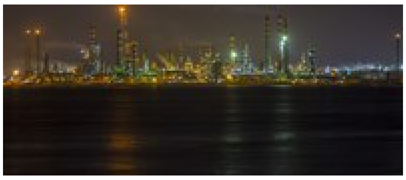
The costs to health and the environment from industrial air pollution in Europe – 2024 update



The economic costs associated with the negative impacts of air pollution caused by Europe's industrial plants are substantial. The methods of estimating the damage or 'external' costs associated with industrial pollution's impacts on human health, ecosystems, infrastructure and climate continue to evolve. This briefing presents the latest assessment of the trends in externalities of industrial air pollution caused by over 10,000 facilities during the last decade (2012-2021).

Key messages

Europe's industry has made significant progress in reducing its environment and climate impacts. Over the last decade, external costs caused by air pollution from industry decreased by nearly 35%, although they rebounded somewhat after a drop in 2020 driven by lower economic activity in Europe during the COVID-19 pandemic.

Almost 80% of the decrease in total external costs during the last decade occurred in the energy sector (thermal plants generating electricity and heat). This has been driven by the successful implementation of best available techniques (BAT) in the sector and a shift to less polluting and carbon-intensive fuels driven by environmental and climate policies. Consequently, other industrial sectors have lower relative reductions in external costs and there may still be potential for further improving environmental performance.

Just over 100 of approximately 10,000 facilities addressed in this study are responsible for 50% of the aggregate damage caused by their air emissions. In 2021, the top five Member States with facilities contributing the highest external costs were Germany, Poland, Italy, France, and Spain. When costs are compared to the GDP as an indicator of relative performance per unit of national economic output, the top five countries were Bulgaria, Poland, Estonia, Greece, and Cyprus.

Over the last decade (2012-2021), the order of countries in both rankings has been stable, with a few exceptions. This means that throughout this period, while industrial emissions have been decreasing at European Union (EU) level, Member States’ relative contributions have been consistent, even when considering the damage/GDP ratio (in euros) mentioned above.

The European Green Deal has promoted the transformation of Europe’s industry towards a more digital and green future. The Zero Pollution ambition and future policy plans to transform industry are an opportunity to further support this objective and continue decreasing the pollution impacts from the sector.

The briefing updates earlier work undertaken by the EEA and its European Topic Centre on Health and Environment (ETC-HE) (Schucht et al., 2021; EEA, 2021). A technical note, with details on the methodology and additional results, accompanies this briefing (Estimating the external costs of industrial air pollution: Trends 2012-2021: Technical note on the methodology and additional results).

Box 1. Scope and novelties: Estimating marginal damage costs per pollutant

Compared to the previous work (EEA, 2021), the current analysis has four new elements:

1. The methodology has been updated with new scientific information and modelling.
2. Year-on-year damage costs per tonne of pollutant have been estimated, rather than a single value for all years. This was done to account for the effect of demographic changes on the calculation of health impacts.
3. Improvement of the adjustment factors used to account for the differences in emission patterns by the various industrial sectors in the scope. Now, it not only considers the different exposure patterns between sectors but also considers the different proportion of Particulate matter (PM) fractions present in each sector and country.
4. The geographical scope of the industrial facilities included in the assessment now focuses only on the EU-27, whereas the previous briefing included facilities located in non-EU countries and the UK (then still reporting to the European Pollutant Release and Transfer Register (E-PRTR)). However, the impact of the EU facilities is still calculated for countries beyond the EU-27, (Albania, Bosnia and Herzegovina, Iceland, Kosovo, Liechtenstein, Montenegro, North Macedonia, Norway, Serbia, Switzerland, and Turkey). This means that the analysis now strongly focuses on the impacts of the EU's industry on the EU and neighbouring countries. More details are available in the technical note relating to this briefing (Estimating the external costs of industrial air pollution: Trends 2012-2021: Technical

note on the methodology and additional results).

EU industry in context

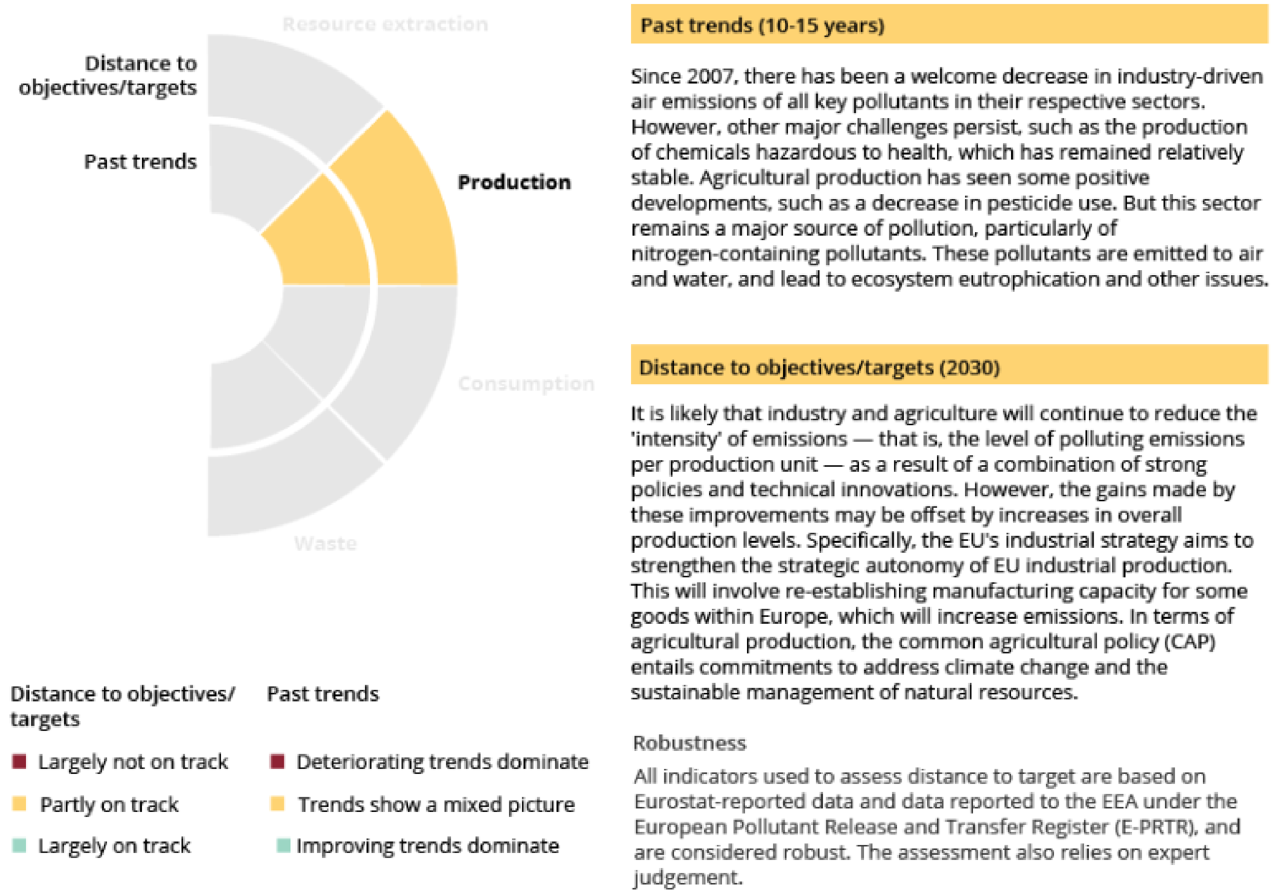
In recent years, European industry has faced the hurdles of global disturbances to logistics routes during the COVID-19 pandemic, including risky dependencies from a small number of countries for key resources. Since 2022, the additional challenges posed by Russia's war of aggression against Ukraine have increased the prices of raw materials and have made energy security a more critical issue.

In 2021, the European Commission unveiled its industrial strategy, which focused on bringing back production, reducing the EU's dependency on unstable or opaque economies for supplying critical raw materials, and a green and digital transition. The subsequent proposal for a Net Zero Industry act also aims to address key drivers of net-zero technology manufacturing by improving investment certainty, streamlining administrative processes, facilitating market access, supporting carbon capture and storage/utilisation projects, promoting innovation and skills development, and coordinating industrial partnerships (EC 2021a; 2023).

Part of this transition is also about reducing pollution to levels that no longer pose a risk to humans and the environment. One of the key pillars of the EU Green Deal – the EU's ambitious and comprehensive strategy to transform the EU into a climate-neutral and sustainable economy by 2050 – is the Zero Pollution Action Plan (EC, 2019; 2021b). The plan has targets covering air, water, and soil pollution, with focus on health impacts, ecosystems, and production-consumption value chains. The latter includes using chemicals management (safe and sustainable by design) and the circular economy as means to achieving zero pollution in product manufacturing.

The EEA's Zero Pollution Monitoring Assessment (EEA, 2022) shows that although there has been some progress, emission trends have stagnated in recent years and a transformation from industry in line with the long-term policy objectives would require significant new actions and investments towards 2050. In addition, certain production has relocated to non-EU countries, so part of past progress could be hampered by emissions produced elsewhere in the manufacturing process of products (Figure 1).

Figure 1. Extract from the Zero Pollution Monitoring Assessment: Summary analysis of industrial production in the EU



Source: EEA, 2022.

Understanding the trends and patterns of industrial emissions provides valuable insights into the effectiveness of current measures and the need for developing further transformative approaches to ensure a sustainable and low-pollution future.

Box 2. Methodological steps for estimating the external costs of industrial air pollution

- Emissions to air reported by industry to the European Industrial Emissions Portal: The industries in scope are large operators such as power plants, refineries, or steelworks. The 'About' section of the Portal includes the range of activities. This comprises a scope of circa 30,000 industrial facilities, of which around 10,000 report air emissions from the pollutants assessed in this study every year, with the remainder reporting only water emissions and/or waste and pollutant transfers.
- Dispersion/atmospheric chemistry modelling: This modelling enables understanding of where pollution would likely end up after being emitted.
- Exposure assessment: A calculation of the extent to which the population and the environment are exposed to the different pollutants, by combining spatial concentration and deposition data with data on population, crops, forests, and location of Natura 2000 protected areas, among other factors.
- Impact assessment: An analysis of how this pollution is likely to affect the population (mortality and morbidity) and the environment based on a defined set of response functions combined with exposure data.
- Economic valuation of impacts: Calculation of the monetary value of those impacts based on peer-reviewed literature and established economic methods. For the main air pollutants (NH_3, NO_X, PM_{10}, SO_2, and NMVOCs), the estimation of mortality impacts was done using two distinctive methods:

1. Value of statistical life (VSL): an estimate of damage costs based on the value a given population places ex ante on avoiding the death of an individual. VSL is based on the sum of money each individual is prepared to pay for a given reduction in the risk of premature death, for example from diseases linked to air pollution (OECD, 2012); and
2. Value of a life year (VOLY): an estimate of damage costs based on the potential years of life lost (YOLL) from a specific risk, based on an estimated life expectancy, and then evaluated by multiplying them by the VOLY. Therefore, the result is affected by the age at which deaths occur (OECD, 2012).

- The ranges of external costs included in the results of this briefing correspond to the values estimated using these two methods, rather than quoting a minimum/maximum level of health impacts.

What were the external costs of industrial air emissions during the last decade?

During the last ten years of available data in the European Industrial Emissions Portal (2012-2021), industrial air emissions had an estimated external cost of between EUR 2.7 to EUR 4.3 trillion, averaging between EUR 268 to EUR 428 billion per year (see Table 1). These external costs have decreased consistently (-33%) over the decade. This suggests that policies to mitigate and control pollution and other factors, such as the use of less carbon-intensive fuels, have had a positive impact leading to decreased environmental damage and associated societal costs. However, significant costs persist, indicating the need for continued action to further reduce pollution levels and associated impacts. In 2021, the external costs of industrial air pollution from the large industrial operators included in this study were equivalent to approximately 2% of the EU's GDP.

Over the past 10 years, a sharper drop compared to previous years is noticeable in 2020 due to the COVID-19 pandemic, followed by a rebound effect in 2021 when a higher rate of industrial activities resumed to a certain extent.

Total external costs for 2021 are dominated by the main air pollutants (27-55%), depending on whether the value of a life year (VOLY) method or the value of statistical life (VSL) are used[1], followed by greenhouse gases (GHG) at 43-69%[1], [2], heavy metals at 3-4%[1] and organic pollutants at 0.02-0.03%[1]. The relative proportion of external costs caused by GHGs has increased during the 2012-2021 period.

Table 1. External costs from industrial air pollution by pollutant group (EU-27)

	Aggregated external costs (million EUR)										
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**TOTAL**
Main air pollutants (NH_3, NO_X, PM_{10}, SO_2, NMVOCs) VOLY	119,042	104,531	98,362	95,345	82,197	80,721	76,608	63,255	54,277	59,728	834,066
Main air pollutants (NH_3, NO_X, PM_{10}, SO_2, NMVOCs) VSL	329,152	291,050	274,609	277,302	237,010	238,591	226,419	186,285	173,111	193,056	2,426,585
Greenhouse gases (CO_2, CH_4, N_2O)	193,641	187,188	183,596	181,747	180,129	180,852	174,949	157,898	137,567	150,657	1,728,224
Heavy metals (As, Cd, Cr VI, Hg, Ni, Pb)	13,803	13,055	13,179	11,553	14,041	14,493	13,395	10,140	8,039	8,924	120,622
Organic pollutants (benzene, dioxins and furans, B(a)P)	66	143	141	147	140	154	99	60	52	69	1,071
Sum VOLY	**326,553**	**304,919**	**295,277**	**288,791**	**276,507**	**276,219**	**265,051**	**231,354**	**199,935**	**219,378**	**2,683,984**
Sum VSL	**536,663**	**491,437**	**471,524**	**470,749**	**431,320**	**434,089**	**414,862**	**354,383**	**318,769**	**352,707**	**4,276,503**

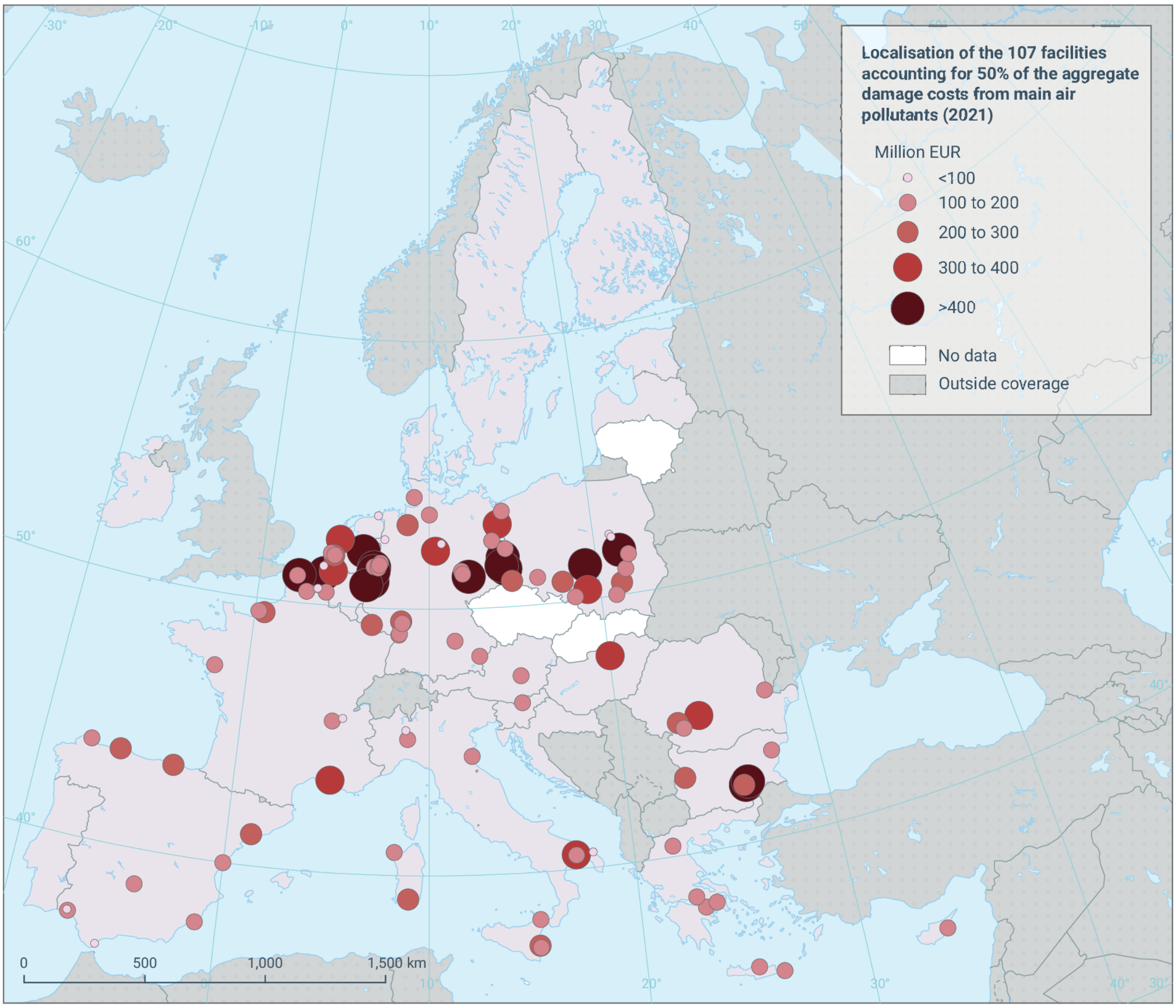
Notes: For the main air pollutants, the lower value of the range is a calculation of mortality using VOLY, while the upper value uses VSL.

Euro price base: 2021.

Data gaps: Czechia (2021), Malta (2020-2021), Lithuania (2020-2021) and Slovakia (2018-2021). This data has been projected using the latest reported year for the summaries at EU level (by pollutant group and by sector), but not when individual countries or facilities are presented.

As shown in Map 1 below, and consistent with earlier analysis from the EEA and the European Topic Centre (ETC), a small number of facilities remain responsible for 50% of the external costs caused only by the main air pollutants, e.g. in 2021 just 107 (1.1%) of the 9,400 facilities. It is worth noting that almost half (24) of the 50 most polluting facilities in 2021 were thermal power stations, with most of them located in Germany (nine) and Poland (six). Twenty-two of these 24 plants burn lignite or hard coal as their main fuel.

Map 1. The 107 facilities that together account for 50% of the aggregate damage costs estimated from main air pollutants (2021)



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: Mortality valued using the value of a life year (VOLY).

Euro price base: 2021.

Data gaps: Czechia, Malta, Lithuania, and Slovakia. No data reported for 2021.

Source: See technical note (Estimating the external costs of industrial air pollution: Trends 2012-2021: Technical note on the methodology and additional results).

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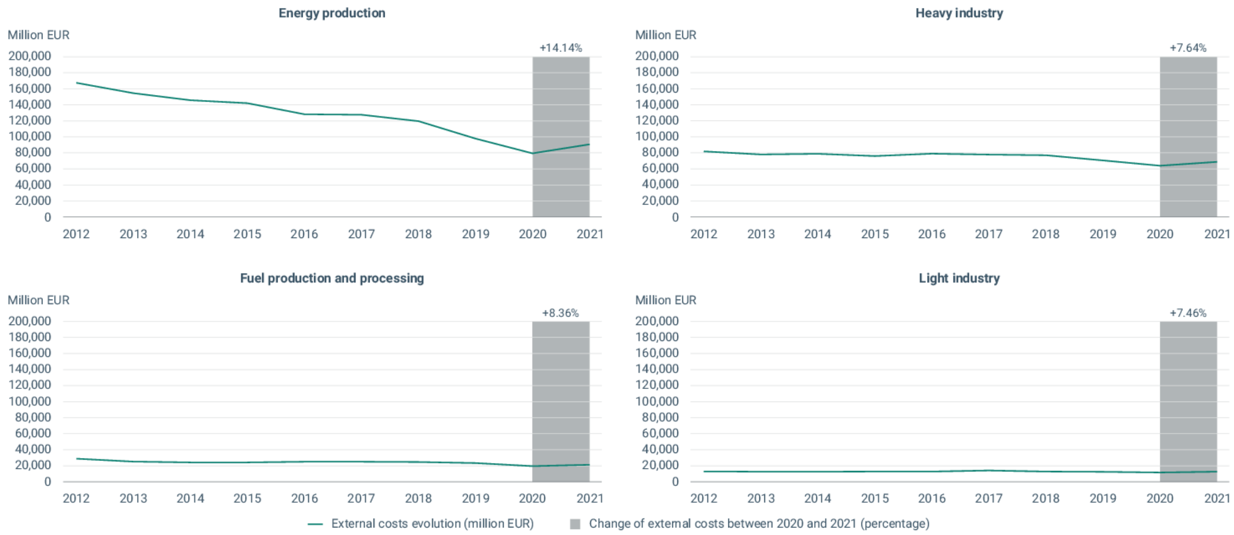
The updated assessment also identifies the sectors with the highest externalities. Over the decade (2012-2021), the highest external costs were caused by the energy sector, followed by heavy industry, fuel production and processing, light industry, waste management, livestock[3] and wastewater treatment[4].

The ranking of relative contributors to the total damage costs is the same in 2021 as during the decade (see above paragraph), but the energy sector has been cutting emissions at a higher rate than the other sectors. Almost 80% of the decrease of total external costs during the study period corresponds to this sector (Figure 2). This has been driven by the successful implementation of the best available techniques (BAT) in the sector via European environmental legislation from the last decades, including Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants (LCPD), earlier legislation tackling large power stations, Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPCD) and more recently the Industrial Emissions Directive (IED) – Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions. Climate policy has also played a major role in the shift from coal to natural gas (as a transitionary fuel) and the increase in renewables seen in the last 25 years, which has also contributed successfully to the reduction of air emissions from power stations (EEA, 2019; 2023).

Whereas the energy sector has always represented the biggest source of external costs from industrial air emissions (around 50%), other sectors have become increasingly important as their relative decrease in external costs has been lower and they now represent a bigger proportion of industrial pollution. The need for tighter control and better environmental performance was also one of the key themes in the European Commission’s proposal for the revision of the IED, which has a strong focus on applying the most stringent emission limits and reducing the opportunity of using derogations (EC, 2022).

Figure 2. External costs by sector aggregated over all pollutants (2012-2021)



Notes: Mortality valued using the value of a life year (VOLY).

Euro price base: 2021.

Data gaps: Czechia (2021), Malta (2020-2021), Lithuania (2020-2021) and Slovakia (2018-2021). This data has been projected using the latest reported year for the summaries at EU level (by pollutant group and by sector), but not when individual countries or facilities are presented.

In addition to the sectors shown in the Figure 2, the analysis also covered livestock (i.e. intensive rearing of pigs and poultry on large farms), waste management and wastewater. Due to the nature of the sectors, the scope of the European Pollutant Release and Transfer Register (E-PRTR) legislation and the selection of pollutants, these sectors represented a low amount of external costs to health and the environment, which could lead to misleading conclusions. Therefore, they have not been presented in this figure.

Source: See technical note (Estimating the external costs of industrial air pollution: Trends 2012-2021: Technical note on the methodology and additional results).

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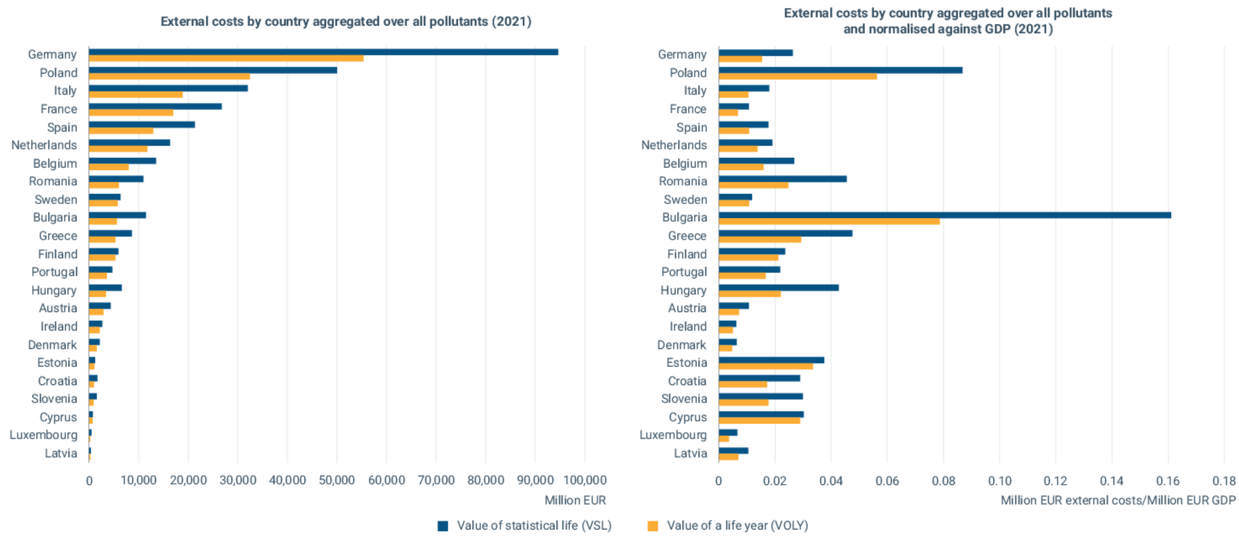
In 2021, the main polluting facilities were located in Germany, Poland, Italy, France, and Spain. These countries have the largest facilities and highest number of facilities reporting to the E-PRTR.

When these costs are compared to the GDP as an indicator of relative environmental performance per unit of national economic output, the top five polluting facilities were in Bulgaria, Poland, Estonia, Greece, and Cyprus (Figure 3).

Considering the trends in external cost per country over the last decade, the relative contribution of countries remained fairly stable with very little changes to the top 5 considering absolute external costs and the ratio of external costs by GDP. Only Greece and Cyprus emerged in recent years as two of the top 5 in external costs normalised by GDP. It is worth considering, however, that Czechia would usually be one of the top countries in terms of absolute and normalised externalities, but they have not been presented in Figure 3 due to their failure to submit 2021 data.

Figure 3. External costs by country aggregated over all pollutants (2021)



Notes: Mortality valued using the value of a life year (VOLY) and the Value of Statistical Life (VSL). The order in the ranking is based on the VOLY.

Euro price base: 2021.

Data gaps: Czechia, Malta, Lithuania, and Slovakia. No data reported for 2021.

Source: See technical note (Estimating the external costs of industrial air pollution: Trends 2012-2021: Technical note on the methodology and additional results).

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Notes

[1] The high and low percentages correspond to the relative weight of GHGs, heavy metals or organic pollutants in the total external costs, depending on whether the health impacts from the main air pollutants are calculated using the VSL or the VOLY. Using the VOLY, the other pollutant groups represent a higher proportion of total costs, and vice versa when using the VSL.

[2] As opposed to air pollutants, GHG externalities are calculated based on the carbon abatement cost required to comply with the Paris Agreement, which seeks to limit global warming increase to below 2°C above pre-industrial temperatures.

[3] This corresponds to air emissions from livestock in the scope of the E-PRTR Regulation: Installations for intensive rearing of poultry or pigs: i) with 40,000 places for poultry, ii) with 2,000 places for production pigs over 30 kg and iii) with 750 places for sows. Cattle farming, which is now the biggest source of methane and the second biggest source of ammonia emissions to the air from agriculture, does not report to E-PRTR and consequently, is not reported in the European Industrial Emissions Portal.

[4] Since the scope of the assessment is air emissions, this sector had the least externalities. However, it causes environmental pollution due to water emissions.

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