their range of expansion trends from 2011 to 2020

Species name	Occurrences	% Change in range of expansion
Trend 2011-2020		
Heracleum mantegazzianum	67,576	186%
Elodea nuttallii	66,533	90%
Impatiens glandulifera	177,150	110%
Lysichiton americanus	7,144	156%
Myriophyllum aquaticum	8,159	208%
Lagarosiphon major	6,371	393%
Heracleum persicum	4,036	175%
Myriophyllum heterophyllum	434	222%

356 https://op.europa.eu/en/publication-detail/-/publication/2021d734-d9e9-11ee-b9d9-01aa75ed71a1/language-en

Species name	Occurrences	% Change in range of expansion
Acacia saligna	1,099	30%
Baccharis halimifolia	11,234	489%
Hydrocotyle ranunculoides	8,440	62%
Pontederia (Eichhornia)	648	158%
Ludwigia grandiflora	4,180	287%
Asclepia syriaca	18,574	1,890%
Pennisetum setaceum	807	158%
Heracleum sosnowskyi	7,173	13,432%
Ludwigia peploides	1,194	3,020%
Humulus scandens	45	1,150%
Cardiospermum grandiflorum	113	169%
Trend 2012-2021		
Ailanthus altissima	13,759	37%
Cabomba caroliniana	545	-3%
Gunnera tinctoria	1,746	222%
Trend 2013-2022		
Hakea sericea	544	54%
Celastrus orbiculatus	186	238%
Pistia stratiotes	761	661%
Koenigia polystachya	3,344	290%

Table A2-10-26: The occurrence of Invasive Alien animal Species and their distribution trends from 2002 to 2022

Species name	Occurrence	% Change in distribution trends
Trend 2015-2020		
Lepomis gibbosus	11,688	30%
Pacifastacus leniusculus	36,539	24%
Pseudorasbora parva	24,676	25%
Eriocheir sinensis	13,194	-28%

Species name	Occurrence	% Change in distribution trends
Procambarus clarkii	10,633	16%
Perccottus glenii	976	62%
Faxonius (Orconectes) limosus	12,201	-27%
Procambarus fallax f. virginalis	97	269%
Trend 2014-2019		
Plotosus lineatus	30	-67
Trend 2017-2022		
Ameiurus melas	3,799	4,880%
Gambusia holbrooki	5,006	1,444%
Gambusia affinis	521	5,767%
Trend 2011-2020		
Alopochen aegyptiaca	542,141	57%
Lithobates catesbeianus	4,775	175%
Corvus splendens	9,859	94%
Trachemys scripta	8,450	955%
Acridotheres tristis	17,250	82%
Threskiornis aethiopicus	6,353	193%
Myocastor coypus	23,175	724%
Ondatra zibethicus	173,216	472%
Procyon lotor	18,945	706%
Nyctereutes procyonoides	7,163	880%
Trend 2013-2022		
Oxyura jamaicensis	42,869	31%
Pycnonotus cafer	275	154%
Trend 2009-2020		
Sciurus carolinensis	222,293	28%
Callosciurus erythraeus	280	124%

Species name	Occurrence	% Change in distribution trends
Tamias sibiricus	316	782%
Trend 2010-2022		
Callosciurus finlaysonii	50	167%
Trend 2002-2021		
Muntiacus reevesi	32,288	87%

Water

Surface waters

Additional policy context

Table A2-10-27: Links between the supporting legislation and waterbody status under the WFD

EU Water legislation	Waterbody status under the WFD			
	Surface water bodies (SWB)		Groundwater bodies (GWB)	
	Ecological Status	Chemical Status	Quantitative status	Chemical Status
Groundwater Directive (GWD)			X	X
Bathing Water Directive (BWD)	X			
Urban Waste Water Treatment Directive (UWWTD)	X	X		X
Nitrates Directive (ND)	X	X		X
Environmental Quality Standards Directive (EQSD)		X		
Floods Directive (FD)	X	X		

Estimation of benefits foregone in the COWI et al. 2011 and the 2019 study

The cost of the WFD implementation gap in COWI et al. (2019) uses the same method as COWI et al. (2011)[357], namely applying the percentage of waters below good ecological status in the EU to an estimate of the overall benefits of achieving good status in EU waters.

The estimate of the overall benefits of achieving good status in EU waters was based on work done in the UK in 2007[358] which used survey methods to estimate the household willingness to pay (WTP) in England & Wales (E&W) for improvements to the water environment under the following scenarios of WFD implementation:

- **Maximum benefit scenario:** full improvement (100%) to High Quality achieved by 2015;
- **Front loaded scenario:** 50% of improvements by 2015, followed by 30% in 2021, and 20% in 2027;
- **Even loaded scenario:** 33% of improvements achieved by each of 2015, 2021, 2027;
- **Back loaded scenario:** 20% start in 2015 followed by a further 30% in 2021 and 50% in 2027;
- **Less stringent objectives scenario:** 25% by each of 2015, 2021, 2027, then no more (i.e. assumes less stringent ultimate objectives, amounting to the last 25% of improvement); and
- **Nature assimilation lag scenario:** constraints from natural conditions, such as stocks of pollutants in sediment, mean that 50% of the improvement will not occur until 50+ years.

[357] https://op.europa.eu/en/publication-detail/-/publication/c1ea3ac1-ed7f-4abb-a06b-41b8f515991c/language-en/format-PDF/source-search
[358] Report on The Benefits of Water Framework Directive Programmes of Measures in England and Wales, Nera & Accent, November 2007

Noting that the target of WFD was full compliance by 2015, the 2011 report (and consequently the 2019 report) selected the maximum benefit scenario as the best scenario for estimation of the value of not implementing the WFD. This provides a WTP per household in E&W of between £45 and £168 per household per year for achieving 'good status' (or £24 to £89 per person per year)[359].

With the UK as a base (=100) purchasing power parity (PPP), the EU as 98 and with a population of just below 500 million inhabitants, the COWI et al. (2011) study (and consequently the 2019 study) estimated that the total value of achieving 'good status' in the EU was between €12 billion and €44 billion per year.

COWI et al. (2019) (and 2011) assessment assumed that the implementation gap cost (the foregone benefit) was proportionate to the length/area of SWBs below good ecological status as a percentage of the total length/area multiplied by the total WTP (€12-44 billion per year[360]). The resulting implementation gap cost on EU-28 level was between €3.2 billion and €13.0 billion per year.

Values and approach applied in this (2025 study)

The 2007 E&W WTP values underpinning both the COWI et al. (2011) and 2019 were updated in 2012 to provide the much more detailed series of National Water Environment Benefit Survey (NWEBS) values[361], presented below in the table. These provide the annual benefit of moving from bad to poor, poor to moderate and moderate to good ecological status per km of river and per km^2 of lake, transitional or coastal waters.

Table A2-10-28: England and Wales National Water Environment Benefits Survey (NWEBS) values

	Annual per km values, 2012 prices, for rivers		Annual per km^2 values, 2012 prices, for coastal, lakes and transitional waters
	England & Wales		England & Wales
Bad to Poor	Low	£14,300	£5,200
	Central	£17,400	£6,400
	High	£20,500	£7,500
Poor to Mod	Low	£16,400	£6,000
	Central	£20,000	£7,400
	High	£23,600	£8,700
Mod to Good	Low	£19,100	£7,000
	Central	£23,200	£8,500
	High	£27,400	£10,100

Owing to the fact the NWEBS values allow for explicit application to waterbodies of varying status (bad, poor, and moderate) they provide the possibility of measuring (in monetary terms) the benefits of incremental improvements in the ecological status of waterbodies (e.g. moderate to good).

While the appraisal method is not refined and needs to rely on some strong assumptions, a search for alternative (more EU based) values has not identified anything that can offer the same capabilities. Unfortunately, a project

[359] The average household size in the sample was identified as 2.6.
[360] It is not clear in the 2019 report whether or how the base 2011 WTP was updated to 2019 prices.
[361] https://assets.publishing.service.gov.uk/media/5a75a2e8e5274a4368298cc3/LIT_8348_42b259.pdf

to update the E&W NWEBS is currently being undertaken with a target end date for completion of April 2026 and so not within the timescale of the current study.

Primary research to develop similar benefit values specifically for the EU context would clearly improve the information to policymakers and analysts. For this study, however, we have been constrained to resort again to a value transfer approach to convert the E&W NWEBS into an EU Equivalent. This has been achieved through the following steps:

A. Taking the 2012 E&W values for rivers and lakes, transitional and coastal waters in and dividing them by the total number of households in E&W in the closest census year (2011) to give annual per household WTP values per km/km^2 of improvement in UK 2012 prices.

B. Converting these values (in A) from UK 2012 prices (in £s) into UK 2023 prices (in £s)[362];

C. Converting these values (in C) from UK 2023 prices (in £s) to 2023 prices in €s (Euros)[363];

D. Applying purchasing power parities (PPP) from Eurostat[364] for each of the 19 Member States that had submitted information for the 3rd RBMP by July 2024 to produce annual WTP values per household per km/km^2 for each Member State;

E. Multiplying these values (in D) by the number of households in each Member State in 2023 (Eurostat) to give annual WTP values per km/km^2 of each level of improvement for each Member State;

F. Multiplying each of the Member State values (in E) by the Member State's percentage share of the total length of rivers and total area of lakes, transitional and coastal waters totalled across all the 19 Member States that had submitted information for the 3rd RBMP by July 2024. This provides weighted average EU values[365] of improvements in the ecological status of waterbodies per km of river per year and per km^2 of lakes, transitional and coastal waters.

The resulting weighted average EU annual values of improvements in the ecological status of waterbodies in 2023 prices are provided in Table A2-10-29. As a sense check, these values have been back calculated to UK 2012 prices using exchange rates and inflation (as opposed to PPP). The result is in line with the original (2012) values in Table A2-10-28.

The values in Table A2-10-29 have been aggregated to provide total values for improvements:

- From bad to good = the sum of bad to poor, poor to moderate and moderate to good;
- Poor to good = the sum of poor to moderate and moderate to good; and
- Moderate to good (as in Table A2-10-29).

The resulting weighted average EU annual values[366] of improvements to achieve good ecological status in waterbodies (2023 prices) are provided as Table A2-10-30.

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362 https://www.bankofengland.co.uk/monetary-policy/inflation/inflation-calculator
363 https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/timeseries/thap/mret
364 https://ec.europa.eu/eurostat/databrowser/view/prc_ppp_ind__custom_13528596/default/table
365 Across the 19 Member States that had submitted information for the 3rd RBMP by July 2024
366 Across the 19 Member States that had submitted information for the 3rd RBMP by July 2024

Table A2-10-29: Weighted average EU Annual values per km or km² of improvement in ecological status (€s 2023 prices)

		Weighted average EU Annual values per km of improvement (rivers) – €s 2023 prices	Weighted average EU Annual values per km² of improvement (lakes, transitional and coastal waters) – €s 2023 prices
Bad to Poor	Low	€27,914	€10,199
	Central	€33,965	€12,552
	High	€40,016	€14,710
Poor to Moderate	Low	€,32,013	€11,768
	Central	€,39,040	€14,514
	High	€46,067	€17,063
Moderate to Good	Low	€37,283	€13,729
	Central	€45,286	€16,671
	High	€53,485	€19,809

Table A2-10-30: Weighted average EU Annual values per km or km² of improvement to good ecological status of waters (€s 2023 prices)

		Weighted average EU Annual values per km of improvement (rivers) - €s 2023 prices	Weighted average EU Annual values per km² of improvement (lakes, transitional and coastal waters) - €s 2023 prices
Bad to Good	Low	€97,210	€35,696
	Central	€118,291	€43,737
	High	€139,568	€51,583
Poor to Good	Low	€69,296	€25,497
	Central	€84,327	€31,185
	High	€99,552	€36,873
Moderate to Good	Low	€37,283	€13,729
	Central	€45,286	€16,671
	High	€53,485	€19,809

Benefits of achieving chemical status objectives

The values presented in Table A2-10-30 relate only to the achievement of ecological status objectives. No similar values are available to estimate the costs and benefits of achieving chemical status objectives.

In the series of (four) studies carried out for DG Environment on registration requirements for 1-10t substances[367], the benefits of reducing chemical risks were estimated by drawing upon the NWEBS values. Total NWEB values reflect improvement in six components of waterbody status, namely: fish; other animals such as invertebrates; plant communities; the clarity of the water; condition of the river channel/flow of water; and the safety of the water for recreational contact. Where projects/actions only target some of these components the approach used in the UK is to divide the overall NWEBS values equally between the six components and then multiply by the number of components that are affected by the action/project. To estimate the benefits of addressing chemical risks in water, the 1-10t studies assumed that three components would be affected (fish; other animals such as invertebrates; plant communities). Thus, the benefits are estimated to be about 3/6 (50%) of the NWEBS values.

Applying the same approach, the benefits of moving from failing good chemical status to achieving good chemical status are assumed to equal the average of the benefits of moving from Bad to Good, Poor to Good and Moderate to Good ecological status. Table A2-10-31 provides the resulting assumed/derived EU Annual values per km or km^2 of improvement in chemical status of waters.

Table A2-10-31: Assumed/derived EU Annual values per km or km^2 of improvement in chemical status of waters (€s 2023 prices)

	Weighted average EU Annual values per km of improvement (rivers) - €s 2023 prices	Weighted average EU Annual values per km^2 of improvement (lakes, transitional and coastal waters) - €s 2023 prices
Low	€33,965	€12,487
Central	€41,317	€15,266
High	€48,768	€18,044

Surface water bodies – impacts and supporting legislation

The delivery of the good status objectives under the WFD is supported by other pieces of legislation that seek to address specific issues and areas. Thus, the implementation gap associated those pieces of legislation is captured within the overall implementation gap cost estimates.

The data collated from the 3rd RBMP provides the means to attribute portions of the overall implementation gap to impacts that are within the influence of supporting legislation. The RBMP reporting framework requires that, for each waterbody failing to meet good ecological status, Member States must identify one or more significant impacts that are responsible for causing the failure of that waterbody. Information on the length/area of waterbodies affected by each significant impact has been extracted from the 3rd RBMP data. Table A2-10-32 provides the length/area of waterbodies for which identified impacts have been attributed.

[367] Most recently, European Commission: Directorate-General for Environment, Footitt, A., Postle, M., Vencovska, J. and Camboni, M., Gather further information to be used in support of an impact assessment of potential options, in particular possible amendments of REACH Appendices, to modify requirements for registration of low tonnage substances (1-10t/year) and the CSA/CSR requirement for low tonnage substances with or without CMR properties in the framework of REACH – Final report, Publications Office, 2020, https://data.europa.eu/doi/10.2779/37609

Table A2-10-32: Length/area of waterbodies with identified significant impacts attributed (2021)

	River waters (km)	Lake Waters (km^2)	Transitional Waters (km^2)	Coastal Waters (km^2)
Total length/area below good status	**675,411**	**47,208**	**10,232**	**115,113**
Length/area of these waterbodies impact attributed as:				
• **Acidification**	22,799	1,456	70	2,969
• **Altered habitats due to hydrological changes**	253,215	21,192	5,101	4,234
• **Altered habitats due to morphological changes**	445,141	27,062	5,662	10,263
• **Associated surface waters**	8,814	73	38	973
• **Chemical pollution**	547,792	41,395	8,112	81,408
• **Dependent terrestrial ecosystems**	4,148	62	34	973
• **Elevated temperatures**	22,851	149	44	322
• **Litter**	85	6	0	22
• **Microbiological pollution**	35,616	204	753	3,334
• **Nutrient pollution**	383,196	14,620	8,108	79,592
• **Organic pollution**	238,876	6,505	5,221	8,924
• **Saline or other intrusion**	37,983	692	2,438	675
• **Water balance / Lowering water table**	860	0	0	0

These data can be used in two ways:

- **Data can be expressed as frequency** – this provides the frequency with which an impact is identified across the population of waterbodies that are below good status; and
- **Data can be expressed as a relative frequency**- this provides the relative weight or importance of each impact in the overall 'failure' to achieve good status.

Frequency of impacts

The frequency of impacts (as a percentage) is derived by calculating the proportion of the population of waterbodies below good where a given impact is identified as (one of) the impacts causing 'failure'. These frequency values are provided in Table A2-10-33. Thus, from the table, for 81.1% of 'failing' rivers, chemical pollution is identified as being one of the impacts that cause failure.

Table A2-10-33: Percentage frequency of attribution of identified impacts within population of 'failures' (2021)

	River waters (km)	Lake Waters (km²)	Transitional Waters (km²)	Coastal Waters (km²)
Acidification	3.4%	3.1%	0.7%	2.6%
Altered habitats due to hydrological changes	37.5%	44.9%	49.9%	3.7%
Altered habitats due to morphological changes	65.9%	57.3%	55.3%	8.9%
Associated surface waters	1.3%	0.2%	0.4%	0.8%
Chemical pollution	81.1%	87.7%	79.3%	70.7%
Dependent terrestrial ecosystems	0.6%	0.1%	0.3%	0.8%
Elevated temperatures	3.4%	0.3%	0.4%	0.3%
Litter	0.0%	0.0%	0.0%	0.0%
Microbiological pollution	5.3%	0.4%	7.4%	2.9%
Nutrient pollution	56.7%	31.0%	79.2%	69.1%
Organic pollution	35.4%	13.8%	51.0%	7.8%
Saline or other intrusion	5.6%	1.5%	23.8%	0.6%
Water balance / Lowering water table	0.1%	0.0%	0.0%	0.0%

Relative importance of impacts

As can be seen from Table A2-10-33, some significant impacts (such as chemical pollution) are identified more frequently than others and, hence, one can assume that their role in the overall 'failure' of waterbodies is greater than impacts that are identified with less frequency (for example Acidification).

The weight of this role can be expressed as a percentage by expressing the frequencies as relative frequencies. Thus, for rivers, for example, the weight (or relative importance) of 'chemical pollution' in the overall 'failure' for rivers is equal to the frequency for 'Chemical Pollution' (81.1%) divided by the sum of all the frequencies across all impacts identified for rivers (296%) = 27.4%. In other words, 27.4% of the observed 'failure' of rivers to meet good status is owing to 'chemical pollution'.

Table A2-10-34 provides these data for all impacts for each waterbody type as the weight (relative frequency) of individual impacts in the overall 'failure' of waterbodies. In relation to waterbodies currently (in 2021) failing to achieve good status objectives and the overall implementation gap described in the main section of the report, these data suggest, for example, that:

- 19.1% of the implementation gap for all river waters is attributable to nutrient pollution; and
- 27.4% of the implementation gap for all river waters is attributable to chemical pollution.

Table A2-10-34: Weight (relative frequency) of individual impacts in the overall 'failure' of waterbodies to meet good status (2021)

	River waters (% Length)	Lake Waters (% Area)	Transitional Waters (% Area)	Coastal Waters (% Area)
Acidification	1.1%	1.3%	0.2%	1.5%
Altered habitats due to hydrological changes	12.7%	18.7%	14.3%	2.2%
Altered habitats due to morphological changes	22.2%	23.9%	15.9%	5.3%
Associated surface waters	0.4%	0.1%	0.1%	0.5%
Chemical pollution	27.4%	36.5%	22.8%	42.0%
Dependent terrestrial ecosystems	0.2%	0.1%	0.1%	0.5%
Elevated temperatures	1.1%	0.1%	0.1%	0.2%
Litter	0.0%	0.0%	0.0%	0.0%
Microbiological pollution	1.8%	0.2%	2.1%	1.7%
Nutrient pollution	19.1%	12.9%	22.8%	41.1%
Organic pollution	11.9%	5.7%	14.7%	4.6%
Saline or other intrusion	1.9%	0.6%	6.9%	0.3%
Water balance / Lowering water table	0.0%	0.0%	0.0%	0.0%

Following on from this, if 19.1% of the implementation gap for all river waters is attributable to nutrient pollution; and 27.4% is attributable to chemical pollution then 19.1% of the cost (forgone benefit) of the implementation gap for all river waters is attributable to nutrient pollution and 27.4% is attributable to chemical pollution. This results in the attribution of costs in Table A2-10-35.

Table A2-10-35: SWB – central estimate of costs of non-implementation (foregone benefits) by impact – € million per year*

	River waters	Lake Waters	Transitional Waters	Coastal Waters	Total
Total implementation gap cost	€ 47,447.1	€ 1,103.0	€ 298.7	€ 2,590.1	**€ 51,438.92**
Implementation gap cost attributable to:					
• **Acidification**	€ 540.5	€ 14.2	€ 0.6	€ 39.7	€ 595.0
• **Altered habitats due to hydrological changes**	€ 6,003.0	€ 206.1	€ 42.8	€ 56.6	€ 6,308.6
• **Altered habitats due to morphological changes**	€ 10,553.1	€ 263.2	€ 47.5	€ 137.2	€ 11,001.0
• **Associated surface waters**	€ 208.9	€ 0.7	€ 0.3	€ 13.0	€ 223.0
• **Chemical pollution**	€ 12,986.6	€ 402.6	€ 68.1	€ 1,088.6	€ 14,545.9
• **Dependent terrestrial ecosystems**	€ 98.3	€ 0.6	€ 0.3	€ 13.0	€ 112.3
• **Elevated temperatures**	€ 541.7	€ 1.5	€ 0.4	€ 4.3	€ 547.9
• **Litter**	€ 2.0	€ 0.1	€ 0.0	€ 0.3	€ 2.3
• **Microbiological pollution**	€ 844.4	€ 2.0	€ 6.3	€ 44.6	€ 897.3
• **Nutrient pollution**	€ 9,084.5	€ 142.2	€ 68.1	€ 1,064.3	€ 10,359.1
• **Organic pollution**	€ 5,663.1	€ 63.3	€ 43.8	€ 119.3	€ 5,889.5
• **Saline or other intrusion**	€ 900.5	€ 6.7	€ 20.5	€ 9.0	€ 936.7
• **Water balance / Lowering water table**	€ 20.4	€ 0.0	€ 0.0	€ 0.0	€ 20.4

* Represents costs/foregone benefits across Austria, Belgium, Croatia, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden only.

Marine

Figure A2-10-15 to Figure A2-10-24 provide data on each descriptor by regional sea area. As the NE Atlantic is so large, data are presented separately on a different horizontal axis.

Figure A2-10-15: Area of all marine waters according to D1 – Marine biodiversity by 2018 (km²)

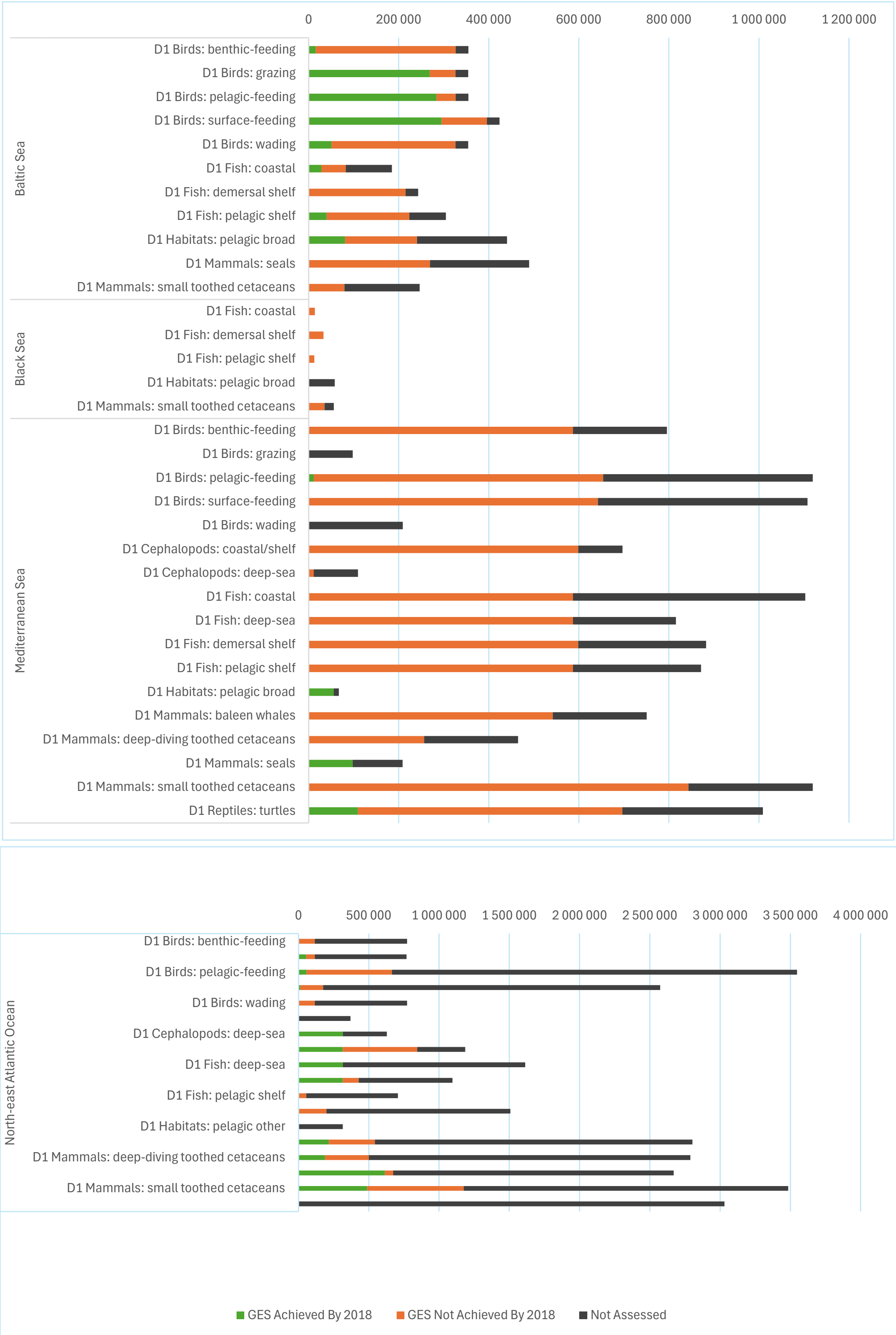


Figure A2-10-16: Area of all marine waters according to D2 – Non-indigenous species by 2018 (km²)

Figure A2-10-17: Area of all marine waters according to D3 – Commercial fish and shellfish by 2018 (km²)

Figure A2-10-18: Area of all marine waters according to D4 – Food webs by 2018 (km²)

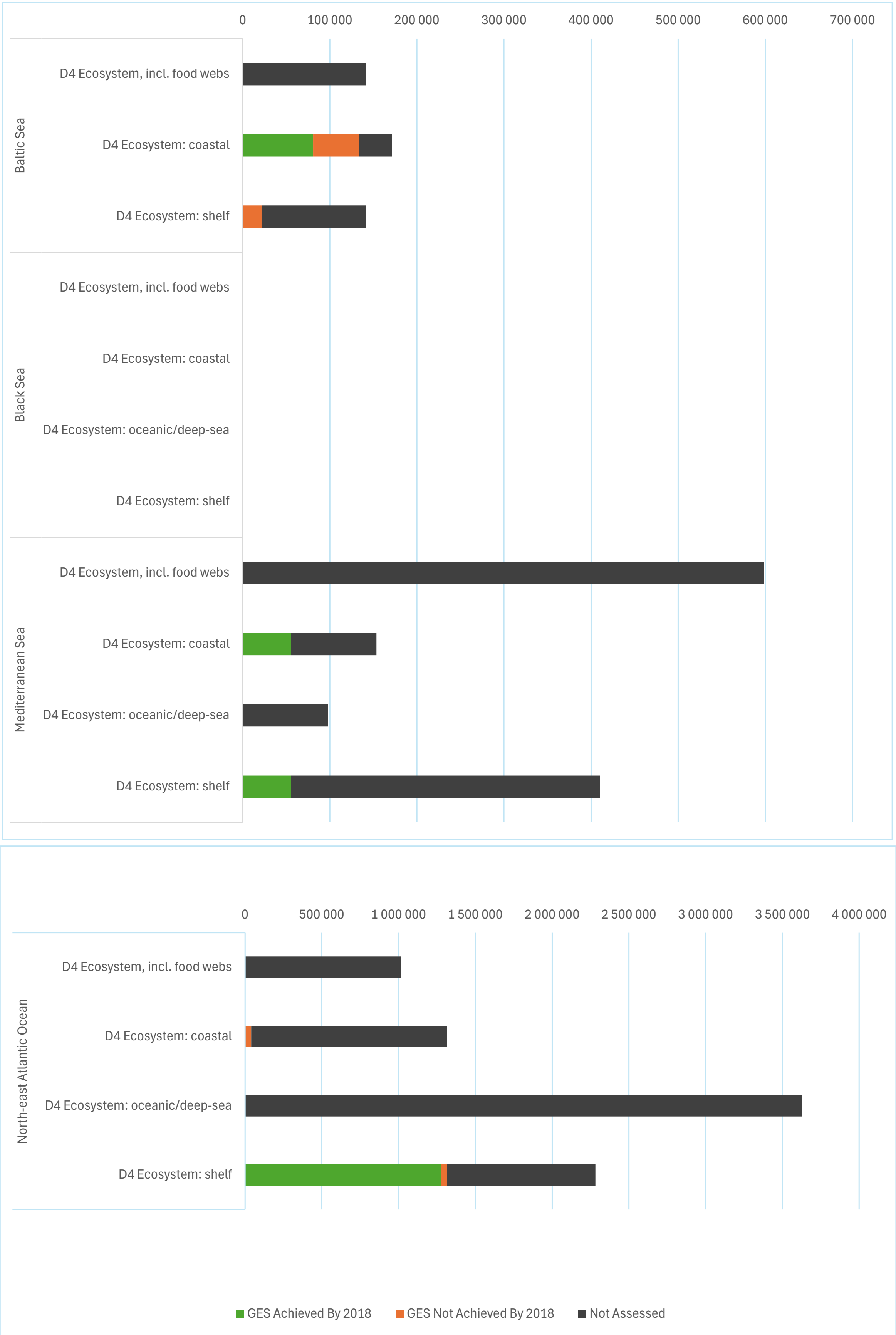


Figure A2-10-19: Area of all marine waters according to D5 – Eutrophication by 2018 (km²)

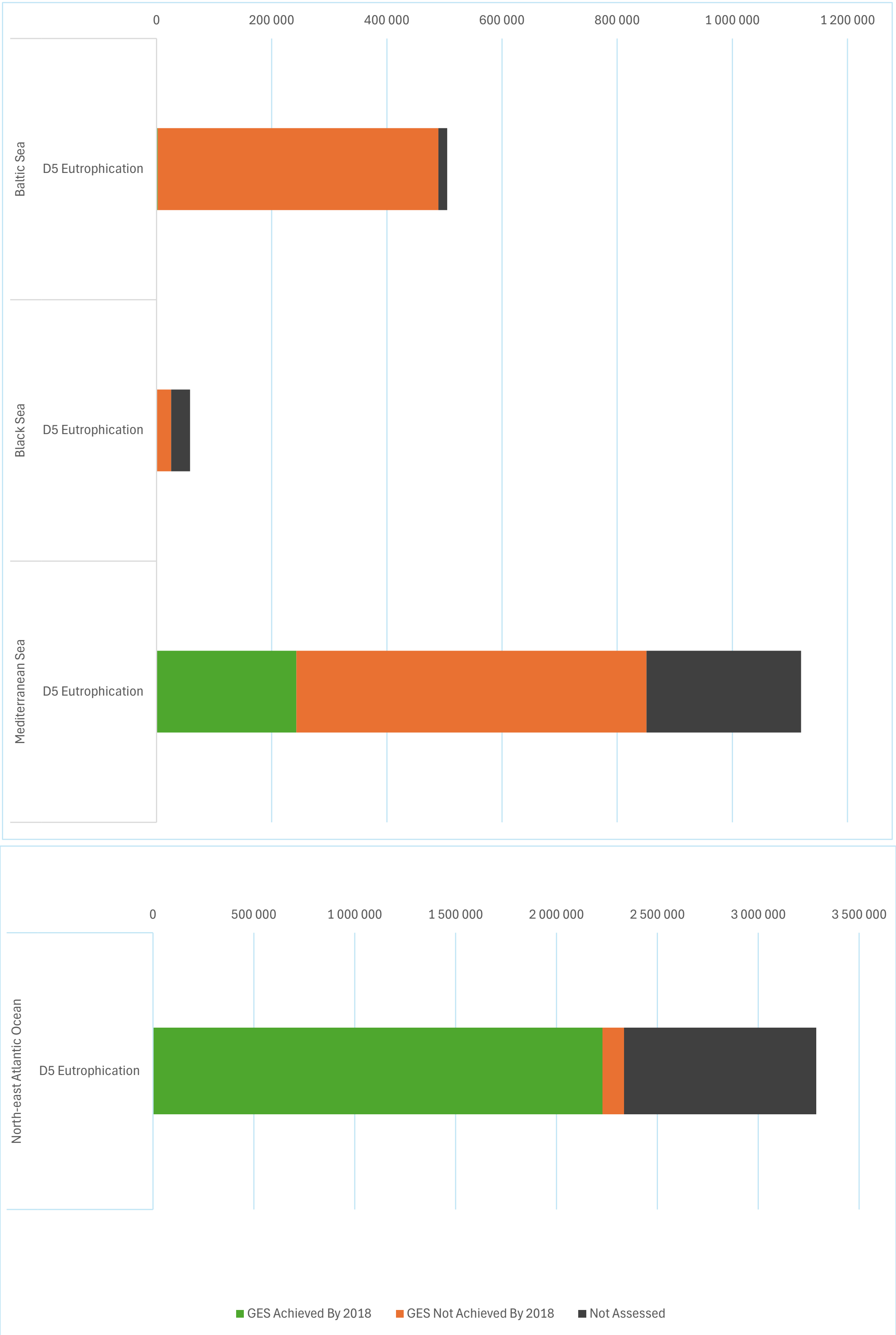


Figure A2-10-20: Area of all marine waters according to D6 – Seabed integrity by 2018 (km²)

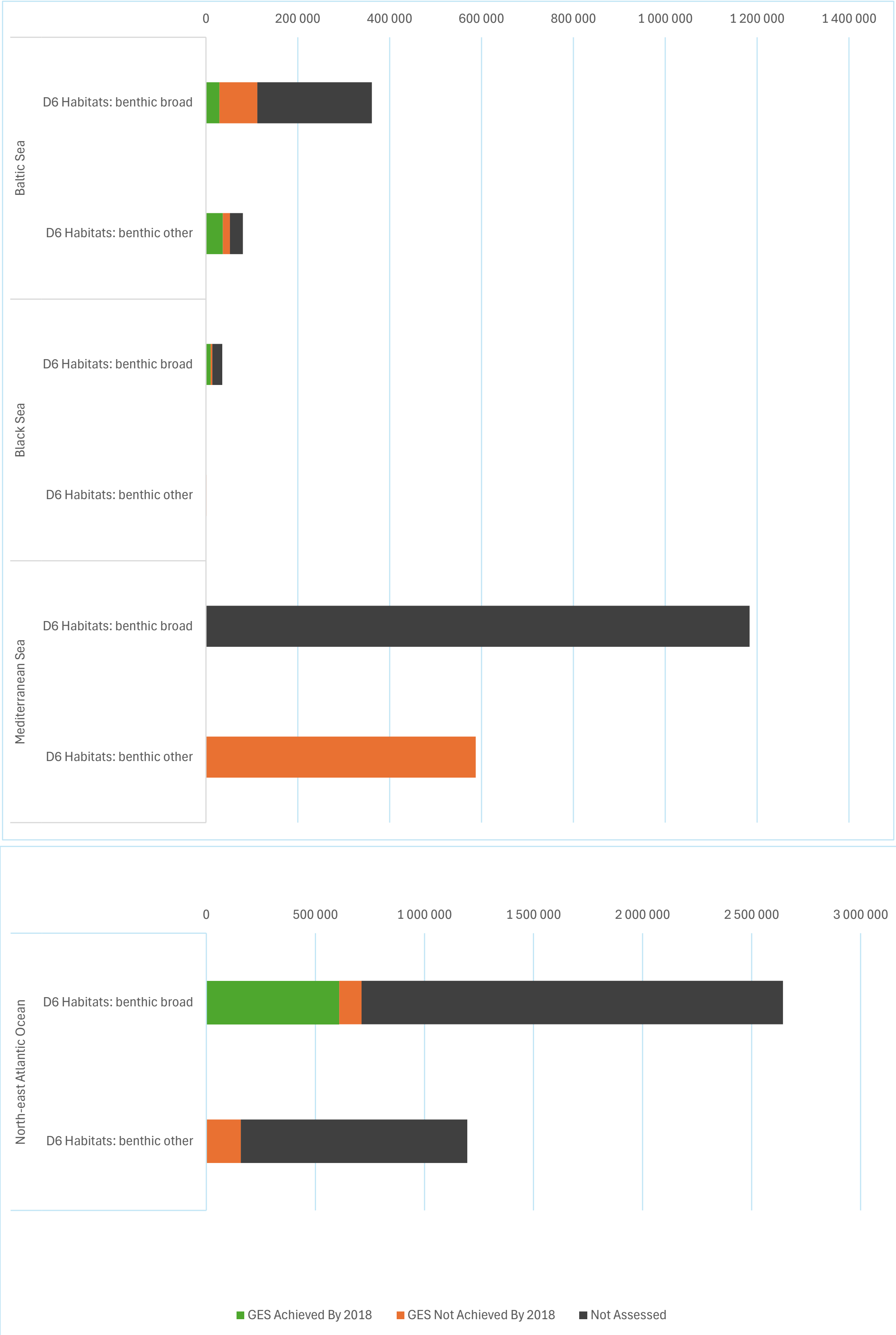


Figure A2-10-21: Area of all marine waters according to D8 – Contaminants by 2018 (km²)

Figure A2-10-22: Area of all marine waters according to D9 – Contaminants in seafood by 2018 (km^2)

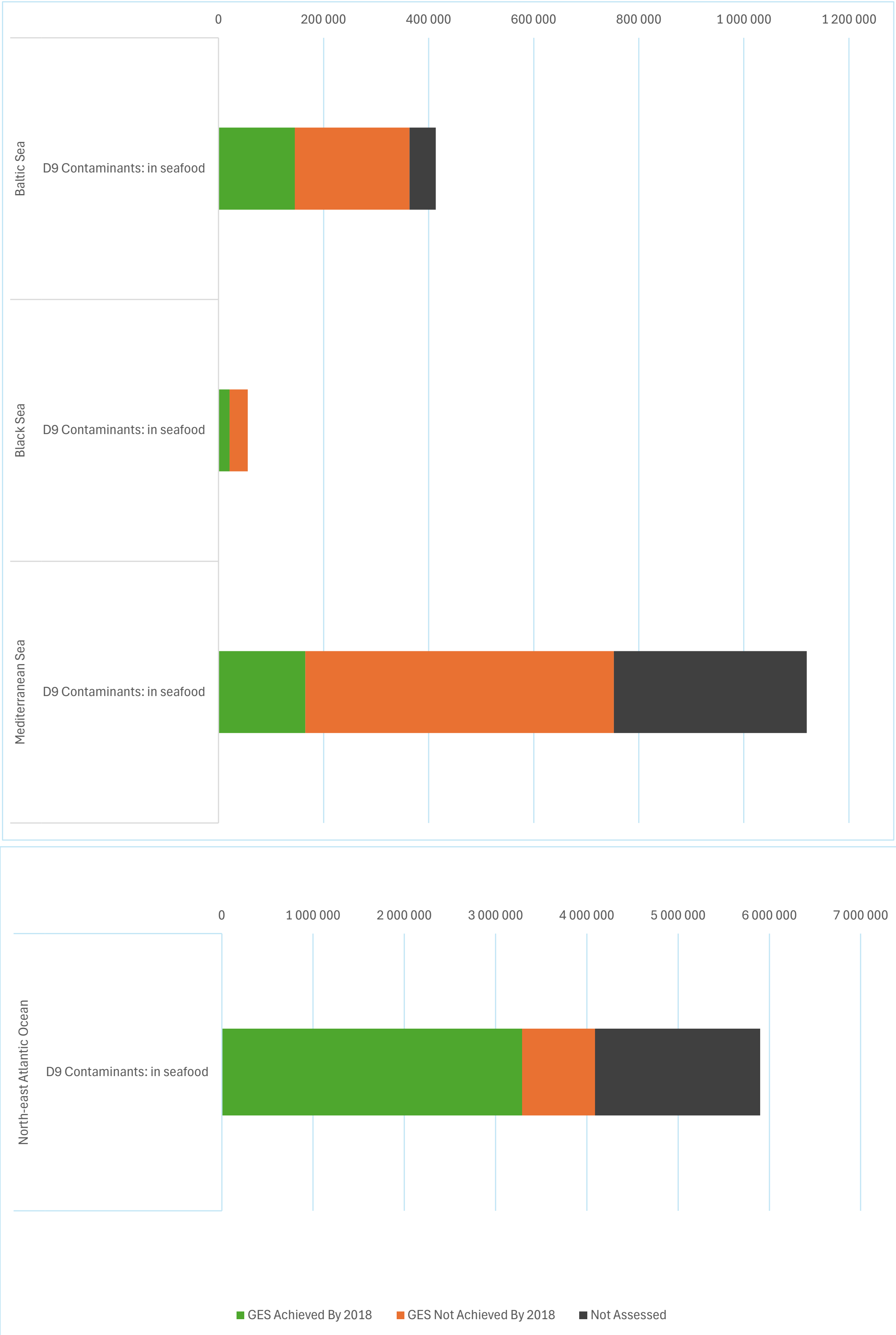


Figure A2-10-23: Area of all marine waters according to D10 – Marine litter by 2018 (km²)

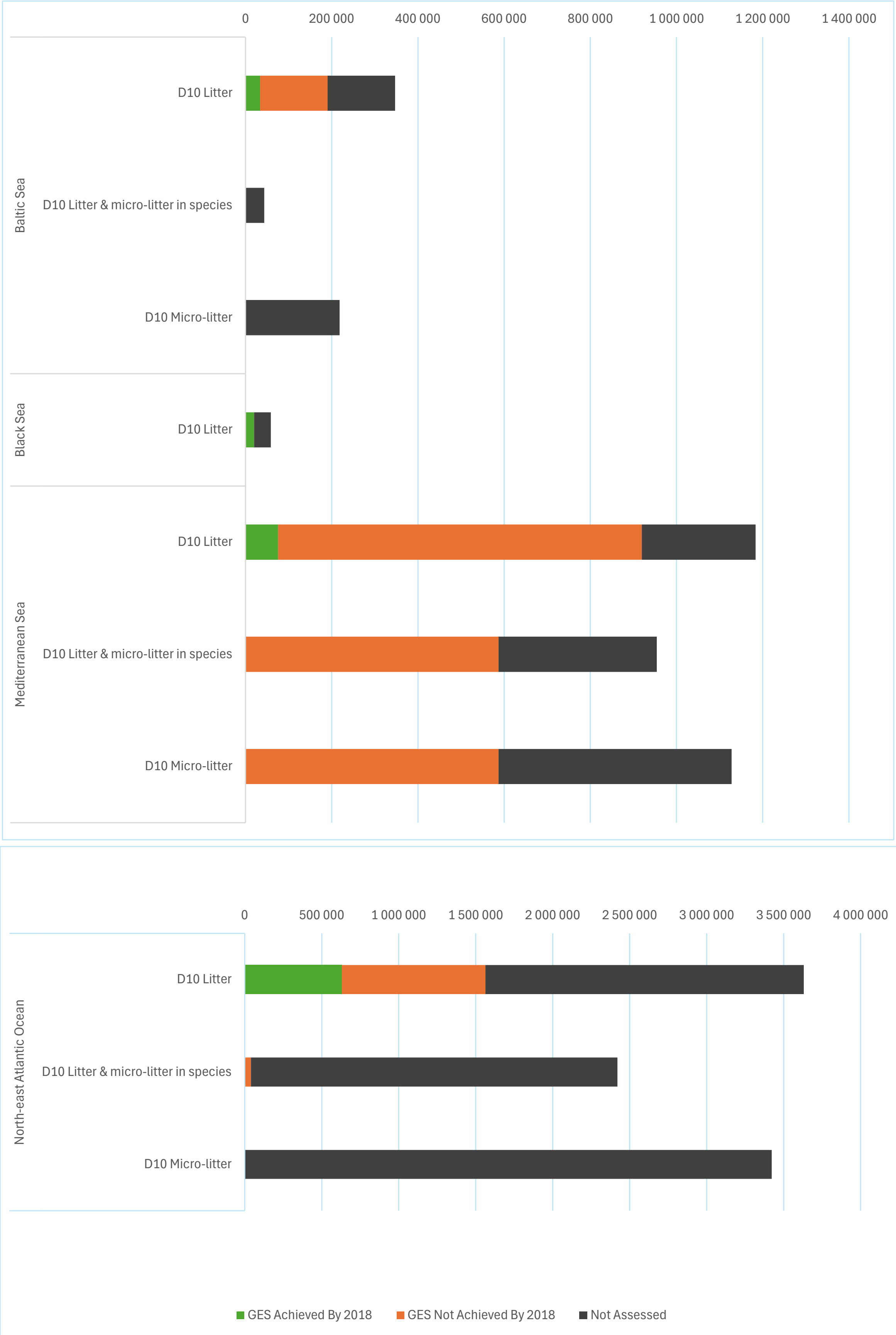
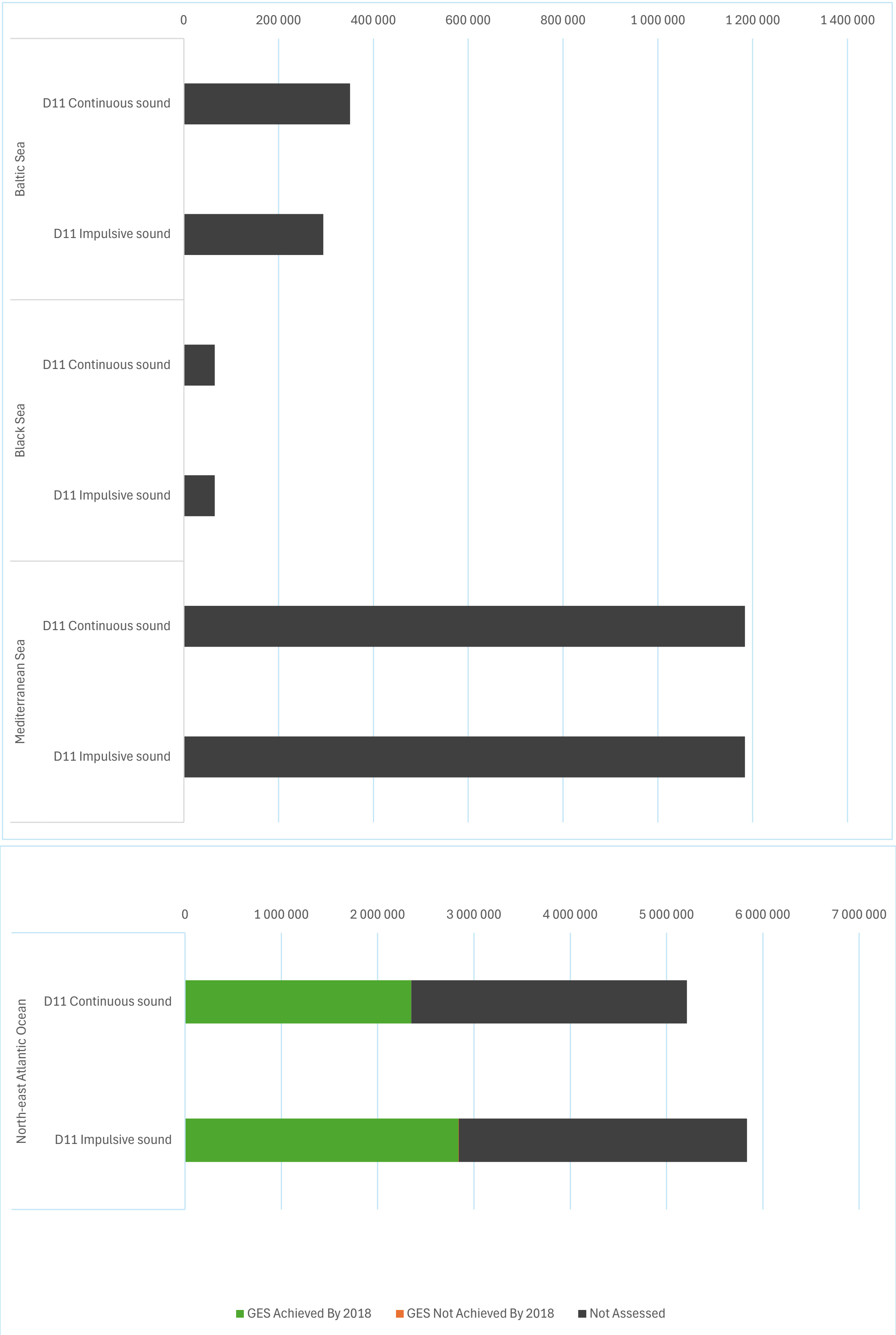


Figure A2-10-24: Area of all marine waters according to D11 – underwater noise by 2018 (km²)



Circular Economy and Waste

Environmental target

Table A2-10-36: Overview of targets in the Waste Framework Directive

Target Description	Targets	Derogations
Targets on the preparation for re-use and recycling of municipal waste	Past: 2020: Minimum of 50% by weight Current: 2025: Minimum of 55% by weight Future: 2030: Minimum of 60% by weight 2035: Minimum of 65% by weight	Yes: Member States may postpone 2025, 2030 and 2035 deadlines by up to 5 years
Target on the recovery of construction and demolition waste (includes preparation for reuse, recycling and other material recovery including backfilling operations)	2020: Minimum of 70% by weight	None
Reduce generation of food waste (Sustainable Development Goal)	2030: Reduce by 50% the per capita food waste at the retail and consumer levels	None
Target on the reduction of food waste at a national level	Proposed: By 31 December 2030: 10% reduction of food waste generation in processing and manufacturing compared to 2020 amounts 30% reduction of food waste generated per capita in retail and other distribution of food, in restaurants and food services, and in households compared to 2020 amounts	None
Separate collection of textile waste	Proposed: By 1 January 2025 Member States will have separate collection of textiles for reuse and recycling	None
Harmonised textile EPR scheme	Proposed: Member States will ensure EPR schemes for various textiles	

Table A2-10-37: Overview of targets in the Landfill Directive

Target Description	Targets	Derogations
Limit the amount of municipal waste landfilled	2035: Reduce to 10% or less of the total amount of municipal waste generated (by weight)	Yes: Member States may postpone deadline by up to 5 years
Reduce the fraction of biodegradable waste going to landfills	2016: Reduce to 35% of the amount by weight landfilled in 1995	Yes: Member States may postpone target by up to 4 years
Landfill compliance	Zero non-compliant landfills / landfilling	None

Table A2-10-38: Overview of targets in the Packaging and Packaging Waste Directive and its proposed revision

Target Description	Targets	Derogations
Targets on the recycling of all packaging waste	Current: 31 December 2025: Minimum of 65% by weight Future: 31 December 2030: Minimum of 70% by weight	None
Targets on the recycling of specific materials in packaging waste	Current: 31 December 2025: Plastic: 50%; Wood: 25%; Ferrous metals: 70%; Aluminium: 50%; Glass: 70%; Paper and cardboard: 75% Future: 31 December 2030: Plastic: 55%; Wood: 30%; Ferrous metals: 80%; Aluminium: 60%; Glass: 75%; Paper and cardboard: 85%	Yes: Member States may postpone the 2025 and 2030 deadlines by up to 5 years
Reduction in packaging waste generated	Proposed: 2030: 5% reduction per capita compared to the amount of packaging waste generated per capita in 2018 2035: 10% reduction per capita compared to the amount of packaging waste generated per capita in 2018 2040: 15% reduction per capita compared to the amount of packaging waste generated per capita in 2018	None
Minimum recycled content in plastic packaging	Proposed: From 1 January 2030: Minimum 30% for contact sensitive packaging made from PET Minimum 10% for contact sensitive packaging made from plastic materials other than PET (except single use plastic beverage bottles) Minimum 30% for single use plastic beverage bottles Minimum 35% for packaging other than those above From 1 January 2040: Minimum 50% for contact sensitive plastic packaging (except single use plastic beverage bottles) Minimum 65% for single use plastic beverage bottles Minimum 65% for plastic packaging other than those above	Derogations to be determined in 2028
Targets on reuse and refill	Proposed: Various targets from 1 January 2030 and 1 January 2040 for: • large household appliances made available in reusable transport packaging; • hot or cold beverages, take-away ready-prepared food packaging, alcoholic beverages, wine, and non-alcoholic beverages made available in reusable packaging or by enabling refill;	Some economic operators are exempt from targes

Target Description	Targets	Derogations
	• transport packaging, e-commerce transport packaging, pallet wrappings and grouped packaging is reusable	
Deposit and return systems (DRS)	Proposed: By 1 January 2029, Member States shall set up DRS systems for single use plastic and metal beverage containers	Exempt if can reach 90% separate collection rate by weight by other means

Table A2-10-39: Overview of targets in the WEEE Directive

Target Description	Targets	Derogations
Minimum rates for collection	From 2019: 65% of the average weight of EEE placed on the market in the 3 preceding years in the Member State OR 85% of WEEE generated in the territory of the Member State	Yes: listed Member States can have a lower collection rate of EEE placed on the market OR postpone target until 14 August 2021
Targets on recovery for types of WEEE	From 2018: Depends on the type of WEEE; Between 75% and 85%	None
Targets on preparation for reuse and recycling for types of WEEE	From 2018: Depends on the type of WEEE; Between 55% and 80%	None

Table A2-10-40: Overview of targets in the New Batteries Regulation

Target Description	Targets	Derogations
Targets for collection of waste LMT batteries for producers	Future: 31 December 2028: 51% 31 December 2031: 61%	None
Targets for collection of waste portable batteries for producers	Past: 31 December 2023: 45% Current: 31 December 2027: 63% Future: 31 December 2030: 73%	
Targets for recycling efficiency	Current: 31 December 2025: 75% by average weight of lead-acid batteries 65% by average weight of lithium-based batteries 80% by average weight of nickel-cadmium batteries 50% by average weight of other waste batteries Future: 31 December 2030: 80% by average weight of lead-acid batteries 70% by average weight of lithium-based batteries	
Targets for recovery of materials	Current: 31 December 2027: 90% for cobalt; 90% for copper; 90% for lead; 50% for lithium; 90% for nickel Future: 31 December 2031: 95% for cobalt; 95% for copper; 95% for lead; 80% for lithium; 95% for nickel	
Targets for recycled content	Future: From 18 August 2031: 16% cobalt; 85% lead; 6% lithium; 6% nickel From 18 August 2036: 26% cobalt; 85% lead; 12% lithium; 15% nickel	

Table A2-10-41: Overview of targets in the ELVs Directive and its proposed revision

Target Description	Targets	Derogations
Target on reuse and recovery	2015: For all end-of-life vehicles, the reuse and recovery shall be increased to a minimum of 95% by an average weight per vehicle per year	None
Target on reuse and recycling	2015: The re-use and recycling shall be increased to a minimum of 85% by an average weight per vehicle per year	
Minimum recycled content of plastic in vehicles	Proposed: Date unknown: Minimum 25% of plastic recycled by weight from post-consumer plastic waste	
Targets for the reusability, recyclability and recoverability of vehicles (Similar to targets laid out in Appendix I of Directive 2005/64/EC)	Proposed: Dates unknown: Minimum 85% by mass of each vehicle is constructed so that is *reusable or recyclable* Minimum 95% by mass of each vehicle is constructed so that is *reusable or recoverable*	
Targets for reuse, recycling and recovery by waste management operators (Similar to targets laid out in Article 7 of Directive 2000/53/EC)	Proposed: Dates unknown: *Reuse and recycling*: Minimum of 85% by average weight per vehicle *Reuse and recovery*: Minimum of 95% by average weight per vehicle	

Table A2-10-42: Overview of targets in the Plastic Bags Directive

Target Description	Targets	Derogations
Consumption level of lightweight plastic carrier bags	Current: 31 December 2019: Annual consumption does not exceed 90 bags per person Future: 31 December 2025: Annual consumption does not exceed 40 bags per person	None

Table A2-10-43: Overview of targets in the Single Use Plastics Directive

Target Description	Derogations	Derogations
Targets on separate collection of single use plastic beverage bottles	Future: 2025: 77% of single-use plastic bottles placed on the market in a given year by weight per Member State Future: 2029: 90% of single-use plastic bottles placed on the market in a given year by weight, per Member State.	None
Recycled content	Future: From 2025: PET beverage bottles contain at least 25% recycled plastic (average for all SUP-PET bottles placed on the market per Member State) From 2030: SUP beverage bottles contain at least 30% recycled plastic (average for all SUP beverage bottles placed on the market per Member State)	
Consumption reduction	No set targets, but Member States must take measures to achieve a measurable quantitative reduction in the consumption of certain single-use plastic products (cups for beverages and food containers) by 2026 compared to 2022, which can be supported by Member States.	

Implementation gap assessment

Waste Framework Directive (EU) 2018/851

Target on the preparation for re-use and recycling of municipal waste

Data was compiled from Eurostat (env_wasmun) for the year 2022. The implementation gap was calculated for the percent difference between the 2025 target recycling rate (55%) and the actual recycling rate (amount of waste recycled over the amount of waste generated) and the difference between the tonnage necessary to be recycled to meet the target and the reported recycled tonnage. The method for calculating the actual recycling rate for each Member State was the same as the one used in the EEA's 2023 Early Warning Assessment[368].

[368] https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-products/methodology-for-the-early-warning-assessment-related-to-certain-waste-targets

Table A2-10-44: Implementation gap for recycling rates of Member States against the 2025 municipal waste target of 55%

Member State	Implementation gap against current target (thousand tonnes)	Implementation gap against current target %
Austria (2021 value)	-558	-7.5%
Belgium	183	2.3%
Bulgaria (2021 value)	821	26.8%
Croatia*	383	20.8%
Cyprus	247	40.2%
Czechia (2021 value)	698	11.7%
Denmark	125	2.7%
Estonia	110	21.8%
Finland (2021 value)	559	16.0%
France	4,829	13.2%
Germany	-6,999	-14.1%
Greece* (2021 value)	2,019	37.5%
Hungary*	868	22.2%
Ireland (2020 value)	456	14.2%
Italy (2021 value)	916	3.1%
Latvia (2021 value)	95	10.9%
Lithuania*	87	6.6%
Luxembourg	2	0.4%
Malta*	140	42.8%
Netherlands	-213	-2.5%
Poland*	1,896	14.1%
Portugal (2021 value)	1,304	24.6%
Romania*	2,466	42.9%
Slovakia*	142	5.5%
Slovenia	-78	-7.6%
Spain	3,652	16.4%
Sweden	631	15.3%

Member State	Implementation gap against current target (thousand tonnes)	Implementation gap against current target %
EU-27	22,629	
*denotes Member States with a derogation to the target set out in Article 11(2), point c of the WFKD Values are from 2022, unless otherwise stated Source: Eurostat env_wasmun		

Target on the recovery of construction and demolition waste

Data is from env_wasgen and env_wastrt for the year 2020. Recovery rate calculated as the amount of non-hazardous mineral waste from construction and demolition recovered (recycling and backfilling R2-R-11) divided by the amount of non-hazardous mineral waste from construction and demolition generated.

Table A2-10-45: Implementation gap for the recovery of construction and demolition waste (non-hazardous mineral waste) of Member States against the 2020 recovery target of 70%.

Member State	Implementation gap (tonnes)	Implementation gap %
Austria	-1,748,658	-15.3%
Belgium	9,845,642	47.6%
Bulgaria	-97,757	-8.5%
Croatia	63,038	10.1%
Cyprus	96,331	22.3%
Czechia	-2,269,176	-35.8%
Denmark	-888,546	-24.5%
Estonia	-64,115	-8.1%
Finland	74,906	6.8%
France	-2,326,892	-3.9%
Germany	-17,073,528	-20.5%
Greece	808,672	23.8%
Hungary	-2,532,433	-103.6%
Ireland	521,653	35.1%
Italy	-12,515,197	-27.3%
Latvia	-92,312	-29.0%
Lithuania	-73,917	-10.1%
Luxembourg	-58,323	-8.5%
Malta	-867,393	-29.2%

Member State	Implementation gap (tonnes)	Implementation gap %
Netherlands	-4,556,196	-23.5%
Poland	718,033	11.4%
Portugal	230,941	11.1%
Romania	-25,401	-2.2%
Slovakia	21,976	2.1%
Slovenia	-269,180	-27.6%
Spain	-376,304	-2.6%
Sweden	843,427	28.8%
EU-27	13,224,618	
Values are from 2020 Source: Eurostat env_wasgen and env_wastrt		

Target on the reduction of food waste

For the implementation gap against the 2030 proposed target of reducing food waste by 10% in processing and manufacturing compared to the amount in 2020 and 30% in retail and other distribution of food, in restaurants and food services and households compared to the amount in 2020, data was compiled from Eurostat (env_wasfw) for the year 2021. For both 2020 (reference year) and 2021, the total amount of food waste per capita in processing and manufacturing was summed and the total amount of food waste in retail and other distribution of food, in restaurants and food services and households was summed. The implementation gap was calculated for the percent difference between the target reduction rates (10% and 30%) of the summed 2020 total amounts and the actual amount of food waste generated in 2021 (2021 amount of food waste in kilograms per capita divided by the 2020 amount). The implementation gap of the difference between the amount (kg per capita) necessary to be reduced to meet the target and the reported amount of food waste collected in 2021 was also calculated.

Table A2-10-46: Implementation gap for the 2030 food waste reduction targets of 10% in processing and manufacturing compared to the amount in 2020 and 30% jointly in retail and other distribution of food, restaurants and food services and households compared to the amount in 2020

Member State	Implementation gap to 10% reduction in processing and manufacturing		Implementation gap to 30% reduction in retail and other distribution of food, restaurants and food services, and households	
	Amount per capita (kg)	%	Amount per capita (kg)	%
Austria	3.9	20.5%	31.5	27.4%
Belgium	30.1	18.7%	24.5	28.8%
Bulgaria	1.9	10.0%	20.0	25.0%
Croatia	0.2	10.0%	18.4	31.7%
Cyprus				

Member State	Implementation gap to 10% reduction in processing and manufacturing		Implementation gap to 30% reduction in retail and other distribution of food, restaurants and food services, and households	
	Amount per capita (kg)	%	Amount per capita (kg)	%
Czechia				
Denmark	12.2	12.0%	41.1	38.4%
Estonia	9.4	39.2%	24.2	28.8%
Finland	2.9	10.0%	34.1	44.3%
France	1.6	6.2%	24.8	28.8%
Germany				
Greece				
Hungary	-1.1	-5.8%	22.6	31.4%
Ireland	3.4	7.7%	28.4	29.0%
Italy	0.9	10.0%	37.8	32.6%
Latvia	-0.1	-0.5%	20.7	19.0%
Lithuania	1.0	10.0%	31.4	32.0%
Luxembourg	2.7	15.9%	18.7	15.7%
Malta				
Netherlands	11.9	20.2%	11.8	15.5%
Poland	2.1	10.0%	23.9	32.7%
Portugal	1.6	26.7%	49.3	30.6%
Romania				
Slovakia	2.3	10.0%	22.7	32.9%
Slovenia	1.5	30.0%	17.9	28.4%
Spain				
Sweden	0.5	10.0%	21.3	26.3%
EU-27 (based on Eurostat total)	3.7		27.3	

All values are from 2021. Some countries have values that are not applicable because the data available in Eurostat is from 2020 (reference year).
Source: Eurostat env_wasfw

Landfill Directive (EU) 2018/850

The implementation gap for target limiting overall municipal waste sent to landfill was calculated using the Eurostat database (env_wasmun) for the year 2021. The implementation gap was calculated for the percent difference between the target landfilling rate (10%) and the actual amount landfilled (the amount of municipal waste landfilled divided by the amount of municipal waste generated) and the difference between the tonnage of the actual amount landfilled and the tonnage needed to meet the target.

Table A2-10-47: Implementation gap for the 2035 target limiting overall municipal waste sent to landfill to 10% or less

Member State	Implementation gap against current target		Implementation gap against future (2035) target	
	Tonnes of total MSW (kt)	%	Tonnes of total MSW (thousand tonnes)	%
Austria	No such target in force		-596	-8,0%
Belgium			-835	-9,5%
Bulgaria			586	19,2%
Croatia			853	48,3%
Cyprus			296	50,5%
Czechia			2,169	36,2%
Denmark			-401	-8,9%
Estonia			51	9,6%
Finland			-335	-9,6%
France			5,055	13,2%
Germany			-5,229	-9,7%
Greece			3,802	70,7%
Hungary			1,657	41,0%
Ireland (2020 value)			196	6,1%
Italy			2,694	9,2%
Latvia			369	42,5%
Lithuania			73	5,4%
Luxembourg			-31	-6,1%
Malta			237	74,9%
Netherlands			-780	-8,6%
Poland			3,929	28,7%

Member State	Implementation gap against current target		Implementation gap against future (2035) target	
	Tonnes of total MSW (kt)	%	Tonnes of total MSW (thousand tonnes)	%
Portugal			2,278	42,9%
Romania			3,779	65,5%
Slovakia			829	30,6%
Slovenia			-42	-3,9%
Spain			8,168	36,9%
Sweden			-411	-9,4%
EU-27			37,019	
Values are from 2021, unless otherwise stated Source: Eurostat env_wasmun				

Limit the fraction of biodegradable waste going to landfills

The implementation gaps for the Landfill Directive quantitative targets are calculated as the difference in tonnage between the target performance and actual performance. The implementation gap for the reduction target of biodegradable municipal waste sent to landfill is calculated using the EEA "Early warning assessment related to the 2025 targets for municipal waste and packaging waste"[369], which is the most up to date data provided by Member States themselves, as well as the EEA Municipal waste management reports for each Member State.

Table A2-10-48: Implementation gap for the 2016 target reducing biodegradable municipal waste sent to landfill to 35%

Member State	Implementation gap	
	Tonnes of biodegradable Member State waste (kt)	%
Austria (2016 value)	-	-35%
Belgium	-	-35%
Bulgaria*	67,500	3%
Croatia*	414,419	55%
Cyprus*	138,933	51%
Czechia*	105,000	7%
Denmark	-	-35%
Estonia*	-81,879	-26%

[369] https://www.eea.europa.eu/publications/many-eu-member-states/early-warning-assessment-related-to

Member State	Implementation gap	
	Tonnes of biodegradable Member State waste (kt)	%
Finland	-714,000	-34%
France (2017 value)	-3,720,000	-20%
Germany (2016 value)	-700,000	-35%
Greece*	1,512,000	72%
Hungary	-140,000	-7%
Ireland (2021 value)	-345,616	-26%
Italy	-5,160,000	-20%
Latvia*	96,600	21%
Lithuania*	-245,120	-32%
Luxembourg	-44,029	-30%
Malta*	208,624	147%
Netherlands (2017 value)	-793,980	-33%
Poland* (2018 value)	-1,051,200	-24%
Portugal*	225,000	10%
Romania*	432,000	9%
Slovakia*	115,321	12%
Slovenia*	-89,000	-20%
Spain	-720,000	-6%
Sweden	-762,280	-34%
EU-27	3,315,397	

*denotes countries which have a time derogation for 2016 target

Values are from 2019, unless otherwise stated

Sources: European Environment Agency, Early warning assessment related to the 2025 targets for municipal waste and packaging waste; European Environment Agency, Municipal waste management reports for each Member State

Packaging and Packaging Waste Directive (EU) 2018/852

Targets on the recycling of all packaging waste

The recycling rates from Eurostat database env_waspacr were used to calculate the implementation gap between the target recycling rate and the reported recycling rate. Following this, the difference between the tonnage necessary to be recycled in each Member State to meet the target and the actual tonnage recycled was calculated.

Table A2-10-49: Implementation gap for recycling rates for all packaging waste of Member States against the 2025 recycling target of 65% and 2030 target of 70%

Member State	Implementation gap against the 2025 overall recycling target for packaging (65%)		Implementation gap against the 2030 overall recycling target for packaging (70%)	
	Implementation gap (tonnes)	Implementation gap %	Implementation gap (tonnes)	Implementation gap %
Austria	-6,607	-0.8%	66,963	4.2%
Belgium	-296,441	-15.4%	-197,527	-10.4%
Bulgaria (2019 value)	21,112	3.8%	48,836	8.8%
Croatia	41,369	14.2%	55,950	19.2%
Cyprus	1,895	1.5%	5,736	6.5%
Czechia	-57,039	-4.1%	14,814	0.9%
Denmark	17,974	0.4%	71,096	5.4%
Estonia	-10,803	-5.4%	-823	-0.4%
Finland	63,804	-7.5%	107,784	-2.5%
France	784,032	3.2%	1,453,960	8.2%
Germany	-564,590	-2.9%	420,010	2.1%
Greece (2019 value)	42,725	4.9%	86,200	9.9%
Hungary (2020 value)	254,800	12.6%	330,171	17.6%
Ireland	100,671	6.9%	162,613	11.9%
Italy	-649,519	-7.9%	30,221	-2.9%
Latvia	11,640	4.0%	26,142	9.0%
Lithuania	18,371	4.3%	39,693	9.3%
Luxembourg	-8,195	-8.7%	-1,338	-3.7%
Malta	20,788	26.6%	24,688	31.6%
Netherlands	-272,887	-11.8%	-122,526	-6.8%
Poland (2019 value)	622,541	9.5%	949,401	14.5%
Portugal	35,263	1.9%	126,725	6.9%
Romania	649,124	26.7%	770,746	31.7%
Slovakia	-50,866	-8.9%	-22,158	-3.9%

Member State	Implementation gap against the 2025 overall recycling target for packaging (65%)		Implementation gap against the 2030 overall recycling target for packaging (70%)	
	Implementation gap (tonnes)	Implementation gap %	Implementation gap (tonnes)	Implementation gap %
Slovenia	28,090	9.9%	42,213	14.9%
Spain	4,658	-5.1%	437,753	-0.1%
Sweden	120,997	5.4%	202,674	10.4%
EU-27	2,839,852		5,474,387	
Values are from 2021, unless otherwise stated Source: Eurostat env_waspac and env_waspacr				

Overview of Member States with derogations to the targets for specific materials in packaging waste

Table A2-10-50: Member States with a derogation to the targets for specific materials in packaging waste

Member State	Specific material for which the Member State has a derogation to the target							Notes
	Plastic	Wood	Ferrous metals	Aluminium	Glass	Paper and cardboard	Paper and cardboard	
Croatia	X (2025)				X (2025)			
Czechia				X (2025 and 2030)				
Greece	X (2025)				X (2025)			
Hungary								Unclear which 2025 targets will be postponed
Luxembourg	X (2025)							
Malta	X (2025)					X (2025)	X (2025)	
Portugal	X (2025)					X (2025)	X (2025)	
Sweden	X (2025)	X (2025)						

Targets on the recycling of specific materials in packaging waste

Data was compiled from Eurostat env_waspacr for the year 2021.

Figure A2-10-25: 2021 plastic packaging recycling rate compared to the 2025 and 2030 targets on recycling specific materials in packaging waste

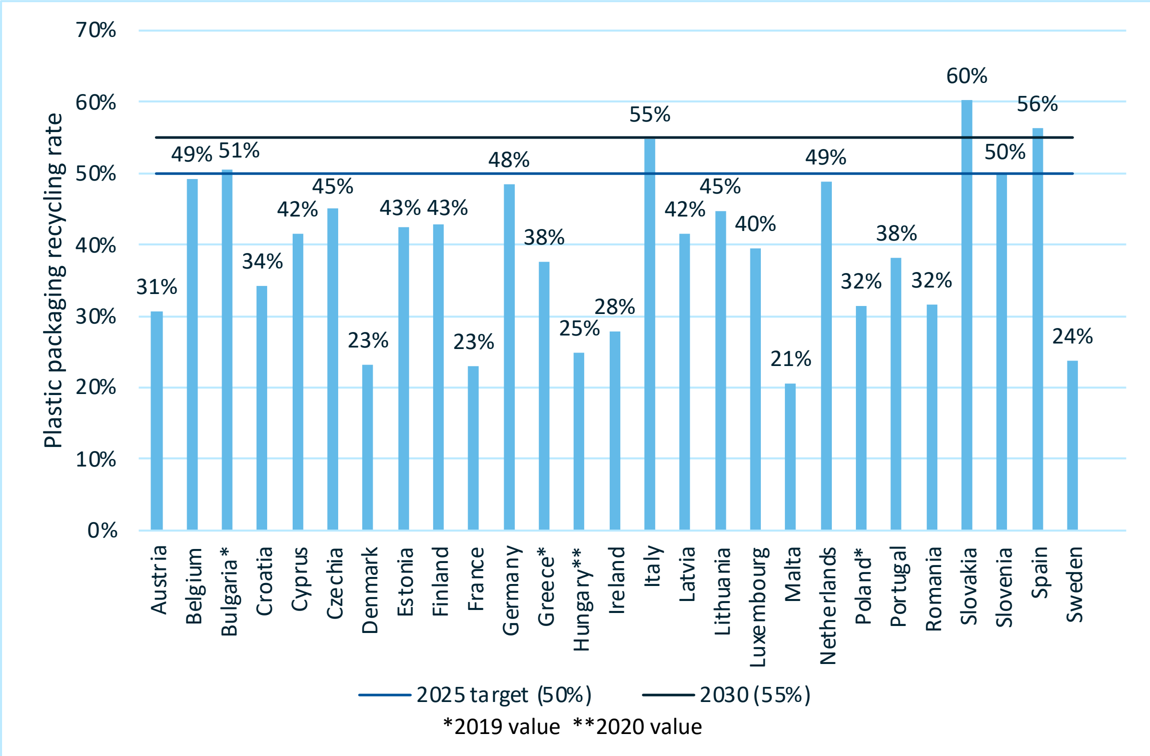


Figure A2-10-26: 2021 wooden packaging recycling rate compared to the 2025 and 2030 targets on recycling specific materials in packaging waste

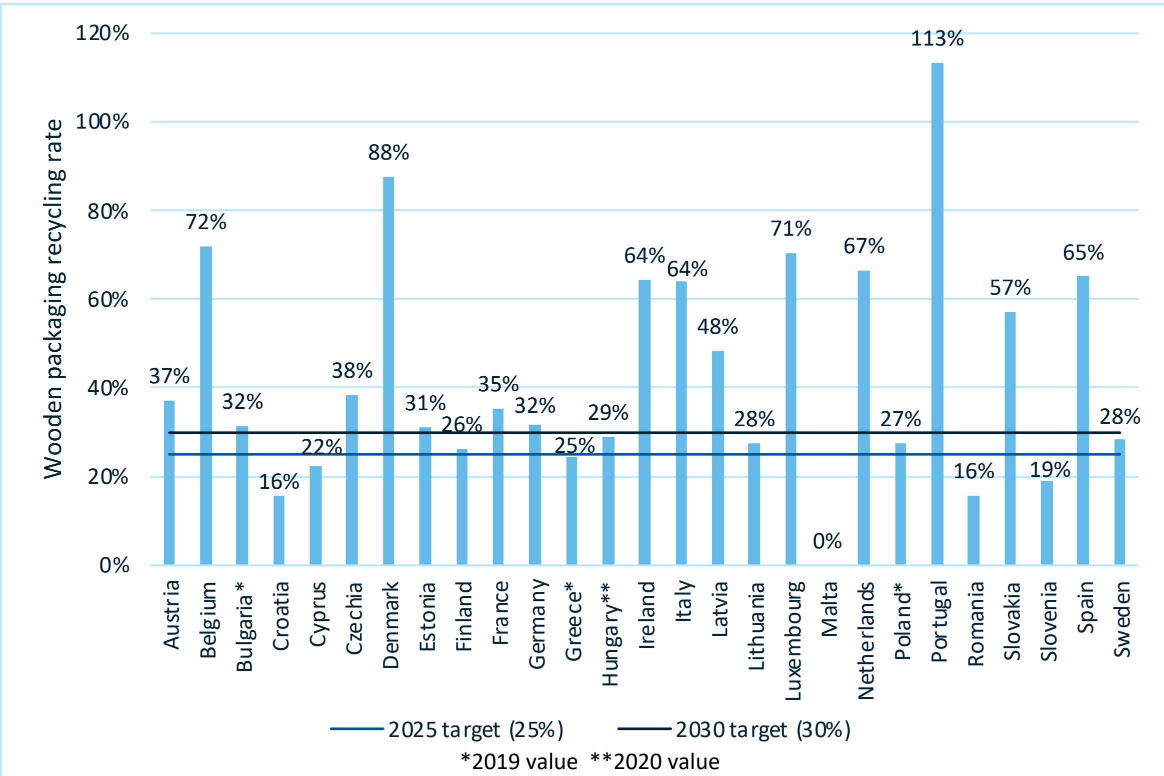


Figure A2-10-27: 2021 steel packaging recycling rate compared to the 2025 and 2030 targets on recycling specific materials in packaging waste

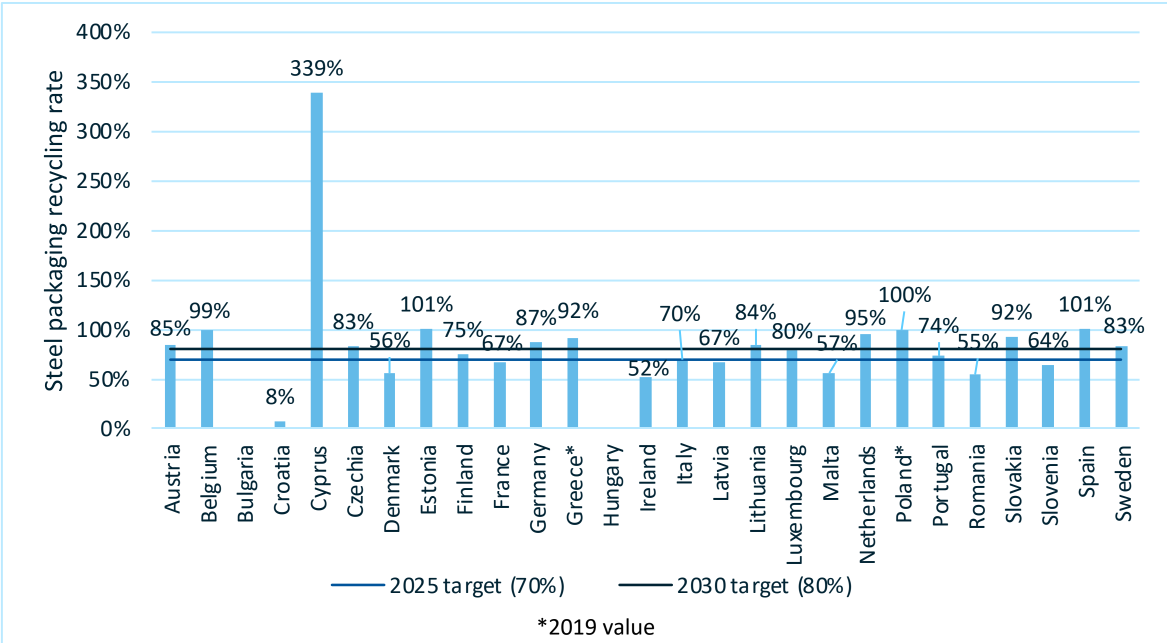


Figure A2-10-28: 2021 aluminium packaging recycling rate compared to the 2025 and 2030 targets on recycling specific materials in packaging waste

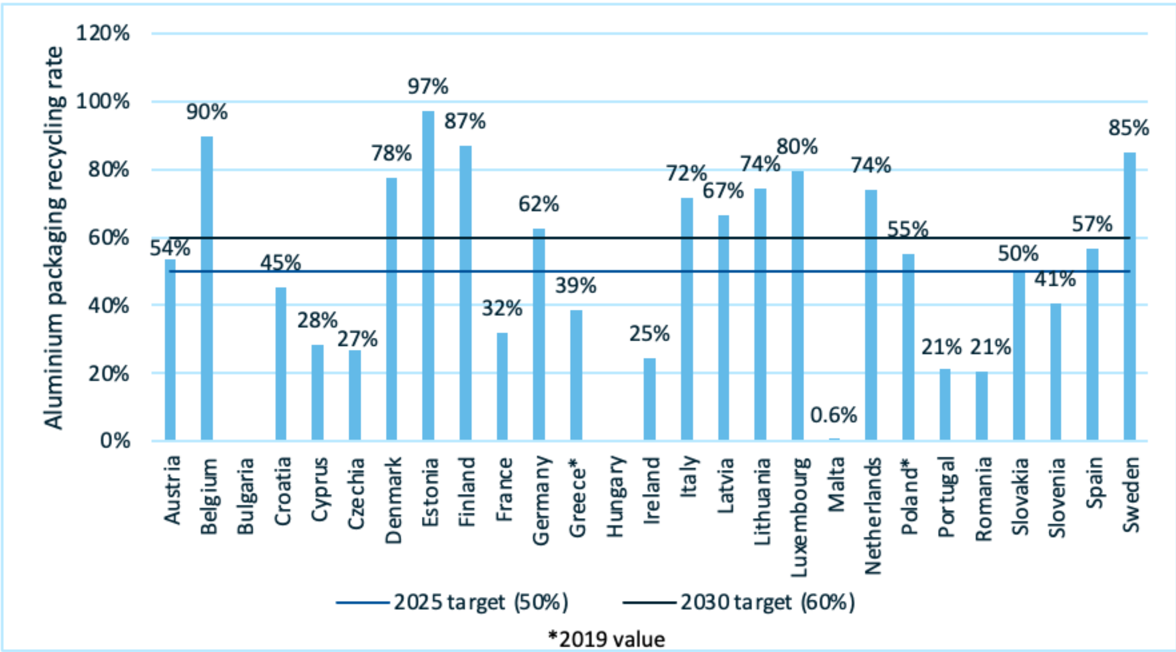


Figure A2-10-29: 2021 glass packaging recycling rate compared to the 2025 and 2030 targets on recycling specific materials in packaging waste

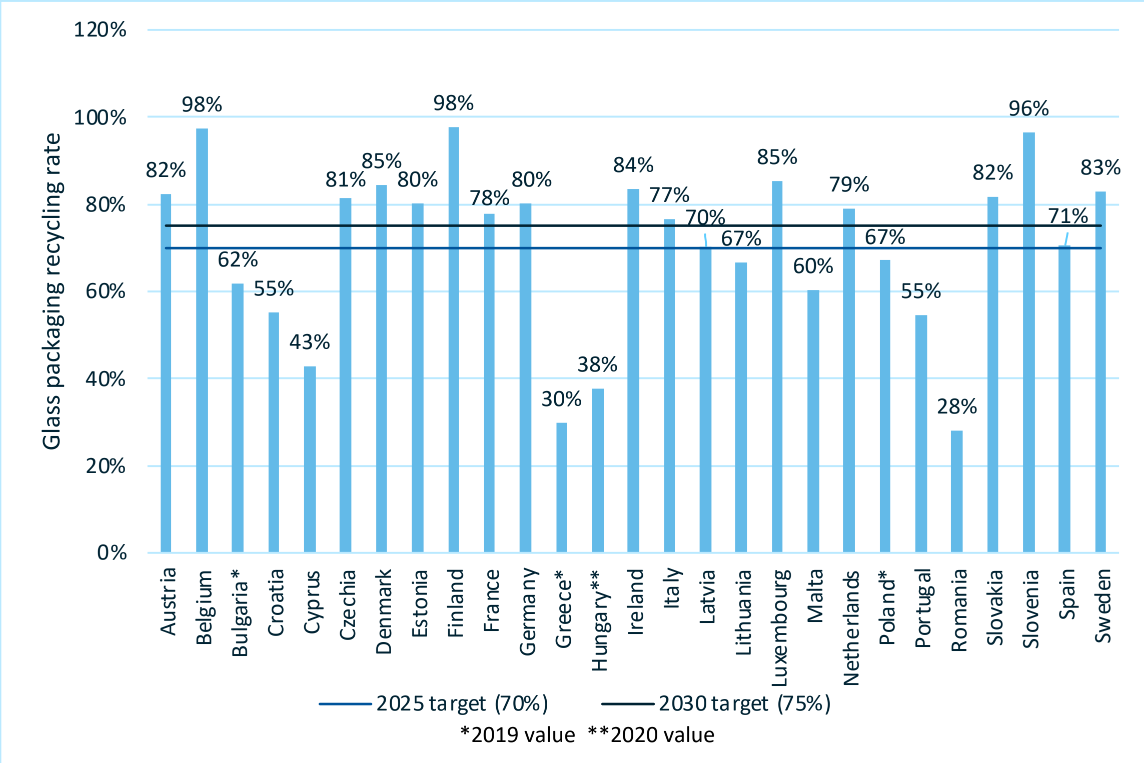
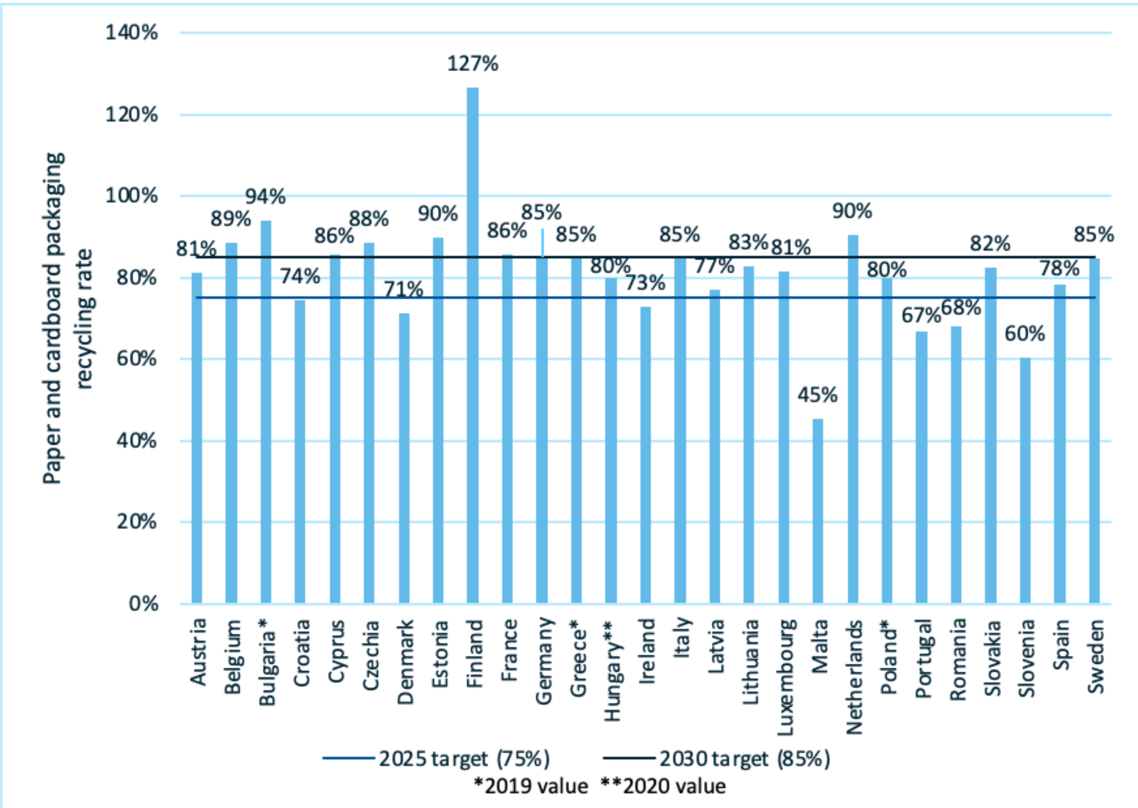


Figure A2-10-30: 2021 paper and cardboard packaging recycling rate compared to the 2025 and 2030 targets on recycling specific materials in packaging waste



The recycling rates from Eurostat env_waspacr were used to calculate the difference between the target recycling rate and the recycling rate. Following this, the difference between the tonnage necessary to be recycled in the Member States to meet the target for each packaging material and the actual tonnage recycled was calculated.

Table A2-10-51: Implementation gap for recycling rates of Member States against the 2025 target for recycling of specific materials in packaging waste

Member State	Plastic (50%)		Wood (25%)		Glass (70%)	
	Tonne	%	Tonne	%	Tonne	%
Austria	71,283	19.3%	-6,007	-12.0%	-39,383	-12.3%
Belgium	2,936	0.8%	-116,777	-46.8%	-110,453	-27.5%
Bulgaria (2019 value)	-1,004	-0.6%	-5,116	-6.5%	10,286	8.3%
Croatia*	11,189	15.8%	2,902	9.3%	10,208	14.8%
Cyprus	1,579	8.4%	1,697	2.8%	5,192	27.1%
Czechia*	14,036	4.9%	-25,738	-13.3%	-26,831	-11.4%
Denmark	60,969	26.8%	-19,986	-62.6%	-28,752	-14.5%
Estonia	3,761	7.5%	-1,365	-6.2%	-3,553	-10.1%
Finland	34,502	7.1%	50,415	-1.3%	-18,903	-27.7%
France	670,621	26.9%	379,679	-10.4%	-234,282	-7.9%
Germany	54,741	1.6%	-239,503	-6.6%	-319,150	-10.3%
Greece* (2019 value)	27,710	12.4%	330	0.5%	44,320	40.1%
Hungary* (2020 value)	116,095	25.1%	1,023	-3.9%	48,507	32.2%
Ireland	82,217	22.1%	-25,229	-39.4%	-23,600	-13.6%
Italy	54,171	-4.8%	-655,319	-38.9%	-187,990	-6.6%
Latvia	4,042	8.4%	-19,077	-23.3%	-213	-0.3%
Lithuania	5,302	5.2%	-1,870	-2.5%	2,835	3.3%
Luxembourg*	2,402	10.5%	-3,308	-45.5%	-5,265	-15.2%
Malta*	4,727	29.5%	1,238	25.0%	1,355	9.6%
Netherlands	6,124	1.1%	-29,801	-41.5%	-45,906	-9.0%
Poland (2019 value)	237,656	18.5%	-36,098	-2.3%	39,118	2.9%
Portugal*	51,081	11.9%	-61,833	-88.4%	63,831	15.3%
Romania	93,019	18.4%	59,546	9.3%	187,856	42.0%
Slovakia	-13,133	-10.2%	-21,374	-32.2%	-11,507	-11.7%

Member State	Plastic (50%)		Wood (25%)		Glass (70%)	
	Tonne	%	Tonne	%	Tonne	%
Slovenia	21	0.0%	2,961	5.9%	-9,605	-26.4%
Spain	76,874	-6.4%	-471,418	-40.1%	62,167	-0.7%
Sweden*	106,599	26.2%	51,953	-3.2%	-33,390	-12.8%

*denotes countries with a derogation to the targets. The grey cells denote which material fraction the country has a derogation for.
All values are from 2021, unless otherwise stated
Source: Eurostat env_ waspac and env_waspacr
Note: Eurostat in env_waspacr uses adjusted recycling rates for plastic and wood. Due to the adjusted rates, some countries, in particular for wood packaging, have rate values that do not align with the tonnage (e.g., Finland)

Member State	Ferrous metals (70%)		Aluminium (50%)		Paper and cardboard (75%)	
	Tonne	%	Tonne	%	Tonne	%
Austria	-6,637	-15.2%	-847	-3.5%	-39,430	-6.0%
Belgium	-26,787	-29.1%	-13,293	-39.7%	-107,550	-13.6%
Bulgaria (2019 value)					-26,261	-18.9%
Croatia*	5,958	62.2%	384	4.9%	614	0.6%
Cyprus	-7,093	-269.1%	778	21.7%	-2,706	-10.5%
Czechia*	-8,188	-12.7%	5,657	23.3%	-80,568	-13.4%
Denmark	3,662	13.8%	-5,884	-27.5%	21,019	3.8%
Estonia	-3,044	-31.0%	-1,157	-47.2%	-11,780	-14.7%
Finland	491	-5.2%	-8,927	-36.9%	-80,693	-51.5%
France	11,375	2.6%	20,120	18.1%	-566,300	-10.6%
Germany	-142,505	-16.7%	-20,167	-12.4%	-858,508	-10.1%
Greece* (2019 value)	-14,050	-22.3%	2,520	11.5%	-36,760	-9.6%
Hungary* (2020 value)					-20,249	-4.7%
Ireland	9,616	18.5%	8,632	25.5%	11,228	2.2%
Italy	-444	-0.2%	-17,673	-21.8%	-509,248	-9.6%
Latvia	345	3.4%	-398	-16.6%	-1,573	-2.0%
Lithuania	-1,989	-14.3%	-1,579	-24.4%	-10,972	-7.6%

Member State	Ferrous metals (70%)		Aluminium (50%)		Paper and cardboard (75%)	
	Tonne	%	Tonne	%	Tonne	%
Luxembourg*	-331	-9.6%	-616	-29.6%	-3,705	-6.4%
Malta*	283	13.4%	1,155	49.4%	11,083	29.7%
Netherlands	-38,762	-24.8%	-10,803	-23.9%	-214,652	-15.4%
Poland (2019 value)	-53,566	-29.8%	-4,971	-5.2%	-100,261	-4.9%
Portugal*	-1,911	-3.5%	9,076	28.7%	69,037	8.4%
Romania	9,968	14.7%	9,375	29.5%	52,669	7.1%
Slovakia	-4,725	-22.3%	36	0.3%	-18,051	-7.3%
Slovenia	612	5.6%	751	9.4%	17,762	14.7%
Spain	-67,273	-30.9%	-9,316	-6.6%	-101,307	-3.3%
Sweden*	-4,205	-12.6%	-11,767	-35.1%	-66,119	-9.8%

*denotes countries with a derogation to the targets (see Table). The grey cells denote which material fraction the country has a derogation for.
All values are from 2021, unless otherwise stated
Source: Eurostat env_ waspac and env_waspacr
Note: Eurostat in env_waspacr uses adjusted recycling rates for plastic and wood. Due to the adjusted rates, some countries, in particular for wood packaging, have rate values that do not align with the tonnage (e.g., Finland)

WEEE Directive 2012/19/EU

Collection target

To calculate the collection target implementation gap, the target of 65% of the average weight of EEE placed on the market in the three preceding years (2018, 2019 and 2020) was used. The implementation gap was calculated as the percentage difference between the target and actual performance, and the difference between the tonnage necessary to be collected, recovered or recycled to meet the target and actual tonnage reported.

Table A2-10-52: Implementation gap for the collection rates of Member States against the 2019 target for waste collection

Member State	Implementation gap against overall collection rate target for WEEE	
	Tonnes	%
Austria	22,275	9%
Belgium	44,375	13%
Bulgaria*	-37,299	-43%
Croatia	5,559	9%
Cyprus	4,694	37%

Member State	Implementation gap against overall collection rate target for WEEE	
	Tonnes	%
Czechia*	17,469	8%
Denmark	55,815	27%
Estonia	3,889	16%
Finland	9,379	7%
France	350,018	17%
Germany	686,623	26%
Greece	41,733	26%
Hungary*	69,688	29%
Ireland	1,379	1%
Italy	464,895	31%
Latvia*	1,285	5%
Lithuania*	5,630	14%
Luxembourg	1,679	13%
Malta*	4,317	39%
Netherlands	196,427	32%
Poland*	14,063	2%
Portugal	75,716	38%
Romania* (2020 value)	-122,728	-43%
Slovakia*	-75	0%
Slovenia*	10,972	27%
Spain	149.229	17%
Sweden	47,783	17%
EU-27	2,284,893	

*Member States with derogations
Values are from 2021, unless otherwise stated
Source: Eurostat (env_waseleeos)

Recovery rate targets

Figure A2-10-31 through Figure A2-10-33 show the recovery rates in the Member States for product categories 1 and 4, 5 and 6, and 2 compared to their respective recovery rate targets that are in place from 2018.

Eurostat data (env_waseleeos) from 2021 was used. Recovery rates were calculated as the amount of waste recovered divided by amount of waste collected.

Waste products falling under categories 1 or 4 of Appendix III of the WEEE Directive must be recovered with a minimum target of 85% recovery. These products include temperature exchange equipment and large equipment (any external dimension more than 50 cm).

Waste products falling under category 2 of Appendix III of the WEEE Directive must be recovered with a minimum target of 80% recovery. These products include screens, monitors, and equipment containing screens having a surface greater than 100 cm^2.

Waste products falling under categories 5 or 6 of Appendix III of the WEEE Directive must be recovered with a minimum target of 75% recovery. These products include small equipment (with no external dimension more than 50 cm) and small IT and telecommunication equipment (with no external dimension more than 50 cm).

The recovery rate for each category was calculated as amount of waste recovered over the amount of waste collected. The implementation gap was calculated as the percentage difference between the target and actual performance, and the difference between the tonnage necessary to be collected, recovered or recycled to meet the target and actual tonnage reported.

Figure A2-10-31: 2021 recovery rate of product categories 1 and 4 compared to the recovery target rate of 85%

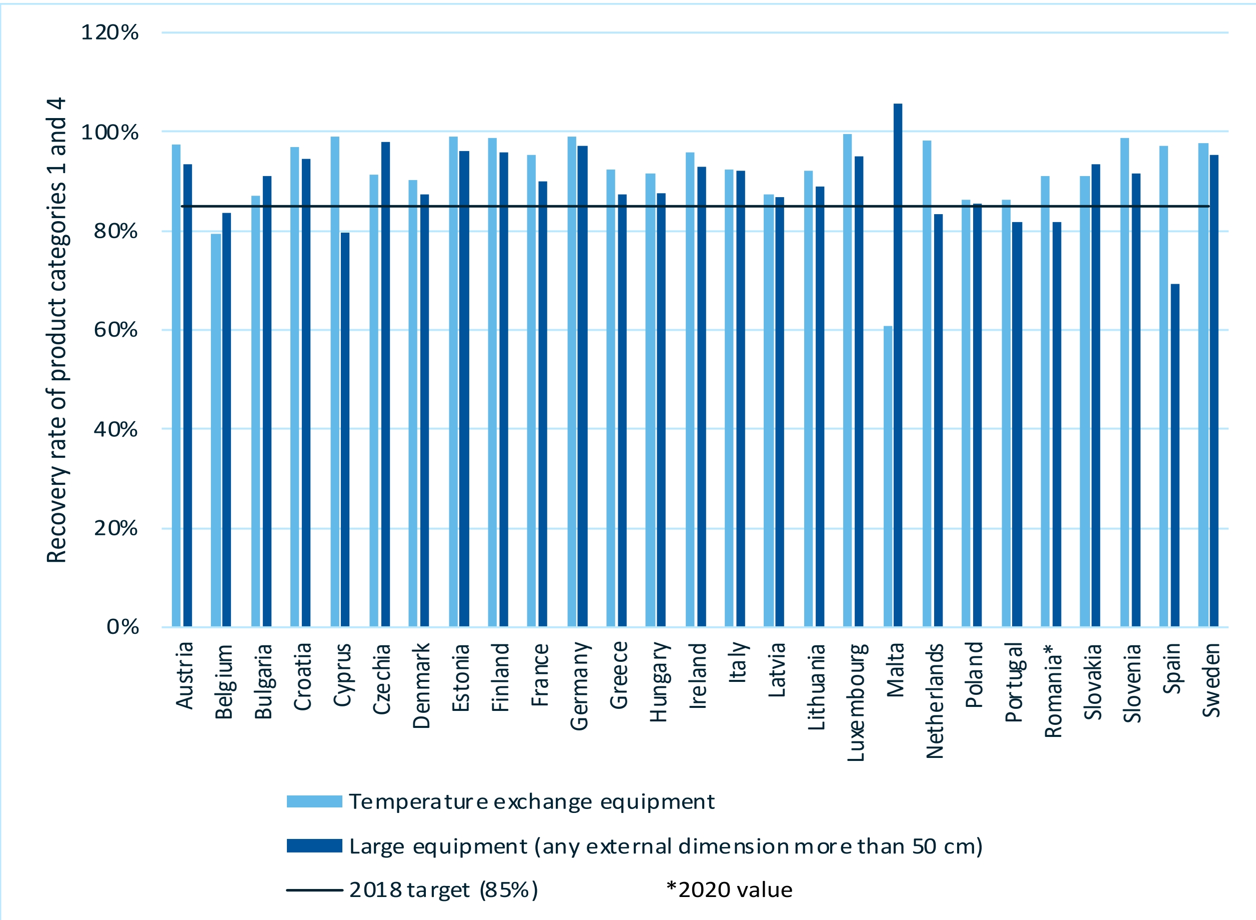


Figure A2-10-32: 2021 recovery rate of product category 2 compared to the recovery target rate of 80%

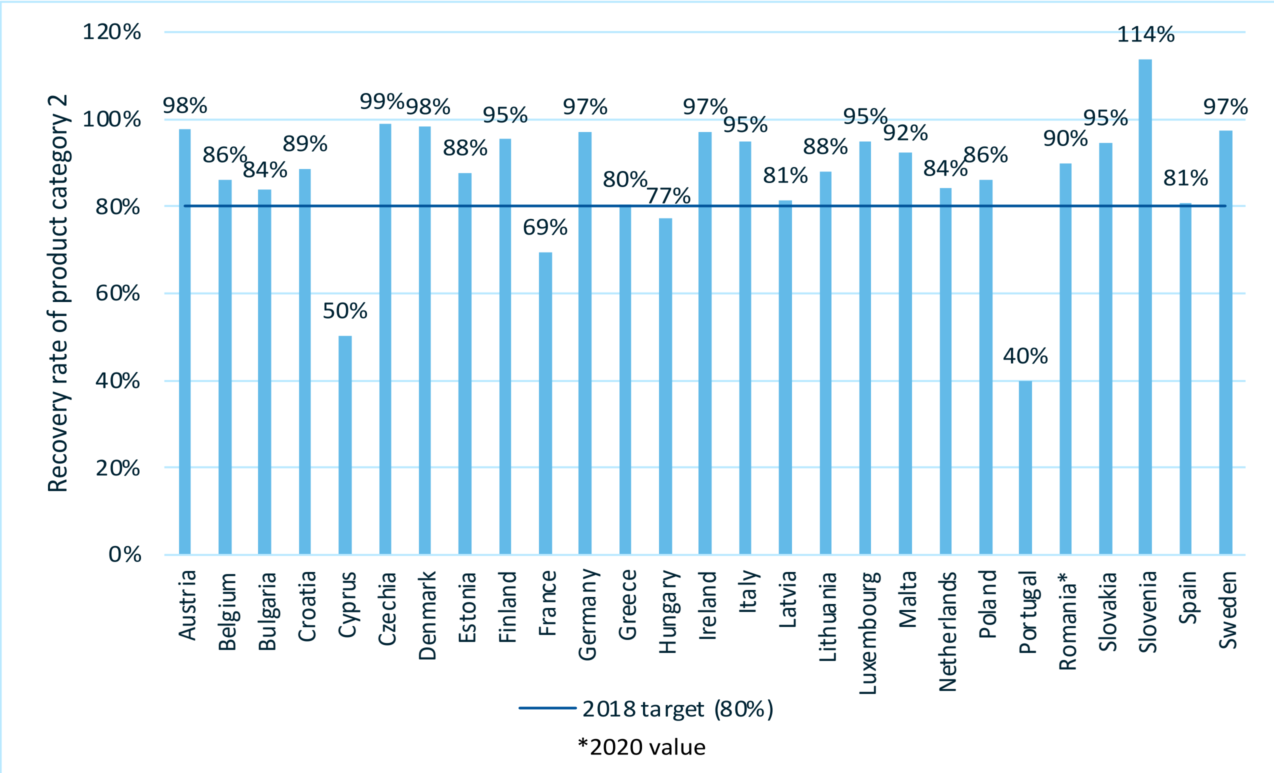


Figure A2-10-33: 2021 recovery rate of product categories 5 and 6 compared to the recovery target rate of 75%

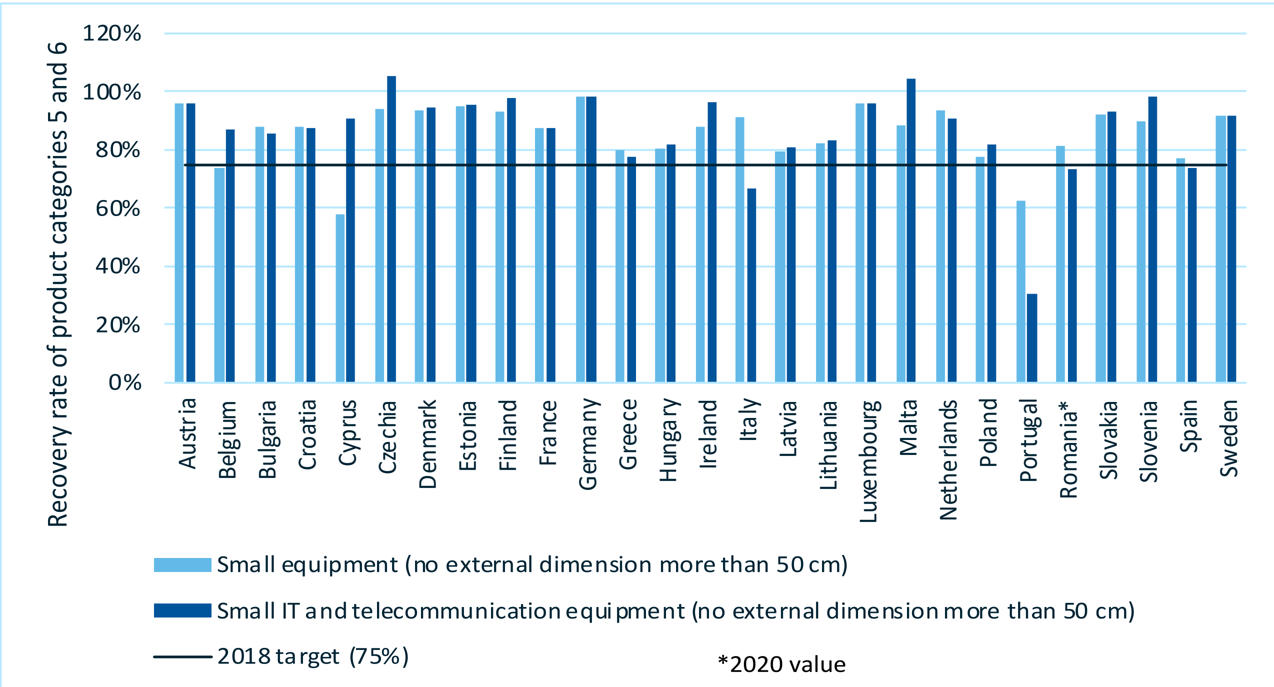


Table A2-10-53: Implementation gap for recovery rate of product categories 1 and 4 against the 2018 target of 85%

Member State	Temperature exchange equipment		Large equipment (any external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Austria	-1,976	-12%	-5,734	-8%
Belgium	1,730	6%	933	1%
Bulgaria	-398	-2%	-3,299	-6%
Croatia	-764	-12%	-1,367	-10%
Cyprus	-175	-14%	60	5%
Czechia	-1,778	-6%	-7,958	-13%
Denmark	-826	-5%	-858	-2%
Estonia	-304	-14%	-671	-11%
Finland	-2,443	-14%	-3,640	-11%
France	-16,316	-10%	-24,378	-5%
Germany	-26,078	-14%	-37,877	-12%
Greece	-1,248	-7%	-750	-2%
Hungary	-431	-7%	-1,119	-2%
Ireland	-1.194	-11%	-2,997	-8%
Italy	-8,508	-7%	-11,925	-7%
Latvia	-73	-2%	-144	-2%
Lithuania	-331	-7%	-294	-4%
Luxembourg	-175	-14%	-259	-10%
Malta	220	24%	-143	-21%
Netherlands	-5,222	-13%	1,429	2%
Poland	-1,253	-1%	-1,107	0%
Portugal	-158	-1%	446	3%
Romania (2020 value)	-1,231	-6%	1,435	3%
Slovakia	-475	-6%	-1,971	-8%
Slovenia	-385	-14%	-363	-7%
Spain	-12,320	-12%	31,559	16%
Sweden	-4,227	-13%	-5,230	-10%
EU-27	1,949		35,861	

Member State	Temperature exchange equipment		Large equipment (any external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Values are from 2021, unless otherwise stated Source: Eurostat (env_waseleeos)				

Table A2-10-54: Implementation gap for recovery rate of product category 2 against the 2018 target of 80%

Member State	Screens, monitors, and equipment containing screens having a surface greater than 100 cm2	
	Implementation gap in tonnes	Implementation gap in %
Austria	-1,505	-18%
Belgium	-845	-6%
Bulgaria	-163	-4%
Croatia	-854	-9%
Cyprus	114	30%
Czechia	-2,507	-19%
Denmark	-1,082	-18%
Estonia	-107	-8%
Finland	-925	-15%
France	5,974	11%
Germany	-17,988	-17%
Greece	-15	0%
Hungary	292	3%
Ireland	-766	-17%
Italy	-15,228	-15%
Latvia	-18	-1%
Lithuania	-183	-8%
Luxembourg	-73	-15%
Malta	-62	-12%
Netherlands	-684	-4%
Poland	-1,718	-6%
Portugal	2,042	40%
Romania (2020 value)	-981	-10%

Member State	Screens, monitors, and equipment containing screens having a surface greater than 100 cm2	
	Implementation gap in tonnes	Implementation gap in %
Slovakia	-732	-15%
Slovenia	-580	-34%
Spain	-170	-1%
Sweden	-2,034	-17%
EU-27	8,423	
Values are from 2021, unless otherwise stated Source: Eurostat (env_waseleeos)		

Table A2-10-55: Implementation gap for recovery rate of product categories 5 and 6 against the 2018 target of 75%

Member State	Small equipment (no external dimension more than 50 cm)		Small IT and telecommunication equipment (no external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Austria	-7,441	-21%	-1,978	-21%
Belgium	461	1%	-2,603	-12%
Bulgaria	-1,617	-13%	-362	-11%
Croatia	-341	-13%	-269	-13%
Cyprus	64	17%	-67	-16%
Czechia	-4,491	-19%	-1,952	-30%
Denmark	-2,898	-19%	-744	-20%
Estonia	-327	-20%	-122	-20%
Finland	-3,396	-18%	-994	-23%
France	-28,190	-13%	-9,498	-13%
Germany	-69,818	-23%	-22,246	-23%
Greece	-290	-5%	-85	-3%
Hungary	-834	-5%	-421	-7%
Ireland	-1,698	-13%	-1,148	-22%
Italy	-14,629	-16%	2,243	8%
Latvia	-155	-4%	-27	-6%
Lithuania	-261	-7%	-102	-8%
Luxembourg	-328	-21%	-155	-21%

Member State	Small equipment (no external dimension more than 50 cm)		Small IT and telecommunication equipment (no external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Malta	-71	-14%	-45	-30%
Netherlands	-6,754	-18%	-2,934	-16%
Poland	-3,011	-3%	-1,260	-7%
Portugal	1,766	13%	3,072	45%
Romania (2020 value)	-571	-6%	86	1%
Slovakia	-1,993	-17%	-680	-18%
Slovenia	-553	-15%	-397	-23%
Spain	-1,395	-2%	204	1%
Sweden	-4,752	-17%	-1,455	-17%
EU-27	2,291		5,605	
Values are from 2021, unless otherwise stated Source: Eurostat env_waseleeos				

Preparing for re-use and recycling rate targets

Figure A2-10-34 through Figure A2-10-37 show the recycling rates in the Member States for product categories 1 and 4, 2, 5 and 6, and 3 compared to their respective recovery rate targets that are in place from 2018.

Eurostat data (env_waseleeos) from 2021 was used. Recycling rates were calculated as amount of waste recycled divided by amount of waste collected.

Waste products falling under categories 1 or 4 of Appendix III of the WEEE Directive must be prepared for re-use and recycled with a minimum target of 80%. These products include temperature exchange equipment and large equipment (any external dimension more than 50 cm).

Waste products falling under category 2 of Appendix III of the WEEE Directive must be prepared for re-use and recycled with a minimum target of 70%. These products include screens, monitors, and equipment containing screens having a surface greater than 100 cm^2.

Waste products falling under categories 5 or 6 of Appendix III of the WEEE Directive must be prepared for re-use and recycled with a minimum target of 55%. These products include small equipment (with no external dimension more than 50 cm) and small IT and telecommunication equipment (with no external dimension more than 50 cm).

Waste products falling under categories 3 of Appendix III of the WEEE Directive, which include lamps, must recycled with a minimum target of 80%.

Figure A2-10-34: 2021 recycling rate of product categories 1 and 4 compared to the recycling target rate of 80%

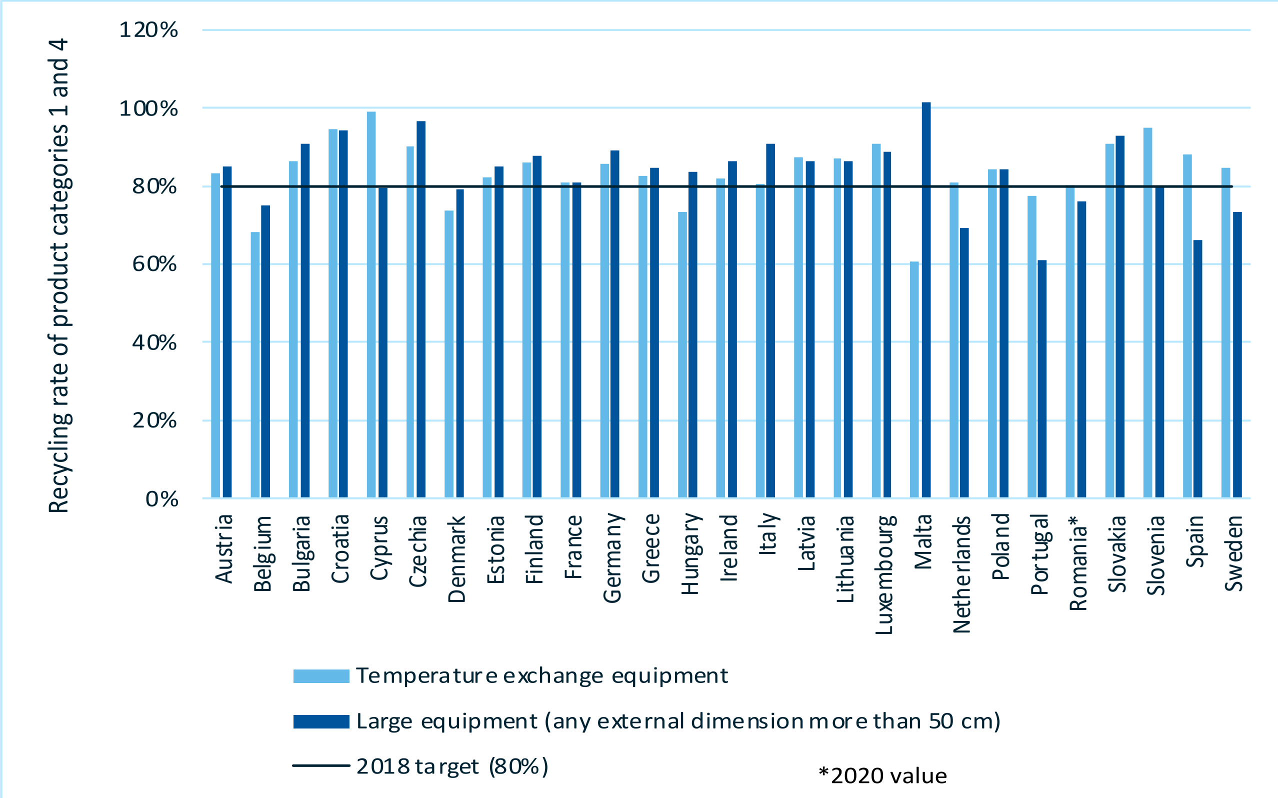


Figure A2-10-35: 2021 recycling rate of product category 2 compared to the recycling target rate of 70%

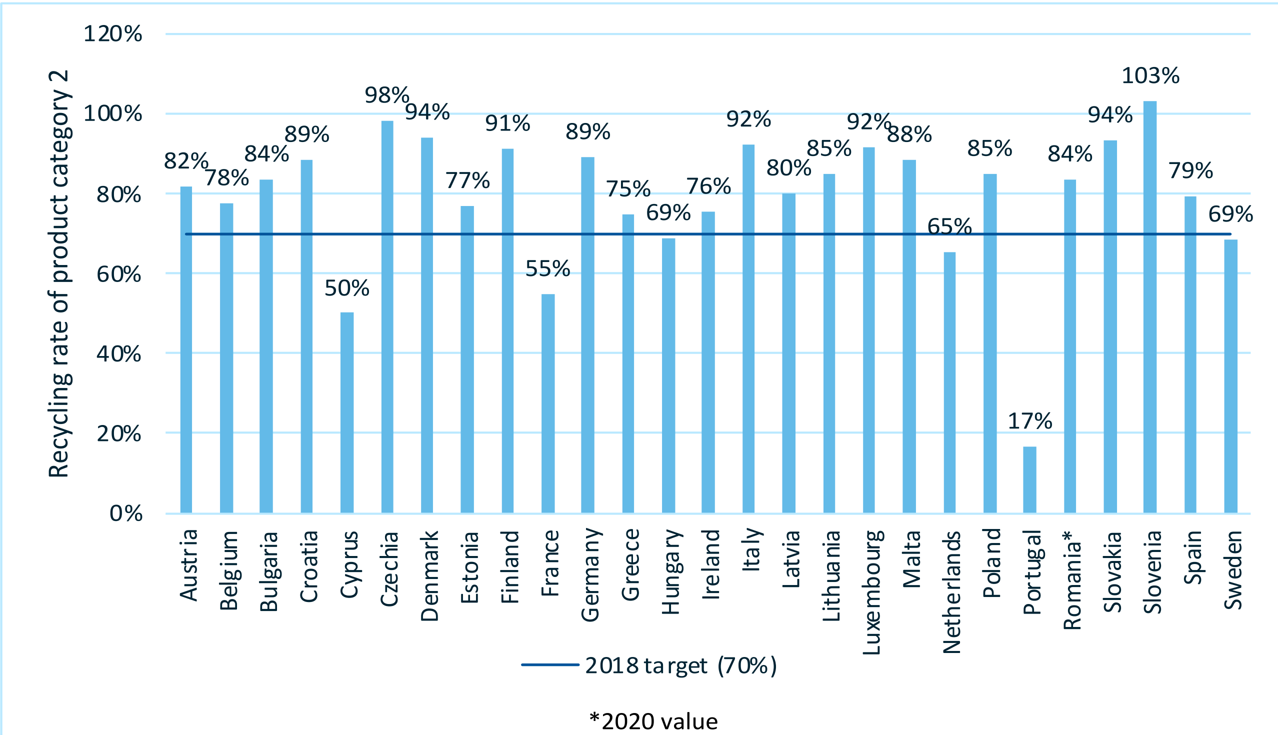


Figure A2-10-36: 2021 recycling rate of product categories 5 and 6 compared to the recycling target rate of 55%

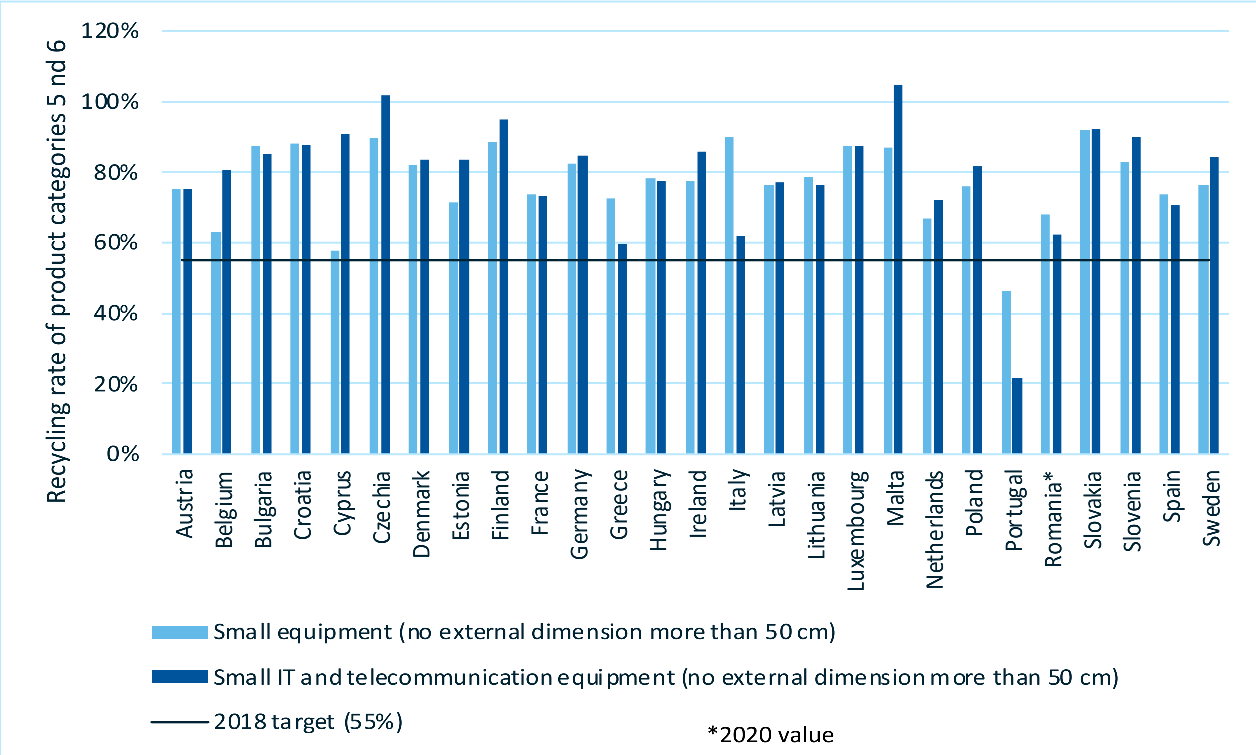
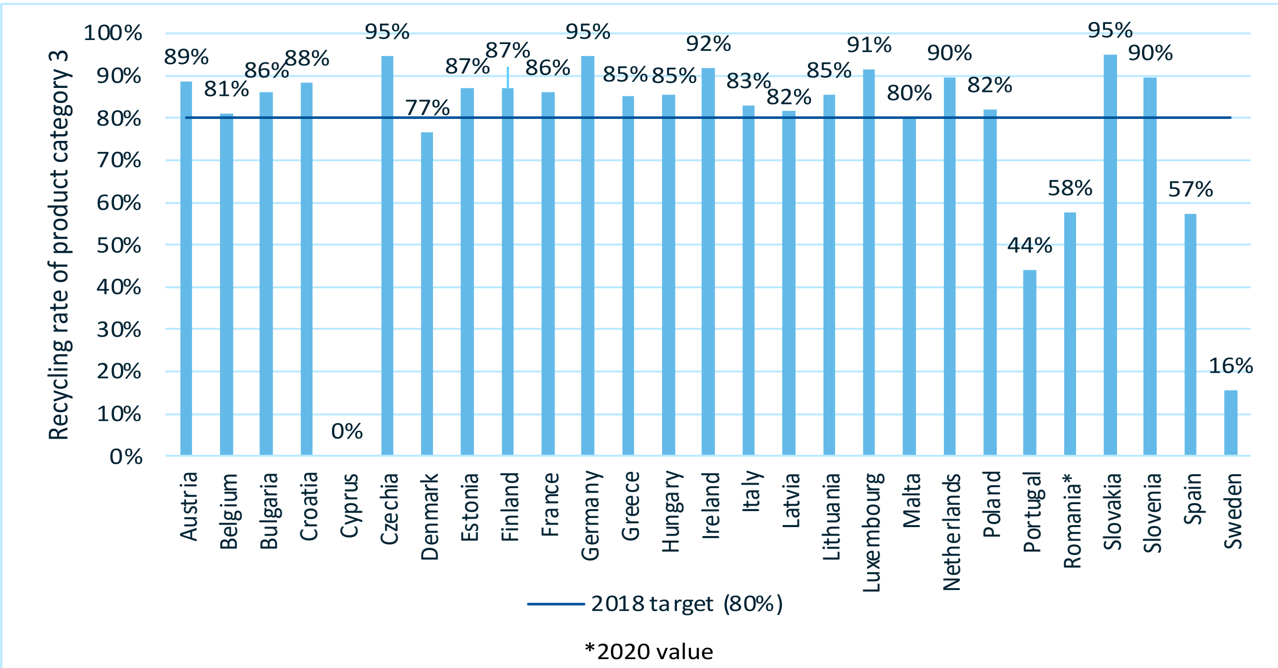


Figure A2-10-37: 2021 recycling rate of product category 3 compared to the recycling target rate of 80%



The recycling rate for each category was calculated as amount of waste recovered over the amount of waste collected. The implementation gap was calculated as the percentage difference between the target and actual performance, and the difference between the tonnage necessary to be collected, recovered or recycled to meet the target and actual tonnage reported.

Table A2-10-56: Implementation gap for recycling rate of product categories 1 and 4 against the 2018 target of 80%

Member State	Temperature exchange equipment		Large equipment (any external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Austria	-524	-3%	-3,494	-5%
Belgium	3,545	12%	3,067	5%
Bulgaria	-1,157	-6%	-5,929	-11%
Croatia	-940	-15%	-2,071	-14%
Cyprus	-237	-19%	4	0%
Czechia	-2,882	-10%	-10,210	-17%
Denmark	971	6%	325	1%
Estonia	-54	-2%	-303	-5%
Finland	-1,053	-6%	-2,614	-8%
France	-1,484	-1%	-4,063	-1%
Germany	-10,484	-6%	-27860	-9%
Greece	-433	-3%	-1,480	-5%
Hungary	447	7%	-1,639	-4%
Ireland	-220	-2%	-2,392	-6%
Italy	-765	-1%	-17,805	-11%
Latvia	-219	-7%	-487	-6%
Lithuania	-332	-7%	-489	-6%
Luxembourg	-131	-11%	-230	-9%
Malta	176	19%	-150	-22%
Netherlands	-330	-1%	10,079	11%
Poland	-4,305	-4%	-11,650	-5%
Portugal	337	3%	2,571	19%
Romania (2020 value)	-50	0%	1,820	4%
Slovakia	-868	-11%	-3,070	-13%
Slovenia	-425	-15%	11	0%

Member State	Temperature exchange equipment		Large equipment (any external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Spain	-8,068	-8%	27,389	14%
Sweden	-1,599	-5%	3,278	6%
Total EU27	5,477		48,545	
Values are from 2021, unless otherwise stated Source: Eurostat (env_waseleeos)				

Table A2-10-57: Implementation gap for recycling rate of product category 2 against the 2018 target of 70%

Member State	Screens, monitors, and equipment containing screens having a surface greater than 100 cm2	
	Implementation gap in tonnes	Implementation gap in %
Austria	-1,016	-12%
Belgium	-1,094	-8%
Bulgaria	-595	-14%
Croatia	-1,851	-19%
Cyprus	76	20%
Czechia	-3,747	-28%
Denmark	-1,419	-24%
Estonia	-95	-7%
Finland	-1,288	-21%
France	8,434	15%
Germany	-20,354	-19%
Greece	-304	-5%
Hungary	136	1%
Ireland	-254	-6%
Italy	-22,778	-22%
Latvia	-149	-10%
Lithuania	-344	-15%
Luxembourg	-106	-22%
Malta	-92	-18%

Member State	Screens, monitors, and equipment containing screens having a surface greater than 100 cm2	
	Implementation gap in tonnes	Implementation gap in %
Netherlands	757	5%
Poland	-4,281	-15%
Portugal	2,698	53%
Romania (2020 value)	-1,356	-14%
Slovakia	-1,187	-24%
Slovenia	-573	-33%
Spain	-2,668	-9%
Sweden	175	1%
Total EU27	12,277	
Values are from 2021, unless otherwise stated Source: Eurostat (env_waseleeos)		

Table A2-10-58: Implementation gap for recycling rate of product categories 5 and 6 against the 2018 target of 55%

Member State	Small equipment (no external dimension more than 50 cm)		Small IT and telecommunication equipment (no external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Austria	-7,168	-20%	-1,906	-20%
Belgium	-3,084	-8%	-5,485	-25%
Bulgaria	-4,057	-32%	-1,035	-30%
Croatia	-860	-33%	-691	-33%
Cyprus	-10	-3%	-150	-36%
Czechia	-8,124	-34%	-3,009	-47%
Denmark	-4,207	-27%	-1,077	-28%
Estonia	-267	-16%	-170	-29%
Finland	-6,180	-33%	-1,733	-40%
France	-40,948	-19%	-13,908	-18%

Member State	Small equipment (no external dimension more than 50 cm)		Small IT and telecommunication equipment (no external dimension more than 50 cm)	
	Implementation gap in tonnes	Implementation gap in %	Implementation gap in tonnes	Implementation gap in %
Germany	-82,905	-28%	-28,403	-30%
Greece	-997	-17%	-145	-5%
Hungary	-3,551	-23%	-1,340	-22%
Ireland	-2,941	-23%	-1,635	-31%
Italy	-31,110	-35%	-1,894	-7%
Latvia	-729	-21%	-101	-22%
Lithuania	-830	-24%	-269	-22%
Luxembourg	-501	-32%	-237	-32%
Malta	-166	-32%	-75	-50%
Netherlands	-4,301	-12%	-3,143	-17%
Poland	-23,441	-21%	-4,963	-27%
Portugal	1,206	9%	2,305	33%
Romania (2020 value)	-1,130	-13%	-425	-7%
Slovakia	-4,304	-37%	-1,387	-37%
Slovenia	-1,013	-28%	-592	-35%
Spain	-11,644	-19%	-2,675	-16%
Sweden	-6,119	-21%	-2,556	-29%
Total EU27	1,206		2,305	
Values are from 2021, unless otherwise stated Source: Eurostat (env_waseleeos)				

Table A2-10-59: Implementation gap for recycling rate of product category 3 against the 2018 target of 80%

Member State	Lamps	
	Implementation gap in tonnes	Implementation gap in %
Austria	-74	-9%

Member State	Lamps	
	Implementation gap in tonnes	Implementation gap in %
Belgium	-15	-1%
Bulgaria	-39	-6%
Croatia	-7	-8%
Cyprus	24	80%
Czechia	-195	-15%
Denmark	25	3%
Estonia	-8	-7%
Finland	-58	-7%
France	-309	-6%
Germany	-1,202	-15%
Greece	-24	-5%
Hungary	-49	-5%
Ireland	-36	-12%
Italy	-132	-3%
Latvia	-3	-2%
Lithuania	-18	-5%
Luxembourg	-9	-11%
Malta	0	0%
Netherlands	-154	-10%
Poland	-238	-2%
Portugal	346	36%
Romania (2020 value)	148	22%
Slovakia	-56	-15%
Slovenia	-16	-10%
Spain	942	23%
Sweden	1,311	64%
EU-27	2,796	
Values are from 2021, unless otherwise stated Source: Eurostat (env_waseleeos)		

Batteries Directive 2006/66/EC and New Batteries Regulation (EU) 2023/1542

Targets for collection of waste portable batteries for producers

The method for calculating the collection rate changed in the New Batteries Regulation (see Appendix XI)[370]. The collection rate in Eurostat is according to the method in Appendix I of the Batteries Directive[371]. The updated collection rate was calculated from Eurostat data for the collection year 2021and sales in years 2018, 2019 and 2020 based on the updated method in the New Batteries Regulation. The updated collection rate was used to calculate the difference between the target collection rate and the actual collection rate. Following this, the difference between the tonnage necessary to be collected in each Member State to meet the target and the actual tonnage collected was calculated.

Table A2-10-60: Implementation gap for collection rates for waste portable batteries of Member States against the 2023 target collection rate of 45% and 2027 target collection rate of 63%

Member State	Implementation gap against past target (2023)		Implementation gap against current target (2027)	
	Tonnes	%	Tonnes	%
Austria	-137	-2.3%	1,034	15.7%
Belgium	-1,000	-18.8%	63	-0.8%
Bulgaria	-62	-7.3%	109	10.7%
Croatia	-342	-39.0%	-167	-21.0%
Cyprus	-2	-1.0%	37	17.0%
Czechia	-437	-9.9%	450	8.1%
Denmark	-603	-13.5%	293	4.5%
Estonia	-4	-0.8%	96	17.2%
Finland	-489	-13.7%	225	4.3%
France	-5,120	-15.4%	1,520	2.6%
Germany	-3,609	-6.2%	7,953	11.8%
Greece	158	9.0%	511	27.0%
Hungary	-91	-3.3%	461	14.7%
Ireland	-310	-10.9%	259	7.1%
Italy	1,125	4.4%	6,292	22.4%
Latvia	-56	-9.7%	60	8.3%
Lithuania	-47	-6.0%	109	12.0%
Luxembourg	-58	-24.5%	-11	-6.5%

[370] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02023R1542-20240718#tocId899
[371] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006L0066-20180704#tocId36

Member State	Implementation gap against past target (2023)		Implementation gap against current target (2027)	
	Tonnes	%	Tonnes	%
Malta	24	18.5%	51	36.5%
Netherlands	-164	-1.7%	1,785	16.3%
Poland	-1,238	-7.1%	2,249	10.9%
Portugal	496	24.2%	906	42.2%
Romania	-1,381	-34.4%	-578	-16.4%
Slovakia	-157	-8.9%	197	9.1%
Slovenia	26	3.2%	192	21.2%
Spain	-1,460	-10.9%	1,213	7.1%
Sweden	-455	-6.3%	997	11.7%
EU-27	1,830		27,058	
Values are from 2021. Source: env_waspb				

Targets for recycling efficiency

The recycling efficiency rate from Eurostat was used to calculate the difference between the target recycling efficiency rate and the actual recycling efficiency rate. Following this, the difference between the tonnage necessary to be recycled in each Member State to meet the target and the actual tonnage recycled was calculated.

Table A2-10-61: Implementation gap for recycling efficiencies of lead, nickel-cadmium and other batteries against current and future targets

Member State	Lead batteries 2025 target (75%)		Lead batteries 2030 target (80%)		Ni-Cd batteries 2025 target (80%)		Other batteries 2025 target (50%)	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
Austria	-2,293	-11.4%	-1,285	-6.4%	-5.8	-5.5%	-686	-29.7%
Belgium	-2,466	-7.1%	-735	-2.1%	2.2	0.7%	-308	-13.9%
Bulgaria	-3,624	-17.0%	-2,559	-12.0%	-0.8	-6.8%	-65	-19.0%
Croatia	-1,036	-8.4%	-417	-3.4%	0.6	1.1%	-1	-35.9%
Cyprus	-560	-14.3%	-364	-9.3%	-0.2	1.0%	-6	-5.7%
Czechia	-3,624	-8.0%	-1,345	-3.0%	-21.0	-14.0%	-17	-14.6%
Denmark	-843	-19.4%	-626	-14.4%	-5.8	-11.8%	-196	-7.9%
Estonia	439	10.0%	658	15.0%			-46	-28.0%

Member State	Lead batteries 2025 target (75%)		Lead batteries 2030 target (80%)		Ni-Cd batteries 2025 target (80%)		Other batteries 2025 target (50%)	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
Finland	-1,485	-7.7%	-521	-2.7%	0.6	0.0	-103	-5.8%
France	-19,739	-10.9%	-10,690	-5.9%		-4.6%	-2,311	-13.0%
Germany	-19,232	-9.5%	-9,156	-4.5%	6.0	0.6%	-10,333	-27.9%
Greece	-3,543	-12.6%	-2,134	-7.6%	0.2	-3.7%	-183	-36.3%
Hungary	-5,634	-19.8%	-4,214	-14.8%	1.6	1.2%	-189	-12.0%
Ireland		-10.8%		-5.8%	1.4	1.1%	-349	-37.1%
Italy	-19,510	-17.4%	-13,901	-12.4%	-15.8	-6.9%	-383	-17.4%
Latvia	-132	-5.0%	0	0.0%	-0.2	4.6%	-2	-0.5%
Lithuania	-1,105	-8.1%	-424	-3.1%	0.6	0.6%	-66	-16.7%
Luxembourg	-156	-8.2%	-60	-3.2%	-0.4	-3.9%	-12	-7.2%
Malta		-3.4%		1.6%		80.0%		50.0%
Netherlands	-1,640	-7.1%	-479	-2.1%	-4.8	-1.1%	-1,304	-32.5%
Poland	-5,605	-4.3%	890	0.7%	-38.4	-18.6%	-2,243	-18.5%
Portugal	639	1.9%	2,278	6.9%				
Romania	-6,298	-13.2%	-3,910	-8.2%	0.2	0.7%	-92	-37.3%
Slovakia	-897	-15.8%	-613	-10.8%	4.8	4.7%	-22	-10.9%
Slovenia	-33	-0.5%	317	4.5%	0.8	4.7%	-92	-37.8%
Spain	9,296	3.7%	22,010	8.7%	-22.0	-5.9%	-3,197	-37.9%
Sweden	-558	-1.0%	2,276	4.0%	21.0	4.5%	-118	-6.8%
EU-27	10,373		28,429		40.0		0	
Values are from 2021 Source: Eurostat env_wasbat								

End of Life Vehicles Directive 200/53/EC

The implementation gaps for the targets set under the ELV Directive have been calculated as the percentage difference between the target rate and actual rate reported, and the difference between the tonnage necessary to meet the targets and the actual tonnage reported by Eurostat (waselvt). Data from 2021 is used, unless otherwise stated. Reuse and recovery rates and reuse and recycling rates were calculated as the amount reused and recovered or reused recycled (sum of the amount reused and recovered or the sum of the amount reused and recycled) over the amount of waste generated.

Table A2-10-62: Implementation gap for recovery and reuse (Target 1) of 95% and recycling and reuse (Target 2) of 85% of ELVs in Member States.

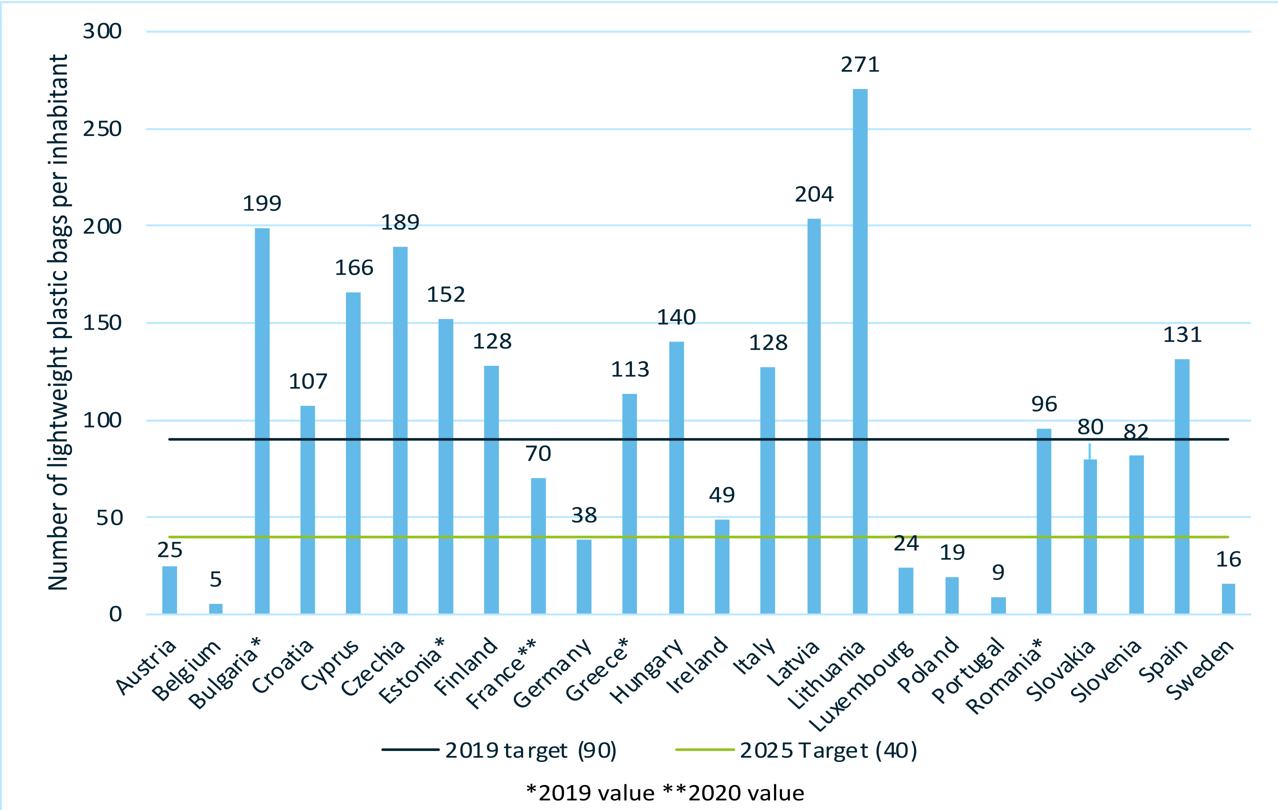
Member State	Implementation gap against recovery and reuse target (Target 1)		Implementation gap against recycling and reuse target (Target 2)	
	Tonnes	%	Tonnes	%
Austria	-1,377	-2%	-473	-1%
Belgium	-2,963	-2%	-11,016	-8%
Bulgaria	-909	-1%	-9,554	-11%
Croatia	-1,241	-3%	-4,903	-13%
Cyprus	-334	-3%	-512	-5%
Czechia	-20,994	-11%	-32,477	-17%
Denmark	1,400	1%	3,180	2%
Estonia	712	3%	-141	-1%
Finland	-253	0%	385	0%
France	-10,378	-1%	-39,533	-3%
Germany	-10,920	-2%	-22,029	-5%
Greece	-1,002	-2%	-3,517	-7%
Hungary	-526	-3%	-2,245	-12%
Ireland	-1,142	-1%	-4,339	-3%
Italy	149,626	11%	9,211	1%
Latvia	1,030	9%	-80	-1%
Lithuania	-283	-1%	-4,114	-9%
Luxembourg	-93	-3%	-381	-12%
Malta	1,605	14%	472	4%
Netherlands	-7,727	-4%	-4,758	-2%
Poland	-11,478	-2%	-49,749	-10%
Portugal	-831	-1%	-3,418	-3%
Romania (2020 value)	2,890	3%	-291	0%
Slovakia	-906	-2%	-4,524	-11%
Slovenia	-253	-2%	-769	-6%
Spain	15,420	2%	-10,825	-1%

Member State	Implementation gap against <u>recovery and reuse</u> target (Target 1)		Implementation gap against <u>recycling and reuse</u> target (Target 2)	
	Tonnes	%	Tonnes	%
Sweden	-4,108	-2%	-6,626	-3%
EU -27	172,683		13,248	
Values from 2021, unless otherwise stated Source: Eurostat (waselvt)				

Plastic Bags Directive (EU) 2015/720

The Plastic Bags Directive sets targets for the number of lightweight plastic bags consumed per inhabitant. Lightweight plastic carrier bags are bags with a wall thickness below 50 microns. For the 2019 target, 13 Member States are not meeting it and 17 are not meeting the 2025 target. See table below for a more detailed breakdown of the implementation gap in each Member State. Based on the total number of bags consumed at the EU level, the implementation gap of the EU-27 is currently at 13.4 bags per inhabitant against the 2019 target and 36.6 bags per inhabitant against the 2025 target.

Figure A2-10-38: 2021 implementation gap to the 2019 and 2025 targets on the number of lightweight plastic carrier bags consumed per inhabitant for 24 Member States



The implementation gap was calculated using data from Eurostat. The difference between the number of bags per inhabitant and the target number of bags per inhabitant was calculated.

Table A2-10-63: Implementation gap for the consumption of lightweight plastic carrier bags against the 2019 target of 90 bags per inhabitant and 2025 target of 40 bags per inhabitant

Member State	Implementation gap against 2019 target (number of bags per inhabitant)	Implementation gap against 2025 target (number of bags per inhabitant)
Austria	-65.2	-15.2
Belgium	-84.6	-34.6
Bulgaria (2019 value)	108.6	158.6
Croatia	17.4	67.4
Cyprus	76.1	126.1
Czechia	99.2	149.2
Denmark		
Estonia (2019 value)	62.1	112.1
Finland	37.8	87.8
France (2020 value)	-19.8	30.2
Germany	-51.6	-1.6
Greece (2019 value)	23.3	73.3
Hungary	50.3	100.3
Ireland	-41.4	8.6
Italy	37.5	87.5
Latvia	113.6	163.6
Lithuania	180.7	230.7
Luxembourg	-65.9	-15.9
Malta		
Netherlands		
Poland	-70.7	-20.7
Portugal	-81.2	-31.2
Romania (2019 value)	5.5	55.5
Slovakia	-10.2	39.8
Slovenia	-8.5	41.5
Spain	41.3	91.3
Sweden	-74.1	-24.1

Member State	Implementation gap against 2019 target (number of bags per inhabitant)	Implementation gap against 2025 target (number of bags per inhabitant)
EU-27 (based on Eurostat total)	-13.4	36.6
Values from 2021, unless otherwise stated Source: Eurostat env_waspcb		

Ecodesign Directive 2009/125/EC and Ecodesign for Sustainable Products Regulation (EU) 2024/1781

Document inspection

Data was compiled from EEPLIANT 2 and 3 projects.

Table A2-10-64: Document inspection non-compliance rates of products

Product	Document inspection		Source
	Number of units	Non-compliance, %	
Air conditioners and comfort fans	110 of 113 models	96%	EEPLIANT3 (4th Newsletter)[372]
Household tumble dryers	101 of 104 models	97%	EEPLIANT3 (4th Newsletter)
Water heaters and storage tanks	46 of 96 models	48%	EEPLIANT3 (4th Newsletter)
Residential ventilation units	61 of 143 models	43%	EEPLIANT3 (4th Newsletter)
Light sources	187 of 199 models	94%	EEPLIANT3 (4th Newsletter)
Local space heaters	104 of 135 models	77%	EEPLIANT3 (4th Newsletter)
Test pilot on TV monitors, washing machines and wine storage appliances	39 of 71 models	55%	EEPLIANT3 (4th Newsletter)
Household refrigerating appliances	29 of 172 products	17%	EEPLIANT 2[373]
Network standby appliances (Household appliances, information technology equipment, consumer equipment, leisure equipment)	119 of 161 products	74%	EEPLIANT 2

[372] https://eepliant.eu/images/Documents/EEPLIANT3/Newsletter_and_Comm/4th_Newsletter/EN-EEPLIANT3_4th_Newsletter.pdf
[373] https://prosafe.org/images/EEPLIANT2/EEPLIANT2%20-%20Laymans_Report_v9_REV_20210709.pdf

Product	Document inspection		Source
	Number of units	Non-compliance, %	
Professional refrigerating storage cabinets	54 of 60 models	90%	EEPLIANT 2

Laboratory testing

Data for this table was compiled from EEPLIANT 2[374] and 3 projects. Lab testing non-compliance rates from the Nordic Council of Ministers not included.

Table A2-10-65: Laboratory testing suspected non-compliance rates of products[375]

Product	Work Package reports					
	Specific product	Energy efficiency related parameter tested	Suspected non-compliance (related to energy efficiency)	Non-compliance (other)	Notes	Final conclusions
Air conditioners and comfort fans	Split air conditioner	Seasonal energy efficiency ratio (SEER)	2 of 20	2 of 20		2 of 20 samples were non-compliant regarding energy efficiency
	Ducted air conditioner	Energy efficiency ratio (EER)	2 of 27	6 of 27		Further testing did not confirm the suspected non-compliance; in the end all samples were compliant regarding energy efficiency
Household tumble dryers	Heat pump dryers	Weighted annual energy consumption	1 of 20	6 of 20	Of the 20 heat pump dyers, 18 were tested for this parameter	1 had a high weighted annual energy consumption in the single test, however further testing did not confirm this. 100% of models met energy efficiency requirements.

[374] https://prosafe.org/images/EEPLIANT2/EEPLIANT2%20-%20Laymans_Report_v9_REV_20210709.pdf
[375] https://cordis.europa.eu/project/id/832558/results

Product	Work Package reports					
	Specific product	Energy efficiency related parameter tested	Suspected non-compliance (related to energy efficiency)	Non-compliance (other)	Notes	Final conclusions
	Heat element dryers	Weighted annual energy consumption	0 of 5	2 of 5		100% of models met energy efficiency requirements.
	Air-vented dryers	Weighted annual energy consumption	0 of 5	3 of 5		100% of models met energy efficiency requirements.
Water heaters and storage tanks	Storage tanks	Wrong energy class for which noncompliance comes from problems in standing heat loss	3 of 5	0 of 5	3 models were tests for this parameter	3 of 5 samples were non-compliant on the standing heat loss parameter
	Heat pump water heater	Daily electricity consumption	1 of 3	1 of 3	2 models were tested for this parameter	1 in 3 samples were non-compliant regarding energy consumption
	Electric storage water heaters	Wrong energy class for which noncompliance comes from problems in ηwh/Qelec	2 of 14	5 of 14	Only 7 models were tested for this parameter.	1 of 18 samples (including SMART models) was non-compliant regarding energy consumption
	SMART electric storage water heater	Non-functioning SMART mode	2 of 4	0 of 4		
Residential ventilation units		Wrong SEC class (Energy efficiency class for the Energy labelling) declared	6 of 30	11 of 30		6 of 30 tested products were noncompliant
Local space heaters	Electric heaters	Seasonal space heating energy efficiency (SSHEE)	3 of 29	8 of 29		3 of the 29 samples were non-compliant regarding

Product	Work Package reports					
	Specific product	Energy efficiency related parameter tested	Suspected non-compliance (related to energy efficiency)	Non-compliance (other)	Notes	Final conclusions
						energy efficiency
	Gas heaters	SSHEE	0 of 9	6 of 9		None of the gas heaters were non-compliant regarding energy efficiency
	Biomass heaters		n/a	9 of 14		Biomass heaters were not tested under the ecodesign regulation
Light sources	-	Exceeding verification tolerances & fail on ecodesign requirements	19 of 80	43 of 80		18 of the 80 product models (23%) were compliant after the laboratory testing; 71 of 80 (89%) were non-compliant when including those with missing technical documentation
Mini testing pilot on TV monitors, Washing Machines, and Wine Storage Appliances	TVs			3 of 5	Unclear what parameters were tested	
	Washing machines			2 of 6	Unclear what parameters were tested	
	Wine storage appliances			5 of 5	Unclear what parameters were tested	

Product	Work Package reports					
	Specific product	Energy efficiency related parameter tested	Suspected non-compliance (related to energy efficiency)	Non-compliance (other)	Notes	Final conclusions
Household refrigerating appliances		Energy consumption	7	10		
Professional refrigerating storage cabinets		Determined EEI passes minimum energy performance standards (MEPS) based on duty confirmed in temperature test	8	n/a		
Network standby appliances (Household appliances, information technology equipment, consumer equipment, leisure equipment)		Network standby requirements		7	7 models with unclear results, 6 not applicable	
		Power Management Requirements		8	7 models with unclear results	
		Standby Power Requirements		7	9 models not applicable	
		Off Mode Power Requirements		3	17 models with not applicable	
		Data provision requirements		17		

Ship Recycling Regulation (EU) 1257/2013

The Ship Recycling Regulation (SRR) requires that EU-flagged ships must be dismantled in an EU approved ship recycling facility. In 2024, the 13th edition of the EU List of approved facilities contains 44 facilities in Europe (including Member State countries, Norway and the UK), Turkey and the US[376].

The introduction of the SRR has impacted the number of EU-flagged ships. Under the United Nations Convention on the Law of the Sea, ships must be registered to a flag state and a ship is under the regulatory control of the country to which it is registered. Ship owners may register a ship to a different country other than the country of ownership in a practice known as "flags of convenience" in order to circumvent various environmental and

[376] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401956

labour legislation requirements, such as the SRR[377]. For example, in 2013, the year the Regulation was proposed, the number of EU-flagged ships dismantled was 105 and, by 2019, this number decreased to 26. Additionally, due to ships changing flags in 2023, there was an overall decrease of 244 EU-flagged ships[378]. Together, this indicates that European ship owners were more active in changing their ship to a non-EU flag to possibly circumvent the SRR[379].

When considering the SRR requirement for EU-flagged ships to be dismantled in an approved facility, while data varies slightly on the number of EU-flagged ships that were recycled in 2023, the number of EU-flagged ships that circumvented the SRR recycling requirements was likely low. According to the European Maritime Safety Agency, in 2023 there were 437 ships dismantled worldwide. Of these, 22 were EU-flagged ships and another four ships may have circumvented the SRR because they were non-EU flagged at the time of recycling in 2023, but EU-flagged in 2022[380]. The data source does not indicate where the ships were dismantled.

Comparatively, the NGO Shipbreaking Platform recorded 446 ships dismantled worldwide in 2023. 21 ships of these ships were registered under an EU flag as the last flag before dismantling and all were dismantled in the EU, UK or Turkey. There were three EU-flagged ships that changed their flag to a non-EU flag before dismantling, of which two circumvented the SRR because they were dismantled at non-approved facilities in South Asia. The third ship was dismantled in Turkey[381]. Moreover, in 2020 and 2021, of the 1,393 ships dismantled worldwide, at least 41 EU flagged vessels swapped to a non-EU flag before being dismantled to circumvent the SRR[382].

Implementation gap costs

Costs associated with major circular economy and waste directives

Table A2-10-66: Material value associated with 2025 WFKD implementation gap

Member State	Implementation gap cost (€ million)
Austria	0
Belgium	21-25
Bulgaria	86-157
Croatia	77-85
Cyprus	44-48
Czechia	75-149
Denmark	16-22
Estonia	18-23
Finland	87-120
France	731-774
Germany	0
Greece	331-383

[377] https://shipbreakingplatform.org/issues-of-interest/focs/
[378] https://www.emsa.europa.eu/eumaritimeprofile/section-2-the-eu-maritime-cluster.html#eu
[379] https://iopscience.iop.org/article/10.1088/1748-9326/ac5a68
[380] https://www.emsa.europa.eu/eumaritimeprofile/section-2-the-eu-maritime-cluster.html#eu
[381] https://www.offthebeach.org/
https://shipbreakingplatform.org/annual-lists/
[382] https://shipbreakingplatform.org/wp-content/uploads/2022/11/NGO-SBP-Annual-Report-2020_2021.pdf

Member State	Implementation gap cost (€ million)
Hungary	119-192
Ireland	71-90
Italy	154-156
Latvia	13-18
Lithuania	9-19
Luxembourg	0.3-0.4
Malta	23-24
Netherlands	0
Poland	291
Portugal	154-212
Romania	407
Slovakia	18-38
Slovenia	0
Spain	545-643
Sweden	89-135
EU - 27	3,380-4,010

Sources:
Composition of municipal solid waste and residual waste: EEA's Early Warning Report[383]
Material values: Eurostat[384] (paper and cardboard, plastic and glass; 2022 average values), WRAP[385] (bio-waste; 2024 average values), MRW[386] (textiles, metals; 2024 average values), Let's Recycle[387] (wood; 2024 average values) converted to 2023 prices

Regarding the WFKD target on construction and demolition waste, costs related to non-implementation of the CDW recovery target are those associated with carbon emissions from improper disposal and materials that can be re-used or recycled. **A cost is not estimated for the CDW implementation gap** because there are several data limitations to CDW data as previously discussed. Also, the implementation gap only assesses non-hazardous mineral waste. CDW is heterogeneous and includes other, non-mineral material fractions such as metals, plastic, glass and wood. While these fractions make up a smaller percentage of CDW, fractions like aluminium and steel are often recycled due to their high market values[388]. Furthermore, high recovery rates of CDW do not necessarily correspond to high value material recovery, as much of it is "downcycled" for lower quality uses such as in road construction filler or backfilling activities[389]. CDW recovery rates also include backfilling activities, and, in some countries, backfilling activities represent a large portion of the total recovered amount of non-

[383] https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-products/methodology-for-the-early-warning-assessment-related-to-certain-waste-targets
[384] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator&oldid=629056
[385] https://www.wrap.ngo/sites/default/files/2024-07/WRAP-Gate-Fees-Report-2023-24-V1.1.pdf
[386] https://prices.mrw.co.uk/prices
[387] https://www.letsrecycle.com/prices/
[388] https://www.sciencedirect.com/science/article/pii/S004896972306922X
[389] ibid

hazardous mineral CDW. Ultimately, low-quality recovery methods play a significant role in meeting the CDW target and overall circularity of CDW through improved recycling pathways remains low[390].

Costs associated with Ecodesign non-compliance

Data for this table was compiled from the EEPLAINT 3 project. Products that were compliant with energy efficiency requirements or not tested under energy efficiency requirements are not included.

Table A2-10-67: Calculation of costs from non-compliance with energy efficiency requirements for relevant products

Costs associated with non-compliance (EEPLIANT 3)							
	Air conditioners and comfort fans	Water heaters and storage tanks			Residential ventilation units	Light sources	Local space heaters
Product	Split air conditioner	Electric storage water heaters	Storage tanks	Heat pump water heaters			Electric heaters
Difference in energy consumption between compliant and non-compliant products (kWh/yr)	42	54	194	185	866	12	9
Corrected non-compliance rate regarding energy efficiency*	3%	2%	20%	11%	7%	5.5%	3%
Sales per year	7,000,000	5,949,800	156,960	208,510	2,000,000	1,213,000,000	18,000,000
Years of operation**	10	10	10	10	10	10	10
Energy lost (GWh)	485 GWh	353 GWh	335 GWh	236 GWh	6,668 GWh	44,032 GWh	267 GWh
GHG emissions (tonnes)	121,275	97,190	92,112	64,762	1,667,050	11,007,975	73,508
Cost to customer (€)*	133 million	88 million	84 million	59 million	1.8 billion	12 billion	67 million
	GHG .25 t/MWh Cost 275 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh	GHG .25 t/MWh Cost 275 EUR/MWh	GHG .25 t/MWh Cost 275 EUR/MWh	GHG .275 t/MWh Cost 250 EUR/MWh

[390] https://www.sciencedirect.com/science/article/pii/S0956053X23003616

*The non-compliance rate is not the same as the non-compliance rates derived from the project results. The EEPLIANT project calculated a corrected compliance rate for each product based on the non-compliance rates from the project results. Since the products were selected using a risk-based sampling approach, a correction factor was applied to better reflect non-compliance rates on the market. It was assumed that product non-compliance rates were 3 times higher in the project than in the market.
**Values were calculated assuming 10 years of operation for each product (10+9+8+7+6+5+4+3+2+1)

Costs associated with non-implementation of 2035 MSW target

Table A2-10-68: Material value associated with 2035 WFKD implementation gap

Member State	Implementation gap cost (€ million)
Austria	19-32
Belgium	112-135
Bulgaria	118-216
Croatia	115-125
Cyprus	55-60
Czechia	139-277
Denmark	77-102
Estonia	26-34
Finland	142-195
France	1,286-1,360
Germany	0
Greece	419-485
Hungary	173-279
Ireland	122-154
Italy	645-656
Latvia	24-34
Lithuania	23-47
Luxembourg	8-9
Malta	29-30
Netherlands	95-100
Poland	497
Portugal	217-298
Romania	501
Slovakia	50-106
Slovenia	3-5
Spain	877-1035

Member State	Implementation gap cost (€ million)
Sweden	147-244
EU - 27	5,919-6,996
Sources: Composition of municipal solid waste and residual waste: EEA's Early Warning Report[391] Material values: Eurostat[392] (paper and cardboard, plastic and glass; 2022 average values), WRAP[393] (bio-waste; 2024 average values), MRW[394] (textiles, metals; 2024 average values), Let's Recycle[395] (wood; 2024 average values) converted to 2023 prices	

Costs associated with Ship Recycling Regulation (EU) 1257/2013

There are several factors that influence the decision of a ship owner to demolish a ship and sell it for scrap (versus extending a vessels life or reselling it) including the age and characteristics of the ship, freight market conditions and trade patterns[396]. Recyclable materials, particularly steel, account for most of a ship's weight. Less environmentally friendly ship recycling methods, such as beaching, tend to offer more competitive prices for recyclable materials compared to the more sustainable methods employed at the EU-approved facilities[397].

Circumvention of the SRR by the re-flagging of EU ships and, more specifically, dismantling re-flagged end-of-life ships in sub-standard facilities has costs associated with the loss in revenue from salvaged raw materials, GHG emissions from inadequate waste disposal, environmental damage from pollutants and hazardous substances, and health issues and safety risks from unsafe working conditions and handling of hazardous materials. Limited information exists on the monetisation of costs associated with circumvention of the SRR. Also, given the illegal nature of circumvention and the variability in the number of previously EU-flagged ships dismantled each year due to many factors influencing a ship-owners decision to dismantle a ship, associating a specific cost with the SRR circumvention is challenging and thus **no quantitative estimate is provided in this study**[398]. The SRR, however, is currently being evaluated to determine its effectiveness and impact.

Additional GHG emissions and monetised GHG impacts from non-implementation of future waste target

Data for this table was compiled using Eurostat data on GHG emissions from waste management between 2019 and 2022 to refine the data in the 2019 report. Slope was calculated to find the change in emissions between 2019-2022 (e.g., how did the amount of GHG emissions from waste management change per year since the 2019 report) in order to refine numbers in the 2019 report. Same rate of change per year was assumed until 2035.

[391] https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-products/methodology-for-the-early-warning-assessment-related-to-certain-waste-targets
[392] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator&oldid=629056
[393] https://www.wrap.ngo/sites/default/files/2024-07/WRAP-Gate-Fees-Report-2023-24-V1.1.pdf
[394] https://prices.mrw.co.uk/prices
[395] https://www.letsrecycle.com/prices/
[396] https://www.oecd.org/content/dam/oecd/en/publications/reports/2019/04/ship-recycling_a64c6a7b/397de00c-en.pdf
[397] https://www.sciencedirect.com/science/article/pii/S0959652621004558
[398] It is worth noting that European owned ships are sold and dismantled at sub-standard facilities in South Asia each year not only through circumvention of the SRR. The NGO Shipbreaking Platform notes that in addition to the two EU ships that de-registered from a European flag registry prior to dismantling, at least eight other EU vessels were sold in breach of the EU Waste Shipment Regulation to South Asia in 2023. The number of European owned ships beached in South Asia is likely higher. In comparison, in 2022, at least eight EU ships circumvented the SRR and nine circumvented the EU Waste Shipment Regulation (The Toxic Tide, 2022 and 2023).

Costs were assigned based on the social cost of carbon in the 2019 report (adjusted for inflation) and in the impact assessments.

Table A2-10-69: Additional GHG emissions and monetised GHG impacts from non-implementation

Member State	Change in GHG emissions per year (kt of CO_2-eq)*	Additional GHG emissions (kt of CO_2-eq) in 2035**	Foregone benefits (€ million) in 2035
Austria	4.4	-181	18-37
Belgium	4.3	-128	13-26
Bulgaria	-2.5	-307	31-63
Croatia	-13.6	-486	49-100
Cyprus	-0.1	-187	19-38
Czechia	-5.0	-1,677	168-344
Denmark	2.7	-209	21-43
Estonia	0.5	-26	3-5
Finland	1.1	19	2-4
France	25.0	-1,771	177-363
Germany	40.6	232	23-48
Greece	11.0	-987	99-202
Hungary	2.3	-174	17-36
Ireland	2.5	-587	59-120
Italy	23.3	-1723	172-353
Latvia	0.0	-70	7-14
Lithuania	0.1	-90	9-18
Luxembourg	-0.1	-32	3-7
Malta	0.6	-92	9-19
Netherlands	11.9	-283	28-58
Poland	25.9	-364	36-75
Portugal	5.8	-504	50-103
Romania	1.4	-1,387	139-284
Slovakia	-1.1	-474	47-97
Slovenia	0.4	-7	1
Spain	-10.5	-2,468	247-506
Sweden	3.8	-954	95-196
EU - 27	134.5	-14,913	1,491 - 3,057

Member State	Change in GHG emissions per year (kt of CO_2-eq)*	Additional GHG emissions (kt of CO_2-eq) in 2035**	Foregone benefits (€ million) in 2035
*based on the rate of change in emissions from waste management between 2019 and 2022 (Eurostat env_air_gge) **Refined values from the 2019 report based on the change in GHG emissions from waste management between 2019 and 2022. The 2019 report estimated the additional GHG emissions associated with not implementing future waste targets by comparing a baseline scenario of no change from 2019 to a scenario in which all major waste targets are met in all Member States by 2035. Negative values indicate a reduction in GHG emissions associated with implementation of future targets.			

Forward looking assessment

Reduction in packaging waste generated

Table A2-10-70: Changes in generation of materials in packaging waste based on proposed targets

Material	Forecasted amount in 2030 with a measure in place (thousand tonnes)	Percent change from the 2030 baseline
Glass	12,970	-12.8%
Steel	2,687	0.5%
Aluminium	909	-9.0%
Paper and cardboard	29,576	-21.6%
Plastic	17,374	-17.2%
Wood	11,030	-26.1%
Other	204	0.0%
Total	74,749	-19.1%
Source: Table adapted from Impact Assessment Report (Table 17) [399]		

[399] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0384

Targets on re-use and refill

Table A2-10-71: Changes in generation of materials in packaging waste based on proposed targets in the food and beverage and the commercial and industrial sectors

Packaging material	Forecasted reduction amount in 2030 with measure in place (tonnes)	Percent change from the 2030 baseline
Glass	-226,800	-2.2%
Steel	16,100	0.2%
Aluminium	-11,900	-1.7%
Paper and cardboard	-2,705,500	-10.2%
Plastic	-219,100	-1.5%
Wood	0	0.0%
Other	0	0.0%
Total	-3,147,200	-4.9%
Source: Table adapted from Impact Assessment Report (Table 30) [400]		

Minimum recycled content in plastic packaging

Table A2-10-72: Overview of ambition targets in the Impact Assessment Report compared to the proposed targets

Product groups	2030 Medium ambition target	2030 High ambition target	2030 Target in the proposal
Contact sensitive packaging	25%	30%	Minimum 30% for contact sensitive packaging made from PET
			Minimum 10% for contact sensitive packaging made from plastic materials other than PET (except single use plastic beverage bottles)
Non-contact sensitive	35%	45%	
Beverage bottles	30%	50%	Minimum 30% for single use plastic beverage bottles
Other			Minimum 35% for packaging other than those above

[400] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0384

Table A2-10-73: Increase in recycled content in plastic packaging based on the medium and high ambition targets

Group	Material	2030 Medium ambition levels (kt)	2030 High ambition levels (kt)
Deposit and return systems (DRS) **Contact sensitive**	Polyolefin	900	1,140
	PET	160	230
	Other	280	340
	Total	1,340	1,710
Non-Contact sensitive	Polyolefin	1,270	2,080
	PET	40	50
	Other	330	440
	Total	1,640	2,570
Beverage bottles	Polyolefin and PET	-	700
Total		2,980	4,980
Source: Table adapted from Impact Assessment Report (Table 61) [401]			

Deposit and return systems (DRS)

Table A2-10-74: Increased recycling from mandatory DRS for plastic and cans compared to 2030 baseline

Material	Tonnage recycled (thousand tonnes) (DRS and other methods combined)	Recycling rate achieved	Percentage point (pp) increase in recycling rate against baseline
Plastic beverage containers	2,720	81.60%	2.0pp
Metal cans – Aluminium	489	93.90%	9.9pp
Metal cans – Steel	206	93.30%	1.9pp
Source: Table adapted from Impact Assessment Report (Table 72) [402]			

[401] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0384
[402] Ibid

Chemicals

Additional detail regarding legislation in scope

Published in 2020, the Chemicals Strategy for Sustainability (the Strategy (CSS)) sets out the long-term vision for EU's chemical policy as part of a toxic free environment. It is one component of the EU's ambition to become a sustainable climate neutral and circular economy by 2050 in line with the European Green Deal (EGD). The overriding theme of the CSS is to maximise the contribution to society from the use of chemicals (e.g., by encouraging innovation to achieve a green and digital transition), while avoiding harm to both people and the environment. To achieve this, it is recognised that it is crucial the EU remains a globally competitive player by attracting investment in the production and use of safe and sustainable chemicals. The CSS sets out a pathway for implementation through:

- strengthening protection provided to human health and the environment, avoiding the various societal (and private) costs that result from chemical pollution.
- supporting innovation for safe and sustainable chemicals, to ensure that the EU is a globally competitive player in the manufacture and use of safe and sustainable chemicals, capturing strategic opportunities in, for example, construction materials, textiles, low-carbon mobility, batteries, wind turbines and renewable energy sources. To do this, the strategy notes innovation efforts need to be stepped up and that chemical policy must respond more rapidly and effectively to the challenges posed by hazardous chemicals.
- simplifying and strengthening the legal, financial and policy framework on chemicals, ensuring it is more coherent and predictable for industry and provides further support to SMEs and start-ups. In turn, this seeks to drive and reward investment in safe and sustainable products and processes.
- Other key aims include building a comprehensive knowledge base to support evidence-based policy making and setting a global example of sound chemicals management.

Actions in the CSS also involve proposed reforms to the REACH Regulation. It also calls on the Commission to define criteria for essential uses to ensure that the most harmful chemicals are only allowed if their use is necessary for health, safety or is critical for the functioning of society and if there are no alternatives that are acceptable from the standpoint of environment and health. A Commission Communication on Guiding criteria and principles for the essential use concept was adopted in April 2024. The Strategy also notes that current chemical legislation is complex and there is a need to simplify processes and reduce administrative burden for industry and for authorities.

Substance specific actions with explicit aims to reduce or eliminate risk, including "unacceptable" risk are embedded in the Restriction and Authorisation processes of ***REACH***. Their success as regulatory interventions and the attainment of these aims depends on the extent to which risk is reduced, which is somewhat dependent on the pace at which such Restriction and Authorisation decisions can be placed into law. Examples of how substance specific actions are captured in the Restriction and Authorisation processes can be broken down as follows:

- For REACH Restrictions (Appendix XVII):
  - Substance-Specific Limits: Restrictions can place quantitative limits on the concentration of certain hazardous substances in products, ensuring that their release into the environment is reduced or eliminated. For example, Restrictions on lead, mercury, and phthalates in consumer goods set precise concentration thresholds (e.g., below 0.1% for certain phthalates in toys) .
  - Bans on Specific Uses: Certain hazardous substances are banned in specific products or industries (e.g., the Restriction of chromium VI in leather goods to prevent allergic reactions,

or asbestos in all uses). The aim of these bans is eliminating exposure, targeting complete removal from the market in those sectors due to significant environmental and human health concerns.

- Environmental Protection: Targets are set to prevent specific environmental risks, such as the contamination of water, soil, or air by substances like cadmium or polycyclic aromatic hydrocarbons (PAHs), which are restricted in products like paints and tyres.

- REACH Authorisation (Appendix XIV) - Phase-Out of Substances of Very High Concern (SVHCs): REACH Authorisation aims to achieve the eventual phase-out of SVHCs, such as carcinogens, mutagens, and persistent, bioaccumulative, and toxic (PBT) substances. Companies using these substances must apply for Authorisation to continue their use and justify why safer alternatives cannot be implemented. The ultimate target is to replace hazardous substances with safer alternatives over time. Examples of how substance specific actions are captured in the Authorisation processes can be broken down as follows:

  - Time-Limited Authorisations: When Authorisation is granted, it is time-limited, with the intention of promoting companies to move towards development and use of less harmful alternatives.

  - Exposure Controls: Authorisations can include limits on exposure levels in workplaces or emissions to the environment. These levels are often tied to specific exposure limits set by EU regulatory agencies.

REACH operates a system of derogations that allows exceptions to its Restrictions under specific conditions. Authorisations are in essence, also derogations in the sense that an Authorisation can be granted when companies can demonstrate that risks from a particular substance are adequately controlled, or if the socio-economic benefits of its use outweigh the risks, and there are no suitable alternatives. Additionally, for research and development purposes, certain derogations are allowed under strict conditions. However, these derogations come with conditions that are subject to periodic review and must align with the broader goal of gradually eliminating harmful substances, ensuring human health and environmental protection remain the priority.

Alongside REACH, there is the Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures ***(CLP Regulation***). The CLP Regulation aims to guarantee free movement of chemical products in the single market and beyond while ensuring that their hazards are clearly communicated through supply chains, and in particular to workers and consumers. It aligns the EU legislative framework with the UN Globally Harmonized System (GHS). The main goals of the CLP Regulation are to protect human health and the environment by defining and classifying the hazards of chemical products, and by informing users about these hazards through standard symbols and phrases on the packaging labels and safety data sheets.

The CLP Regulation requires manufacturers, importers, or downstream users of chemicals to classify, label, and package their hazardous chemicals appropriately before placing them on the market. This involves identifying the hazardous properties of chemicals, assigning them to a specific hazard class and category based on the nature and severity of the hazards they present, and communicating these hazards through labels and safety data sheets that include hazard pictograms, signal words, hazard statements, and precautionary statements.

The CLP Regulation is regularly updated to address evolving scientific and technical knowledge and adapt to technological advances. These amendments include updates to the criteria for classifying substances and mixtures according to their health, environmental, or physical hazards; revisions to the hazard communication elements such as the label requirements; and the introduction of new hazard classes and categories (most recently human health and environmental endocrine disruption; persistence, bioaccumulation and toxicity (PBT) and strong persistence and bioaccumulation (vPvB); persistence, mobility and toxicity (PMT) and strong persistence and mobility (vPvM)).

The ***Zero Pollution Action Plan*** (ZPAP), which is part of the European Green Deal, sets some quantifiable targets related to pollution, including pollution from chemicals. For example, 50% reduction in the use and risk of chemical pesticides by 2030 (part of the broader EU Farm to Fork Strategy) and a 50% reduction in the use of more hazardous pesticides by 2030. Again, both are relevant to the goal of reducing harmful chemical exposure.

The main scope of the chemicals work focused on REACH and CLP but the legislative landscape for chemicals also contains the following directives/regulations:

- **Biocidal Product Regulation (EU) No 528/2012 (BPR).** The BPR concerns the placing on the market and use of biocidal products, which are used to protect humans, animals, materials or articles against harmful organisms like pests or bacteria, by the action of the active substances contained in the biocidal product. It involves listing substances that should not be approved for use (and placing on the market) except in specific situations. When reviewing Authorisation requests, products are compared to existing biocidal products, non-chemical means of control and other prevention methods to understand the risks and benefits. Substances are restricted where alternatives are deemed available, unless the alternatives are not sufficiently effective, economically viable or otherwise impractical.

- **Carcinogens and Mutagens Directive 2004/37/EC (CMD).** The CMD aims to protect workers against risks to their health and safety from exposure to carcinogens or mutagens in the workplace by setting occupational exposure limits (OELs). Companies (workplaces) are responsible for protecting employees and bearing the cost of complying with OELs.

- **Chemical Agents Directive 98/24/EC (CAD).** The CAD sets out minimum requirements for the protection of workers from risks to their health and safety arising from the effects of chemical agents that are present in the workplace. Companies (workplaces) are responsible for bearing the cost of complying with the requirements of the legislation. The CAD also covers evaluation of emissions and process wastes to understand and regulate human and environmental exposure.

- **Cosmetics Regulation (EC) No 1223/2009.** The regulation seeks to provide a high level of protection of human health from cosmetic products. Manufacturers are responsible for ensuring the safety of their products and the regulation sets out lists of restricted substances.

- **Fertiliser Regulation (EU) 2019/1009.** The fertiliser regulation lays down common rules on safety, quality and labelling requirements for fertilising products and introduces limits for toxic contaminants. This prevents pollution by guaranteeing a high level of soil protection and reduces health and environmental risks. Manufacturers and operators are responsible for ensuring compliance with the legislation, and substances that do not comply with the legislation should not be made available on the market.

- **Persistent Organic Pollutants Regulation (EU) 2019/1021.** The Persistent Organic Pollutants (POPs) regulations implement the Stockholm Convention with the overarching aim of protecting humans and the environment from the adverse effects of chemicals with POPs characteristics. It sets out lists of substances subject to Restrictions (for their manufacture and use), release reduction provisions and waste management provisions. The relevant manufacturers are responsible for preventing releases to the environment. The Stockholm Convention lists substances in three Appendices, that EU legislation is aligned with:

  - Appendix A – Elimination
  - Appendix B – Restriction
  - Appendix C – Unintentional Production.

- **Pesticides Directive 2009/128/EC.** The Directive sets out measures to reduce the risks and impacts of pesticide use on human health and the environment. The measures include setting quantitative objectives and targets, promoting research programmes, to provide safety information (especially with online sales), amongst other things. It prohibits aerial spraying, highlights the importance of caution near aquatic environments and promotes integrated pest management approaches. Enterprises are responsible for complying with these measures. General Restrictions are recommended (but not stipulated) at the Member State level, including applying pesticides along railway lines, permeable surfaces, close to groundwater, near areas used by the general public, protected areas or areas recently treated accessible to agricultural workers.

- **Plant Protection Products Regulation (EC) No 1107/2009.** The regulation stipulates rules for the approval of active plant protection substances to ensure high levels of protection for humans and the environment. It seeks to harmonise the rules on the placing on the market of plant protection products. It is underpinned by the precautionary approach. Producers of the active substances are responsible for submitting application dossiers. To be authorised, a plant protection product must satisfy a number of requirements, including not having any (direct or indirect) harmful effects on human or animal health and not having any unacceptable impact on the environment, particularly with regards to non-target species and biodiversity.
- **Reg 649/2012 concerning the export and import of hazardous chemicals.** This regulation sets out procedures for the export and import of hazardous substances that are banned or restricted in the EU. Its overarching aim is to protect human health and the environment and prevent the harmful effects through exposure to chemicals. It promotes that producers and users of chemicals have a shared responsibility to protect human health and the environment.
- **Toy Safety Directive 2009/48/EC.** Established to harmonise safety levels of toys throughout EU Member States. Sets out essential safety requirements regarding physical/mechanical/chemical/electrical properties, flammability, hygiene and radioactivity. It sets out that toys should be designed in such a way that there are no risks of adverse effects on human health.

Industrial Emissions and Major Accident Hazards

Additional cost tables

Table A2-10-75: Benefits of the AEL Upper 2025 scenario compared to Baseline 2025. Units; € million/year.

	VOLY 1&2	VOLY 123	VSL 1&2	VSL 123
Austria	278	435	846	1,002
Belgium	740	1,223	2,420	2,938
Bulgaria	302	430	907	998
Croatia	184	283	606	691
Cyprus	8	11	8	9
Czech Republic	488	711	1,457	1,657
Denmark	76	103	224	250
Estonia	21	32	64	73
Finland	75	112	257	290
France	1,215	1,897	3,607	4,254
Germany	3,319	5,981	10,110	12,350
Greece	169	268	594	678
Hungary	187	261	645	713
Ireland	61	83	171	200
Italy	2,381	4,607	7,740	9,714
Latvia	33	48	125	137
Lithuania	56	84	191	214
Luxemburg	51	70	134	157
Malta	1	1	1	1
Netherlands	441	677	1,277	1,506
Poland	1,392	2,011	4,003	4,531
Portugal	1,011	1,816	3,373	4,098
Romania	802	1,131	2,653	2,948
Slovakia	175	231	568	628
Slovenia	55	87	211	249
Spain	1,512	2,344	4,755	5,586
Sweden	54	77	173	197
Total	**15,087**	**25,013**	**47,117**	**56,069**

Table A2-10-76: Benefits of the AEL Upper 2030 scenario compared to Baseline 2025. Units; € million/year.

	VOLY 1&2	VOLY 123	VSL 1&2	VSL 123
Austria	32	56	95	120
Belgium	1,225	1,971	4,063	4,865
Bulgaria	307	442	907	1,003
Croatia	211	324	695	792
Cyprus	11	15	11	13
Czech Republic	262	378	788	891
Denmark	109	150	317	357
Estonia	19	29	56	64
Finland	(2)	5	(20)	(13)
France	1,044	1,660	3,070	3,655
Germany	1,603	2,997	4,745	5,925
Greece	86	129	323	362
Hungary	271	377	935	1,031
Ireland	66	94	185	221
Italy	2,609	5,055	8,466	10,632
Latvia	26	38	96	106
Lithuania	56	83	188	210
Luxemburg	74	101	193	226
Malta	1	1	1	1
Netherlands	196	347	502	645
Poland	504	691	1,512	1,673
Portugal	1,016	1,824	3,389	4,117
Romania	989	1,387	3,283	3,639
Slovakia	212	279	690	762
Slovenia	89	136	340	397
Spain	1,910	2,920	6,039	7,049
Sweden	98	143	309	358
Total	**13,022**	**21,631**	**41,178**	**49,099**

Table A2-10-77: Benefits of the MTFR 2025 scenario compared to Baseline 2025. Units; € million/year.

	VOLY 1&2	VOLY 123	VSL 1&2	VSL 123
Austria	626	962	1,920	2,255
Belgium	840	1,392	2,747	3,338
Bulgaria	610	856	1,845	2,019
Croatia	286	434	946	1,071
Cyprus	17	25	18	21
Czech Republic	1,196	1,731	3,599	4,079
Denmark	97	128	293	322
Estonia	35	52	112	126
Finland	157	229	540	606
France	1,979	3,022	5,925	6,913
Germany	7,029	12,397	21,743	26,243
Greece	435	669	1,530	1,724
Hungary	241	326	844	921
Ireland	108	145	304	353
Italy	3,578	6,758	11,784	14,596
Latvia	44	61	167	181
Lithuania	80	118	273	305
Luxemburg	75	102	197	230
Malta	6	6	5	6
Netherlands	878	1,286	2,639	3,038
Poland	3,083	4,438	8,892	10,047
Portugal	1,224	2,134	4,147	4,965
Romania	1,234	1,711	4,107	4,533
Slovakia	360	470	1,173	1,295
Slovenia	68	107	260	307
Spain	2,360	3,551	7,505	8,697
Sweden	78	101	252	279
Total	**26,723**	**43,212**	**83,764**	**98,470**

Table A2-10-78: Benefits of the MTFR 2030 scenario compared to Baseline 2030. Units; € million/year.

	VOLY 1&2	VOLY 123	VSL 1&2	VSL 123
Austria	556	841	1,723	2,009
Belgium	1,489	2,412	4,921	5,914
Bulgaria	698	982	2,099	2,299
Croatia	353	532	1,171	1,322
Cyprus	22	30	21	26
Czech Republic	1,201	1,730	3,626	4,101
Denmark	170	225	514	566
Estonia	40	57	133	149
Finland	175	246	613	679
France	2,357	3,597	7,048	8,223
Germany	7,120	12,497	22,103	26,608
Greece	391	590	1,396	1,561
Hungary	382	514	1,341	1,460
Ireland	168	227	473	551
Italy	4,342	8,161	14,327	17,700
Latvia	61	80	240	256
Lithuania	107	154	371	410
Luxemburg	148	202	389	454
Malta	3	3	3	3
Netherlands	921	1,365	2,745	3,178
Poland	2,939	4,170	8,578	9,630
Portugal	1,315	2,270	4,471	5,328
Romania	1,596	2,196	5,337	5,872
Slovakia	462	602	1,509	1,664
Slovenia	109	167	418	489
Spain	3,113	4,646	9,932	11,467
Sweden	131	172	425	471
Total	**30,367**	**48,672**	**95,927**	**112,389**

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