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Industrial waste water treatment – pressures on Europe's environment

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Key messages and recommendations

1. In 2016, more than 34 000 facilities reported data to the European Pollutant Release and Transfer Register (E-PRTR); however, only a relatively small fraction of these reported emissions to water: around 3 600 facilities, equivalent to 10 % (2 500 facilities from industry and around 1 100 Urban waste water treatment plants (UWWTPs)). The presence of pollutant reporting thresholds in the E-PRTR process means that other facilities that have pollutant releases below these thresholds do not have to report data; hence, 3 600 represents only those facilities with discharges above the threshold levels.

2. Based on national assessments, in most countries industrial point sources of pollution are identified as a relatively small source of pressure. The data suggest that industrial point sources not regulated by the Industrial Emissions Directive (IED) may exert greater pressure on the quality of water than the larger installations covered by the IED. This suggests that the IED regulatory process is effective in controlling industrial pollution but that measures to control pollution from smaller industry may be less effective.

3. Industrial sectors that include large-scale activities tend to have a higher proportion of direct releases to water. This is consistent with data for the pulp and paper (82 %), iron and steel (81 %), energy supply (86 %), non-ferrous metals (76 %) and chemicals (49 %) sectors. This would require on-site capacity to treat the waste waters before their release.

4. Those industrial sectors with generally smaller scale installations, e.g. other manufacturing, and food and drink production, tend to report higher proportions of releases to the sewer system (i.e. indirect releases) than direct releases to water. Some of these effluents (e.g. from food and drink production) are similar in character to domestic-type effluents, which may explain why the off-site treatment pathway is an easier option for these sectors.

5. According to E-PRTR data, direct emissions (in mass) to water from industry for most pollutants have slightly decreased in recent years and, in the meantime, transfers from industry towards UWWTPs have marginally increased (except for heavy metals).

6. In terms of eco-toxicity, the largest pressure from industrial direct releases to water can be observed where there are large-scale, or clusters of, thermal power plants, coke ovens or chemical manufacturing plants.

7. Analysis of the eco-toxic loading related to different pollutant groups over the period 2008-2016 indicates that:

   - In terms of eco-toxicity, as would be expected, UWWTPs are the biggest contributor of direct releases to water for each of the pollutant groups. Within industry, chemicals and energy supply are always significant contributors to the eco-toxicity of direct releases to water and to indirect releases to UWWTPs as well.

   - The eco-toxic loading due to direct releases from industry has clearly decreased for heavy metals (mainly originating from metal processing activities), and it has also decreased for chlorinated organic substances and other organic substances.

   - Regarding indirect releases, the eco-toxic loading to UWWTPs has decreased for heavy metals, has remained relatively constant for other organic substances and has no clear trend for chlorinated organic substances.

   - Over the same period the toxic loading due to direct releases to water from UWWTPs has increased for heavy metals, which suggests that other sources not regulated under the IED are impacting on heavy metals in UWWTP releases. The toxic loading has decreased for chlorinated organic substances and other organic substances.

Some limitations due to information gaps have been identified and should be addressed	Recommendations
The current scope of the E-PRTR does not capture all industrial emissions to water.	**Thresholds** - The pollutants covered by the E-PRTR have not changed since the regulation was adopted in 2006. Some substances have become less relevant than other emerging pollutants identified since then. Therefore, reconsidering the scope of substances covered is essential to ensure the mechanism remains fit for purpose. **Scope of activities** - The industrial activities covered by the E-PRTR and the IED are not fully aligned. Neither is there an exact alignment in definitions between E-PRTR 'facilities' and IED 'installations'. Aligning the activities and reviewing the pollutant reporting thresholds would increase the scope of industrial sites reporting to the E-PRTR and would increase the number of potential reporters from the current (approximate) 34 000. - Reporting to E-PRTR is required only for UWWTPs for greater than 100 000 population equivalent (p.e.). Reducing this capacity threshold would provide a more complete understanding of the significance of discharges from UWWTPs. **To go further ...** Emissions from industrial facilities currently not regulated under the IED represent a significant data gap. Given that aggregated EU data sources do not provide relevant emission data, a dedicated study examining this issue could be valuable to better understand the full extent of pressures on UWWTPs. To narrow the scope of an extensive data collection exercise that may be required for such a project, the focus could be on Member States' reporting on non-IED industrial plants that exert a significant pressure on their water bodies and on industrial sectors with probably the highest emissions to water.
The E-PRTR does not collect any information on the associated UWWTPs that receive indirect emissions from an industrial site.	Some of the data reported on a voluntary basis under the UWWTD, such as design capacity, entering load, level of treatment, discharging area, could be reported to a future mandatory EU Registry on Industrial Sites. The EU Registry on Industrial Sites is a reporting mechanism that will compile information on industrial entities regulated by several pieces of EU law in a single system (including E-PRTR and IED). This system will be in place from 2019 with reference to the reporting year 2017 and will receive updates every year thereafter (whereas the UWWTD requires reporting every 2 years). Such data would allow a more detailed assessment of the pressure caused by industrial emissions, for example: • Determining whether indirect releases have an appropriate level of treatment at the receiving UWWTP. • Assessing whether specific industrial pollutant loadings are reflected in the releases from the receiving UWWTPs and thus assessing the potential pressure of indirect emissions on receiving waters (information submitted by reporting countries as part of their river basin management plans (RBMPs) under the WFD indicates that discharges from UWWTPs are considered a significant pressure in a number of countries. However, the contribution of industrial effluents to the reported UWWTP pressures cannot be determined based on available EU-level data). • Identifying whether the receiving treatment plants are operating within their design capacity.
Comparison of data on pollutants released from industry with data on the status of the water bodies is not possible because of variations in the approach taken to assessing the status of surface water bodies in the different Member States (in modelling, monitoring and extrapolating data). These issues need to be addressed in order to have consistent and comparable EU-wide data on industrial emissions and the status of water bodies.	A more consistent approach to assessing ecological and chemical status and the origins of their failure at European level is needed to comply with the requirements of the WFD, as well as reporting at a more detailed level.

Some limitations due to information gaps have been identified and should be addressed	Recommendations
There is a discrepancy between the numbers of plants > 100 000 population equivalent (p.e.) being reported under the E-PRTR and the UWWTD, with a lower number of plants being reported under the E-PRTR. **The data on UWWTPs, as reported under the UWWTD, are incomplete for some reporting countries.** **A comprehensive and reliable data set would provide a stronger basis for comparison with release data from the E-PRTR or other data sources.**	The reliability of data on water releases reported to the E-PRTR and the UWWTD needs to be improved. This needs to be addressed through a combination of improved data checks and improved guidance to reporters.
The UWWTD regulatory process tends to focus on pollutants that are related to domestic type effluents, and it only specifically sets limits for a limited number of pollutants, such as biochemical oxygen demand, chemical oxygen demand and total suspended solids.	As part of the ongoing evaluation of EU water policy, it would be useful to consider Article 11 of the UWWTD (relating to management of industrial effluents) and how its requirements may be better enforced and its implementation may be better monitored. In order to better deal with industrial effluent loadings to UWWTPs, **there may be merit in providing more focused requirements for managing such effluents**, including defining the scope of the pollutants that should be considered and setting emission limits and/or performance standards (e.g. removal efficiency) for a broader range of pollutants.

Executive summary

Europe's water is a resource under pressure. Economic activities, population growth and urbanisation all affect the quality of European freshwaters. Water sustains ecosystems and is a crucial resource for our societies. The collection and treatment of waste waters is one key element in the water cycle that limits these pressures and one in which European action has fostered an ambitious level of protection across Member States. Despite these efforts, water bodies in the EU remain under pressure from pollution sources. On a European scale, only around 40 % of the surface water bodies are in good ecological status and 38 % of surface water bodies are in good chemical status.

Industrial releases to water is one element that exerts pressure on European waters, alongside discharges of pollutants from urban waste water treatment. This report examines the significance of industrial emissions through direct and also indirect releases ([1]) to water and the interaction between industrial releases and Europe's urban waste water collection and treatment facilities.

Much of the analysis in this report is based on data on releases from industry and urban waste water treatment plants (UWWTPs) to surface waters as reported to the European Pollutant Release and Transfer Register (E-PRTR), which collects national information on environmental releases and transfers from large industrial activities across the EU. Other data sets are also used, including data on the status of European water bodies as collected under the EU Water Framework Directive (WFD), and information on UWWTPs as collected under the Urban Waste Water Treatment Directive (UWWTD). The broad approach taken to assessing these data is outlined below:

- Substances covered by the E-PRTR are grouped into categories to allow more coherent analysis (chlorinated organic substances, heavy metals, inorganic substances and other organic substances).
- For each pollutant group, information is presented on the magnitude of and trends in direct and indirect releases from industrial facilities.
- To better compare the environmental significance of releases, the reported emissions are then assessed further in terms of their eco-toxicity.
- The assessment also considers the potential impact of industrial emissions on UWWTP performance and how this relationship can be identified based on available EU-level data.

In addition, based on the findings of the assessment and the analysis of available relevant data sets, gaps in the data sets were identified which, if filled, would allow a more complete and thorough analysis of the impacts of industrial waste water emissions on the receiving environment.

([1]) In this assessment, indirect industrial releases refer to industrial releases that are discharged into a sewer system and receive further treatment, usually at an urban waste water treatment plant (UWWTP).

1 Introduction

1.1 Content and objectives of this report

This report examines the influence of industrial waste waters within the water cycle in Europe, with the aim of better understanding recent trends and the extent of the environmental pressure exerted by industrial waste waters. The report also analyses the different regulatory regimes that control and influence industrial waste water releases and assesses the efficacy of the reporting mechanisms that are available to gather information and data on releases and on their impacts on the receiving environment.

Industrial waste water in Europe is an environmental pressure even if these waters are, in some cases, collected by a local sewer system, treated in an urban waste water treatment plant (UWWTP) and subsequently released to the environment. There are also cases, however, in which these waters are directly released to a water body, generally after treatment at the industrial facility where the waste water is generated. This report analyses both settings, as they are significantly distinct.

Thus, a series of specific questions are addressed:

1. What are the pressures that industrial waste waters place on the treatment infrastructure and the environment?

2. Can any potential impacts on the environment be identified?

3. Are UWWTPs able to respond to the challenges that industrial waste water generates in their operation?

4. Are relevant EU policies adequate to offer an ambitious level of protection of the environment?

While analysing these aspects, it became apparent that the data available are a significant limitation to providing robust evidence and drawing conclusions. Therefore, identifying such information gaps also developed as a key objective of this report. The limitations identified when using the available data sources are also the main reason why this report covers just the Member States of the European Union (EU-28).

The report is structured in the following way:

- Chapter 1 provides an introduction to and a context to the study.

- Chapter 2 compiles the main findings of the analysis.

- Chapter 3 includes considerations on the information gaps and areas for strengthening regulatory mechanisms on the topic.

- Chapter 4 includes recommendations for improving the data collection to enhance the knowledge base.

1.2 Understanding of industry and scope of activities analysed in this report

Europe hosts a large and diverse range of economic activities. The focus of this report is industry, as defined by the following activities:

1. Manufacturing industry: activities involving the fabrication, processing or preparation of products from raw materials and commodities. In this report, a set of manufacturing industries were considered, based on the classification of industrial activities within the European Pollutant Release and Transfer Register (E-PRTR) ([2]):

    i. iron and steel;

    ii. non-ferrous metals;

    iii. non-metallic minerals;

    iv. chemicals;

    v. pulp and paper and wood;

([2]) The E-PRTR is discussed in further detail in Section 1.8.

vi. food and drink;

vii. other manufacturing activities (e.g. processing of metals, tanning of hides).

It has to be noted that the following sectors are not included in the definition we chose of industry: construction, mining and quarrying, management of waste, aquaculture or intensive livestock production.

2. Energy supply: activities that transform a primary energy source into a ready-to-use energy form such as electricity or heat. This includes power plants, district heating plants and refineries.

For the remainder of this report the term 'industry' is used to refer to the activities referenced in points 1 and 2 above. The specific activity mapping used for this report can be found in Annex 1 Sector mapping of industry, which details the aggregation applied within E-PRTR sectors and sub-sectors.

A significant part of industrial waste water is released to the environment only after being collected by the sewer system and treated in UWWTPs. Therefore, this report also considers UWWTPs within the scope of its analysis (but not within its definition of 'industry').

Last, data are available only for point source emitters, which is why diffuse sources of emissions could not be considered in this analysis.

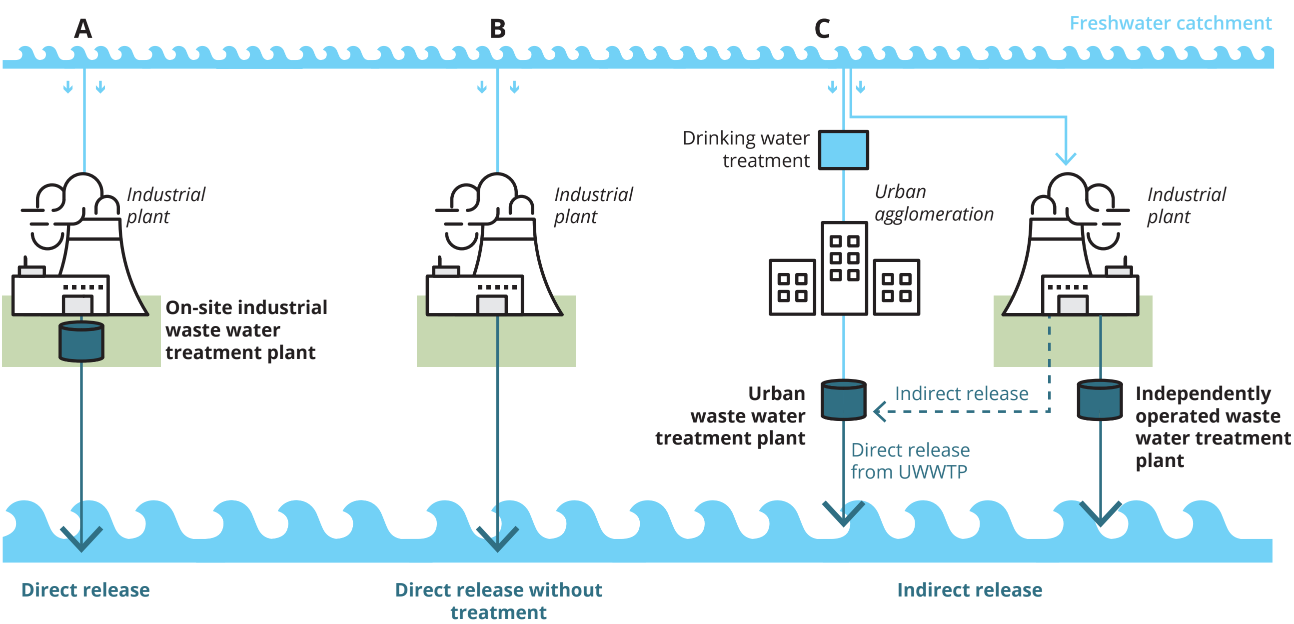
1.3 The relevance of industry in the context of the water cycle

Industry is a highly relevant stakeholder regarding pressure on water media from both a quantitative and qualitative point of view. The uptake of water by industry in Europe is about 54 % of the total uptake for human activities (FAO, 2016). The physicochemical quality of these waters when turned into waste waters is, in most cases, substantially degraded, and therefore the waste waters require treatment before being returned to the environment.

Figure 1.1 presents a simplified overview of water uptake and subsequent waste water pathways back to the environment. The effluents from certain industries may require treatment that is not commonly available in UWWTPs and may therefore be treated on-site before **direct release** to water (scenario A in Figure 1.1). Some industrial units, such as cooling systems, generate waste water streams with low pollutant content that can be **directly released** into receiving waters without treatment (scenario B). Finally, some industrial installations generate effluent that cannot be directly released to surface water (or the operator choses not to treat it on site) and thus is transferred off site for treatment at an UWWTP or independently operated waste water treatment plant (scenario C), the so-called **indirect releases**.

The treatment of industrial waste water at an UWWTP is typically a commercial arrangement between the

Figure 1.1 Simplified waste water treatment cycle



Source: EEA.

industry that generates the waste water and the UWWTP operator that treats it. This can be complex but a charge is normally imposed based on the quantity of waste water and its constituent pollutants. The UWWTP operator will also typically restrict, or even, prohibit the receipt of pollutants that might comprise operation of the UWWTP e.g. pollutants that cannot be treated, hamper the treatment process or impinge on sludge quality.

The quantitative relevance of industry in the water cycle can be measured using two metrics, namely water consumption and water uptake. The term water consumption in industrial activities refers to the difference between the water that is taken from a source (directly from a water body or sourced by the water supply) and the amount of water that is then released either into the environment or into the sewer system after use. Losses, evaporation and water incorporated in the goods produced in a given activity are accounted for as water consumed. Industrial plants use water for many purposes including steam generation, as a raw material, in cooling systems, in air pollution abatement technologies (e.g. wet scrubbers) and in cleaning systems. The most common water outputs are waste water effluents, cooling system purges and evaporation and steam purges to release pressure.

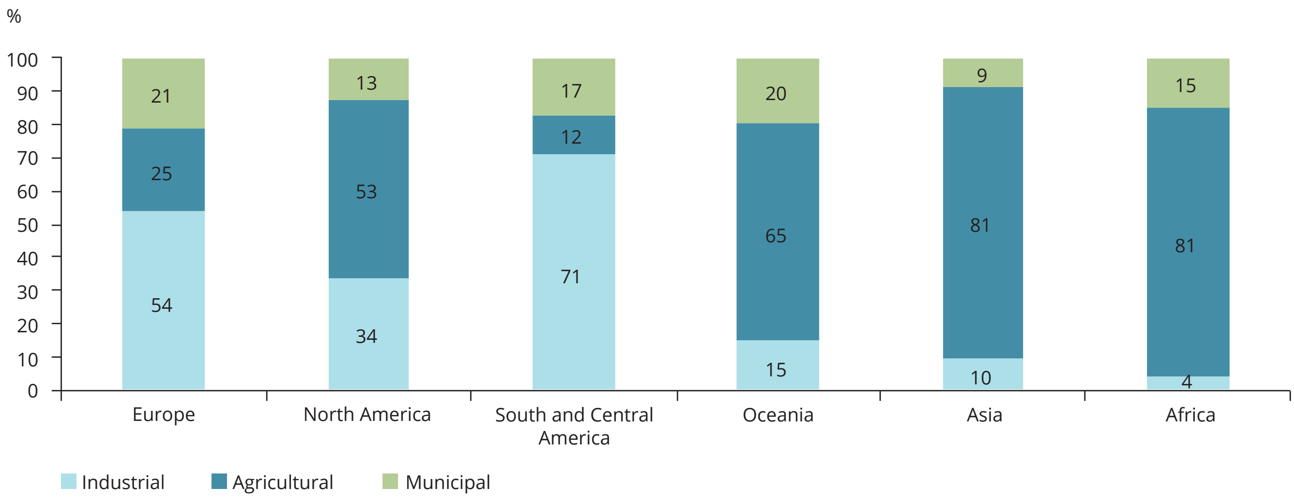
The amount of water used and released is also determined by the product portfolio of the industrial plant. Some plants (e.g. food and drink manufacturing) require intensive equipment cleaning between production lots, which results in high water consumption and large releases of waste water. A manufacturing plant that requires less frequent changes of production lots would generate much lower volumes of effluent.

Water uptake refers to the gross amount of water that enters a facility in a given period. Thus, water uptake is, by definition, greater than water consumed. While water consumption is a better metric to understand the potential distortion of the water cycle by a given industrial site, it is also a metric for which data are scarce and which presents methodological challenges in terms of data collection. Water uptake is a good proxy for understanding the relevance of the sector.

Global data on water uptake per region in 2016 are presented in Figure 1.2. It shows that industry in Europe is a major consumer of water in relation to other sectors (54 %). The global average water uptake by industry is around 19 %.

According to the FAO (Food and Agriculture Organization of the United Nations), industrial water uptake in Europe has, however, decreased in recent years. The overall uptake of water by industry is around 200 billion m^3 per year, dominated by sea water abstraction for cooling systems, which uses around 50 billion m^3 per year. Water uptake for industrial manufacturing processes (not cooling) has experienced a 40 % reduction in Europe since 1990 (from around 50 to 30 billion m^3 per year). These reductions are most significant for Finland, Germany, Italy and Romania.

Figure 1.2 Estimated annual share of global water uptake by activity and region



Note: 'Municipal' refers to water not used by industrial activities or agriculture (mainly households, services and commerce).

Source: FAO, 2016.

1.4 European policy landscape for industrial waste waters

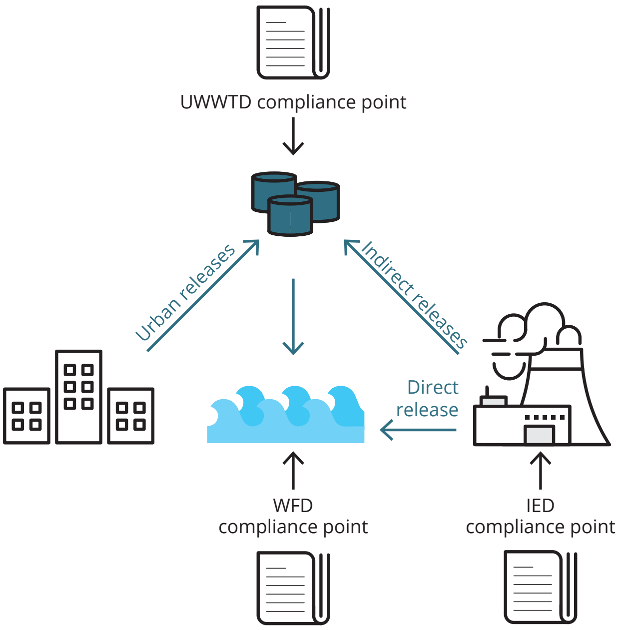
The release of industrial waste water is regulated in Europe both directly as part of the environment law on industry and indirectly by the EU policies that tackle water issues horizontally.

Under the **Water Framework Directive** (WFD, 2000/60/EC), specific directives regulate aspects that will influence industrial waste water generation and management. The most relevant are the **Urban Waste Water Treatment Directive** (UWWTD, 91/271/EEC), the Groundwater Directive (2006/118/EC) and the Environmental Quality Standards Directive (2008/105/EC).

Industry's direct or indirect releases of pollution to the environment are among the key aspects regulated by the **Industrial Emissions Directive** (IED, 2010/75/EU).

All these instruments combined constitute the main mechanism for protection regarding industrial waste water and each regulates a specific element of the various pathways in which industrial waste water can be released. These specific elements are described in this report, and Figure 1.3 is a simplified illustration of the interactions between the compliance points of the three directives.

Figure 1.3 Compliance points for the three key directive protecting the environment from environmental pressures to water



Source: EEA.

Water Framework Directive

EU water policy is established, at an overarching level, by the WFD, which establishes a series of mechanisms for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. It aims to ensure that all aquatic ecosystems, terrestrial ecosystems and wetlands meet 'good ecological status' and 'good chemical status', and sets ambitious deadlines for this. The first deadline for good status was 2015, although a large proportion of the water bodies across Europe failed to achieve this for a number of reasons.

The ecological status is defined as a function of the quality of the biological community, the hydrological characteristics and the chemical characteristics. The biological community that would be expected in conditions of minimal anthropogenic impact is ultimately the desired status for all water bodies. Good chemical status is also a concept used in the WFD and is defined as compliance with all the quality standards established for chemical substances at EU level.

Under the WFD, Member States are required to develop a set of cost-effective measures summarised in comprehensive river basin management plans (RBMPs) that are updated every 6 years.

RBMPs are a key element of the WFD and provide details of how Member States plan to improve, protect and sustainably manage their river basin districts. As part of this process, countries are required to identify key pressures on each of the 110 river basin districts across Europe. These plans contain measures for industrial waste waters where necessary. More information can be found in the report *European waters: assessment of status and pressures* (EEA, 2018d).

Industrial Emissions Directive

The IED takes an integrated approach to industrial emissions, regulating the whole environmental performance of an industrial plant. This includes emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents and restoration of the site upon closure. Currently, the IED regulates 31 industrial sectors and over 50 000 installations in Europe. All installations are required to operate according to a permit issued by the relevant Member State authorities. All permit conditions must be based on the environmental protection level that is expected for the approach known as best available techniques (BAT). In particular, the associated emission levels that can be achieved when operating a BAT (hereafter referred to as BAT-AELs) are used to specify emission limit values for the installations regulated by this piece of EU law.

The IED distinguishes between 'direct' and 'indirect' releases to the environment — the latter occurring after separate treatment; typically off-site, by a third party. The issue of 'indirect release' mostly impacts water discharges, rather than air. In recognition of the prevalence of off-site waste water treatment, Article 15(1) of the IED allows competent authorities to take account of a downstream waste water treatment plant when setting limit values for an installation i.e. setting laxer emission limits than for direct releases, as long as specified safeguards are met ([3]). This has been highlighted as a particularly complicated area of IED implementation with a potential for sub-optimal environmental outcomes ([4]).

In certain BREFs, BAT-AELs are specified only for direct releases to water bodies, although newer BREFs more systematically specify levels for indirect releases since some pollutants are not remediated by conventional UWWTPs. Limit values set in permits for direct releases of certain substances are usually stricter than those for indirect releases. For some substances, this may aim to ensure that pollution levels in the effluent will not damage the sewer system or diminish the UWWTP performance.

Urban Waste Water Treatment Directive

The main instrument regulating the operation of UWWTPs at an EU level is the UWWTD. The Directive was introduced in 1991 and its main objective is to protect the environment from the adverse impacts of waste water discharges from urban areas and the food processing industry and from other industrial discharges into urban waste water collection systems. It regulates the collection, treatment and discharge of urban waste water and sets the following key requirements:

- collection and treatment in all agglomerations (a technical concept to classify urban settlements) of more than 2 000 population equivalent (p.e.);
- secondary treatment in all agglomerations of more than 2 000 p.e.;

Box 1.1 Evaluation of the Urban Waste Water Treatment Directive (UWWTD, 91/271/EEC) and the Water Framework Directive (WFD, 2000/60/EC)

Since the introduction of the UWWTD in 1991, a number of changes have occurred regarding the environment: increased and new pressures, depletion of resources, climate change, changing socio-economic situations, technological progress and increased societal demands for cleaner waters. The legal context has also changed: new and interrelated water directives have come into force, such as the WFD and the Marine Strategy Framework Directive (MSFD, 2008/56/EC).

Therefore, an evaluation of the UWWTD was initiated by the European Commission (October 2017). The evaluation will consider:

- the effectiveness, coherence, efficiency, relevance, and EU added value of the UWWTD by analysing its requirements and implementation in the last 25 years;
- whether the Directive has achieved its objectives: is it addressing key environmental principles?; to what extent are pollutant limits still valid?; to what extent does the Directive encourage/facilitate innovation and adaptation?
- whether there are barriers to its implementation.

The **evaluation of the UWWTD** is planned to be completed in **2019**, and will be closely coordinated with the planned fitness check of the performance of the WFD and the Floods Directive.

The **fitness check for the WFD** and its daughter directives (Groundwater Directive, 2006/118/EC and Environmental Quality Standards Directive, 2008/105/EC) was also launched in October 2017. It is planned to be completed in 2019 as well.

Source: EC, 2017c.

([3]) An equivalent level of protection of the environment as a whole must be guaranteed and there must be no higher levels of pollution in the environment.
([4]) See Berlin Workshop report https://circabc.europa.eu/ui/group/06f33a94-9829-4eee-b187-21bb783a0fbf/library/56767bcd-4958-4e36-9b24-3690fd2723c2/details

- more stringent treatment in all agglomerations of more than 10 000 p.e. discharging into designated sensitive areas and their catchments;

- a requirement for pre-authorisation of all discharges of urban waste water, of discharges from the food-processing industry and of industrial discharges into urban waste water collection systems;

- monitoring of the performance of treatment plants and receiving waters; and

- controls on sewage sludge disposal and re-use, and treated waste water re-use whenever it is appropriate.

In the context of the Directive, urban waste water means domestic waste water or the mixture of domestic and industrial waste waters and run-off rain water.

Article 11 of the UWWTD requires Member States to ensure that competent authorities regulate and give prior authorisation for the discharge of

Table 1.1 Industrial waste water types and their treatment requirements

Category	Description of common features	Technique at UWWTPs	Pollutants	Example industrial sectors
Minimal contamination (can be landspread)	Waste water contains no pollutant that could harm an agricultural crop. Some nutrients (nitrogen compounds, phosphorus or potassium) can be present but these are useful for plant development. Levels of biocides or toxic substances should be very low.	No new/specific technology required, beyond secondary treatment.	Nutrients: nitrogen, phosphorus	Food and drink
Equivalent to domestic-type effluents	Waste water streams with similar, mainly organic, pollutant content to municipal waste water.	UWWTPs do not need major changes in their assets.	Degradable organic matter	Food and drink
Low flow and non-domestic-type pollutants at low concentrations	Waste water contains small concentrations of other pollutants not present in urban effluents. The incoming load to UWWTPs may have a similar composition to municipal waste water due to dilution.	No major investment required: more frequent inlet effluent monitoring. May require a buffer (e.g. tank/basin).	Different from common pollutants: e.g. pesticides, hormones, nano-plastics or endocrine disrupters.	Chemicals
Metals	Waste water from metal processing, iron and steel plants or other industries containing metals and metalloids.	Sedimentation, flotation, microfiltration, electrocoagulation	Metals	Metal processing and mineral industry
High nutrient loading	Waste water containing high nitrogen compounds, phosphates or substances that contribute to eutrophication. Higher inorganic content (i.e. higher conductivity).	Nitrification-denitrification, chemical precipitation	Substances increasing eutrophication	Chemicals: fertilisers
Effluent streams requiring pH adjustment	Waste water streams with very high or very low pH.	Initial neutralisation step to reduce corrosion in the UWWTP.	Acids or alkalis	Chemicals and mineral industry
Persistent organics content	Waste water contains not easily degradable organics such as persistent (xenobiotic) hydrocarbons or bioaccumulative organic toxic substances.	Specific and complex treatment technologies required (e.g. ozonation)	Persistent organics	Textiles and chemicals
Emerging substances	Waste water contains new pollutants or has characteristics that are not currently monitored (because of high cost, high complexity or no legal obligations).	New monitoring methods and subsequent treatments techniques	New parameters and compounds not frequently measured, e.g. antibiotics	Pharmaceuticals

Source: Author's compilation.

industrial waste water into collecting systems and UWWTPs. Such authorisations must ensure that industrial waste water entering the collecting systems and/or the treatment plants is pre-treated, where necessary, so that the functioning of the plant and the collecting system is not hindered and, thus, that discharges from the plants do not adversely affect the environment. However, the requirements of Article 11 are relatively general and the specific interpretation of how to meet the requirements of this article are defined separately in each Member State.

The UWWTD also aims to control the sludge generated in the treatment operations, and to ensure that it can be safely disposed of and, if possible, used in certain applications (e.g. agriculture).

1.5 Types of industrial waste water

Industrial waste water is a complex area and it cannot be simply characterised. Different industrial activities generate very different types and quantities of effluents. This section identifies a set of waste water categories and illustrates the key aspects to consider from an environmental point of view.

Typical domestic waste water contains, primarily, organic content. Organic content can be measured with several accepted metrics, namely total organic carbon (TOC), chemical oxygen demand (COD) or biochemical oxygen demand (BOD). In addition to that, urban waste waters contain nitrogen and phosphorus (the majority as part of the organic matter) and dissolved salts (mostly chlorides).

Industrial effluents, in contrast, are much more varied. Some industrial effluents are similar to a typical urban effluent, but generally the concentration levels and the substances present in industrial waste waters are different from those of urban waste water.

The main industrial waste water types are presented in Table 1.1 and are based on the characteristics of the waste water from different industrial activities.

Some effluents from industrial activities (mainly food and drink) can be spread on land as a source of nutrients. Certain water effluent streams from industry are relatively easily handled by UWWTPs (such as those from slaughterhouses), as they mainly contain organic loads. There are other industrial effluents (e.g. containing metals or recalcitrant chemicals) that may have a significant impact on the environment and would require on-site specific (not conventional) treatments if transferred to an UWWTP.

1.6 Key water pollutants and their significance

This report identifies key substance groups and individual substances on the basis of the available data. This means that those substances that are not currently subject to reporting, essentially those outside the scope of the E-PRTR, are not considered. Section 2.2.4, however, aims to identify emerging issues that were not analysed due to the use of this criterion.

For the purposes of the assessment in Chapter 2, substances are grouped into the following four categories:

- inorganic substances;
- chlorinated organic substances;
- other anthropogenic substances;
- heavy metals.

Pesticides are a common component of urban waste water because of their use in gardens and parks and for weed control on roads and railways (EC, 2001) and therefore are transported by the runoff of rainwater. Direct and indirect releases of pesticides are reported by very few industrial facilities. While releases of pesticides are a more common component of UWWTP releases, they are excluded from the specific analytical elements of this report as they do not, in general, originate from **industrial sources**.

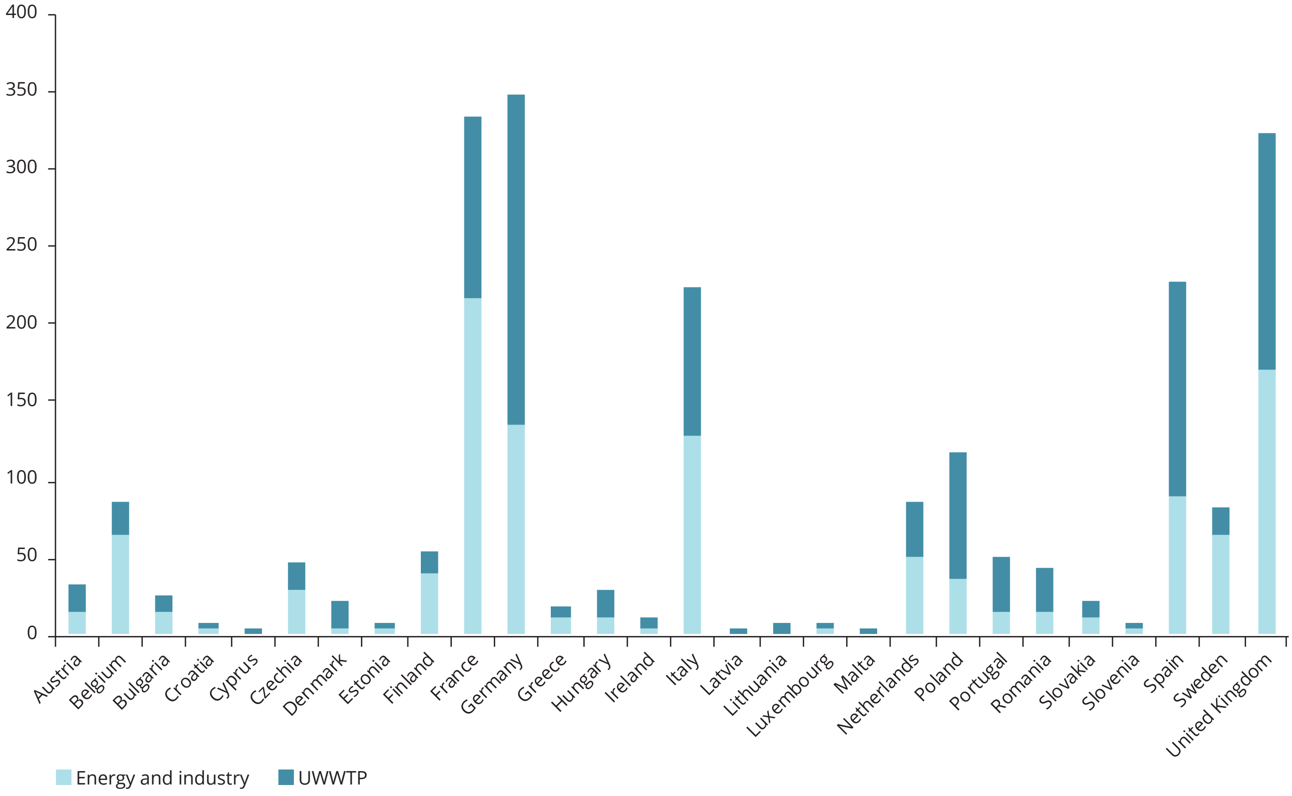
Table 1.2 summarises the substances considered in each group and their main impacts on human health and the quality of the water environment.

Table 1.2 Impact of different pollutant groups on human health and the water environment

Pollutant group	Inorganic substances	Chlorinated organic substances	Other organic substances	Heavy metals
Substances considered in this report	Chlorides Cyanides Fluorides Nutrients (nitrogen and phosphorus)	Brominated diphenylethers Chloro-alkanes Dichloromethane Dioxins and furans Halogenated organic compounds Hexabromobiphenyl Hexachlorobenzene Hexachlorobutadiene Tetrachloroethylene Tetrachloromethane Trichlorobenzenes Trichloroethylene Trichloromethane Polychlorinated biphenyls Pentachlorobenzene Pentachlorophenol Vinyl chloride 1,2-dichloroethane	Anthracene Benzene Benzo(g,h,i)perylene Di-(2-ethyl hexyl) phthalate (DEHP) Ethyl benzene Ethylene oxide Fluoranthene Naphthalene Nonylphenol and nonylphenol ethoxylates Octylphenols and octylphenol ethoxylates Organotin compounds Phenols Polycyclic aromatic hydrocarbons (PAHs) Toluene Xylenes	Arsenic and compounds Cadmium and compounds Chromium and compounds Copper and compounds Lead and compounds Mercury and compounds Nickel and compounds Zinc and compounds
Associated health impacts in humans	Chlorides are generally not toxic to humans except in the special case of impaired sodium chloride metabolism in which congestive heart failure may occur. High nitrate concentrations can cause methemoglobinemia in infants.	Some of these substances are known or suspected carcinogens (e.g. dichloromethane) while others (e.g. chloro-alkanes) can impact on human organs such as the kidneys, liver and thyroid gland.	This is a very broad range of compounds and their impacts on human health are varied. Some (such as benzene) are carcinogenic while others (e.g. PAHs) are known to result in birth defects. Some of these compounds can also be involved in the atmospheric reactions that generate ground-level ozone, an air pollutant that can have significant human health impacts.	Heavy metals have a range of potential impacts on humans, with a number of them being carcinogens. Short-term impacts can also include damage to the kidneys and liver, as well as impacting on brain development in children.
Impact on the water environment	Chlorides may impact freshwater organisms and plants by altering reproduction rates, increasing species mortality, and changing the characteristics of the entire local ecosystem. High nitrate concentrations can cause eutrophication, increased plant growth, problem algal blooms, loss of life in bottom water and an undesirable disturbance to the balance of organisms present in the water.	A number of these substances are known to impact on the growth and reproduction of aquatic animals. Some of these compounds can also accumulate in aquatic animals, presenting problems throughout the food chain. They can also cause oxygen depletion in water, negatively impacting the health of relevant species.	As with human health impacts, the impacts on the water environment of this broad group of pollutants is varied. For example, some organotin compounds are very toxic to algae, molluscs, crustaceans and fish, and have also been identified as endocrine disruptors. Some of these compounds can also bioaccumulate in marine animals, resulting in potential impacts throughout the food chain.	Heavy metals are of particular concern in the aquatic environment due to their toxicity and persistence. A number of these metals are also defined as priority substances under the WFD.

Sources: Author's compilation based on data from EEA (2016a) and WHO (2006).

Figure 1.4 **Number of E-PRTR facilities reporting emissions to water in the EU in 2016 by sector and Member State**



Note: The data above include only direct releases to water from E-PRTR facilities (industry and UWWTP).

Source: EEA, 2018b.

1.7 Industrial sites and treatment infrastructure

In 2016, more than 34 000 facilities reported data to the E-PRTR. However, as discussed later in Section 2.2 only a relatively small fraction of them reported emissions to water: around 3 600 facilities, therefore 10 %. This represents 2 500 facilities from industry and around 1 100 UWWTPs (> 100 000 p.e.) reporting emissions to water (direct and indirect releases) in 2016.

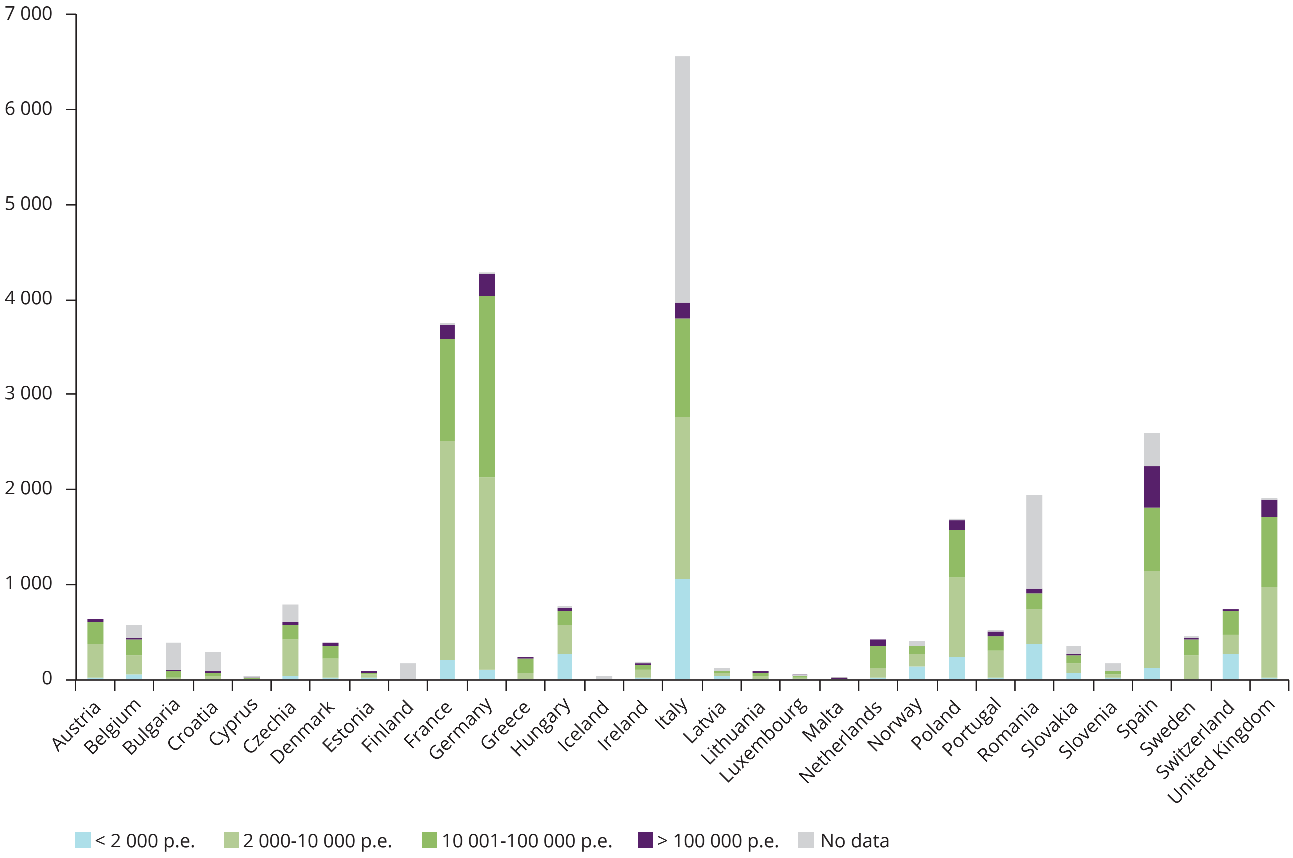
In 2016, direct releases to water were reported by 2 200 facilities, based on E-PRTR data.

Figure 1.4 shows that Germany has the most E-PRTR facilities reporting direct releases to water with a total of 350 facilities (of which 134 are industrial and 216 are waste water treatment plants). Other key contributors include France and the United Kingdom, which had around 320 reporting facilities. The countries with the smallest number of reporting facilities included Latvia and Malta, with only two facilities each (one industrial and one waste water treatment plant), Cyprus (two waste water treatment plants), followed by Luxembourg, Croatia, Estonia, Slovenia and Lithuania, all of which had under 10 reporting facilities.

Figure 1.5 presents an overview of UWWTPs in the EU-28, based on the data reported under the UWWTD for 2014. In total, across the EU-28 there were 29 263 UWWTPs in operation. This is significantly higher than the number of UWWTPs reporting emissions to the E-PRTR (1 128 in 2014), as only plants with a capacity greater than 100 000 p.e. are included there. The largest number of UWWTPs was reported by Italy, Germany, France, Spain, Romania and the United Kingdom. Figure 1.5 also breaks the number of plants into the number reported within each defined capacity class. This indicates that most countries have a relatively small number of plants in the largest (greater than 100 000 p.e.) capacity class, i.e. those plants that are required to report to the E-PRTR.

However, data reported under the UWWTD also include data on the actual capacity of plants, and these have

Figure 1.5 Number of UWWTPs in 2014 by Member State and capacity class



Source: EEA, 2016b.

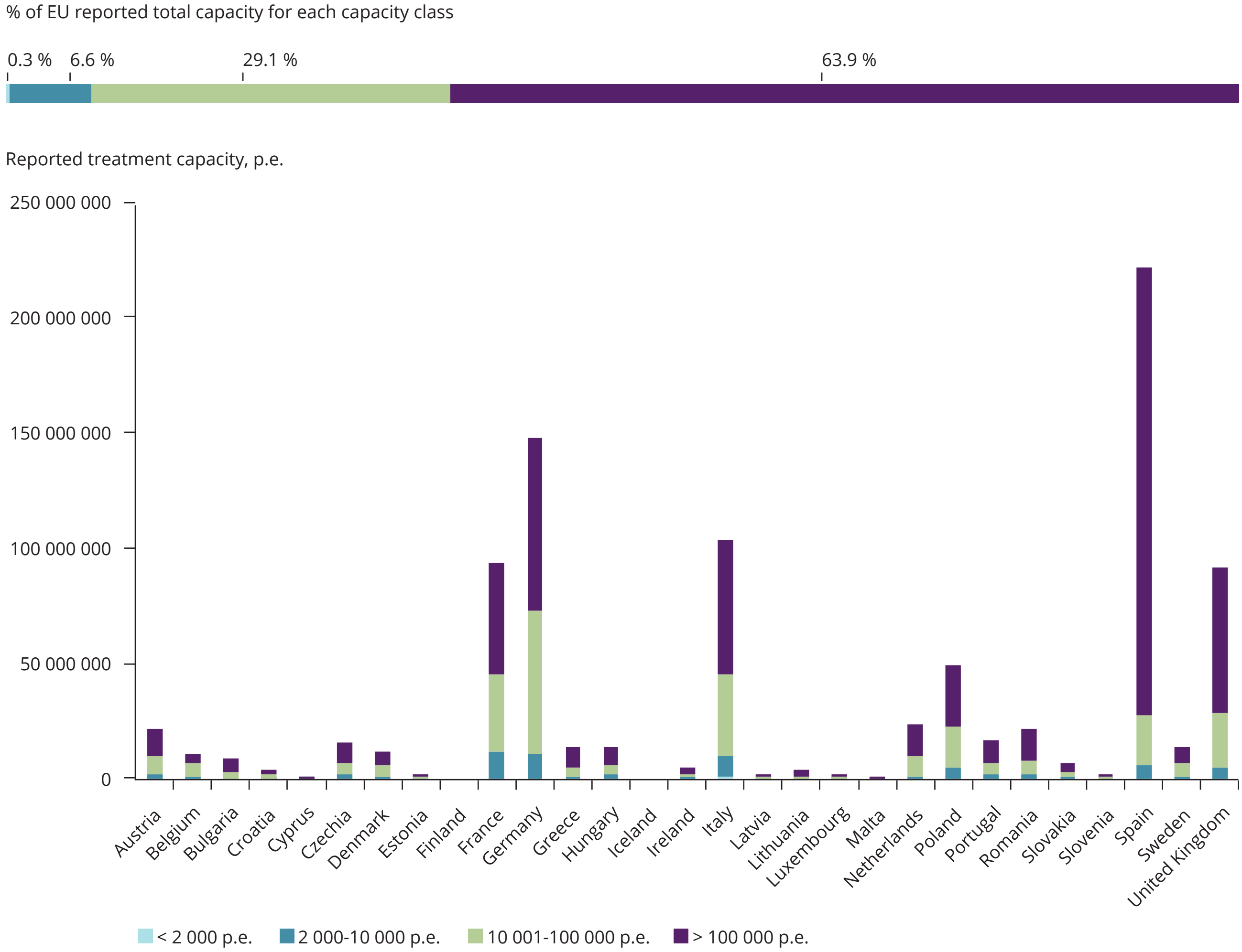
been used in Figure 1.6 to show the available treatment capacity within each capacity class. This clearly shows that, although there is a relatively small number of plants greater than 100 000 p.e., they provide the majority of the treatment capacity, with 63 % of the reported capacity being provided by these plants. This suggests that E-PRTR data do cover a substantial part of UWWTP emissions across Europe.

If the E-PRTR reporting threshold was reduced to 10 000 p.e. instead of 100 000 p.e., then the E-PRTR would capture emissions from 93 % of the available UWWTP capacity.

However, there is one significant caveat in relation to the coverage of UWWTPs by the E-PRTR and this relates to the number of treatment plants reported to be in operation according to the UWWTD compared with the number of plants reported to the E-PRTR. For 2014, the total number of UWWTPs reported to the E-PRTR was 1 128. The UWWTD reporting data from 2014 indicate that there are more than 1 600 plants with a capacity above 100 000 p.e. It would be expected that all plants above 100 000 p.e. would generate pollutant releases above the pollutant thresholds in Annex II of the E-PRTR regulations, hence the reason for the discrepancy between the UWWTD and E-PRTR data sets is unclear. This discrepancy has been identified by the EEA and is being addressed through additional quality control checks on reported E-PRTR data from Member States.

Industrial waste water often presents physicochemical characteristics that require treatment before their release to the environment or the sewer system. For those cases, industrial operators can choose between treatment on site but also off site in an **independently operated waste water treatment plant (IOWWTP)**. IOWWTPs are normally plants dedicated to the treatment of industrial waste water that serve several installations located in proximity to each other. For certain industrial waste water effluents this can be a more efficient option compared with treatment on site, as economies of scale and synergies between waste water types can be exploited. However, according to the reported data in the E-PRTR, IOWWTPs are not common in Europe (the largest number of IOWWTPs

Figure 1.6 **Total treatment capacity, by capacity class for each Member State, and total percentage of EU capacity in each capacity class in 2014**



Notes: For some plants reported under the UWWTD there were no data provided for capacity or capacity class, hence these are not included in the above graph. Also, for Spain, some plants classified as greater than 100 000 p.e. capacity do not have a specific reported capacity. Each of these plants is assumed to have a capacity equal to the average capacity of all Spanish plants greater than 100 000 p.e. that have a reported capacity.

Source: EEA (2016b).

according to the E-PRTR are in Italy — 11 facilities, followed by Poland and France with 10 facilities each and Germany with six). IOWWTPs with a capacity greater than 10 000 m^3 per day are captured under the E-PRTR according to Annex I of the Regulation. The E-PRTR pollutant reporting thresholds mean that only the larger plants will report emissions data. Based on the 2016 E-PRTR data, there were 42 IOWWTPs directly releasing to the environment, which represented less than 4 % of waste water treatment plant facilities reporting in the E-PRTR.

1.8 Data sources

The E-PRTR (EEA, 2018b) is the main source of data for direct and indirect releases from industrial facilities.

The E-PRTR Regulation (EU, 2006) puts a legal obligation on the European Commission and the Member States to establish a coherent, EU-wide pollutant register that can support public access to information concerning emissions from industrial activities. The E-PRTR is the largest industrial emissions database in Europe, containing data on more than 90 substances from 45 economic sectors. Industrial operators meeting certain activity and emission thresholds are responsible for collecting and reporting the data. Because of these emission reporting thresholds, emissions from sectors with larger facilities (e.g. refineries) are better represented than emissions from sectors with smaller facilities (e.g. textiles).

The **best available techniques reference documents (BREFs)** were also a key source of information for this study. BREFs are produced by the European Commission as part of the IED implementation and are the result of an exchange of information among industry operators, regulators and non-government actors. They reflect a consensus regarding the industrial processes that achieve an ambitious level of protection of the environment, while being economically viable at an industrial scale. They also address abatement techniques, including waste water treatment operations, as well as giving information on emissions per source for each type of industrial activity.

The Water Information System for Europe (WISE; EEA, 2018c), another key data source for this study, is a partnership between the European Commission and the EEA. It provides a web-portal entry to water-related data on inland and marine waters alongside information on EU water policies (directives, implementation reports and supporting activities), reported data sets (and their analysis in interactive maps, statistics, indicators, etc.), modelling and forecasting services across Europe, and related projects and research. WISE State of Water (SoW) also includes information on the water quality status and pressures submitted by Member States in the second reporting of RBMPs.

Finally, the **Urban Waste Water Treatment Directive Database** (EEA, 2016b), containing data from the reporting of Member States as part of the UWWTD implementation (the latest data set provides information for 2014) has been used. It provides information on areas receiving waste water releases, agglomerations, identification and capacity data on UWWTPs and their releases, links between agglomerations and UWWTPs, discharge points, and country-level information on sludge handling and treated waste water re-use.

A summary of the key data sources, with their geographical scope and limitations, is presented in Table 1.3.

1.9 General approach to the assessment

This report presents an analysis of trends and interlinkages between emissions data and state of the environment data. Because of the complexity of the data sets and the number of parameters involved, it was necessary to aggregate the data.

To that end, the analysis implements the following steps:

1. Substances covered by the E-PRTR were grouped into the categories described in Section 1.6.

2. For each pollutant group, direct and indirect releases from industrial facilities were illustrated according to the size of direct releases and indirect releases in 2016 (expressed as mass), and the number of facilities reporting.

3. Based on the above parameters and the completeness of the available data in the E-PRTR, heavy metals, chlorinated organic substances and other organic substances were analysed further

Table 1.3 Data sources

Data source	Year	Geographical scope	Limitations
E-PRTR	2007-2016	EU-28, Iceland, Liechtenstein, Norway, Serbia and Switzerland	Data available for plants exceeding capacity (Annex I of E-PRTR Regulation) and pollutant thresholds (Annex II of E-PRTR Regulation) only. Incomplete data for non-EU countries.
BREF documents ([a])	2005-2017	Reference plants across the EU-28 (but data are sometimes also captured from other non-EU countries)	Data collected only for plants exceeding capacity thresholds defined in the IED.
WISE SoW	2017	25 EU Member States (EU-28 except Greece, Ireland and Lithuania)	Different assessment methods used by Member States to determine chemical status affecting status classification and comparability.
UWWTD	2008-2014 (latest data published in 2017)	EU-28, Iceland, Lichtenstein, Norway, Switzerland, Turkey	Incomplete information on UWWTP capacities and loads. Incomplete data for non-EU countries.

Note: ([a]) http://eippcb.jrc.ec.europa.eu/reference in terms of their eco-toxicity. The eco-toxicity of emissions was calculated by combining the 2016 emissions of each substance with a corresponding factor from the USEtox model (version 2.1) ([5]).

4. The eco-toxicity of emissions from industrial activities and UWWTPs was then compared and discussed in the context of data on the quality of EU water bodies.

5. The assessment also considers the potential impact of industrial emissions on UWWTP performance and how this relationship can be identified based on available EU-level data.

In addition, based on the findings of the assessment and the analysis of available relevant data sets, gaps in the data sets were identified that, if filled, would allow for a more complete and thorough analysis of the impacts of industrial waste water emissions on the receiving environment.

Box 1.2 The USEtox model

In this report, 2016 emissions reported in the E-PRTR were multiplied by the USEtox eco-toxicity factors (endpoint eco-toxicity and the characterisation factor 'continental freshwater' for water emissions) sourced from the USEtox model v2.1. The calculated eco-toxicities for individual substances were then added together to obtain total eco-toxicity for each pollutant group and facility. The eco-toxicity results are referred to in this report as 'pressure' or 'eco-toxicity' of emissions.

However, when interpreting the results, the limitations of the applied methodology have to be considered. The USEtox eco-toxicity factors were not available for all individual pollutants for which emission data were reported in the E-PRTR. One of the main limitations of the application of the USEtox eco-toxicity factors in this study has been a lack of appropriate factors for the most common water parameters, such as total suspended solids, chemical oxygen demand, and emissions of inorganic substances, which constitute the largest stream of emissions (by mass) from industry and waste water treatment facilities.

Moreover, the ranking of the pollutants in terms of pressure is very different regarding the mass and the eco-toxicity. For example, the heavy metals group has the smallest emissions contribution in terms of mass; however, the pressure due to this group is very significant in term of eco-toxicity. According to the developers of the USEtox approach, it is not accurate to compare toxicity levels across different pollutant groups. Hence, the analysis is based on the assessment within each individual pollutant group.

([5]) At the time of writing this report version 2.1. was the latest version available, although it is expected to evolve further in the future.

2 Pressures from industry on Europe's treatment infrastructure and water bodies

This report analyses both direct releases to a water body and indirect releases. The latter refers to transfers of industrial waste water by one given facility to another. In most cases, this transfer occurs via the sewer system and the receiving facility is an urban waste water treatment plant (UWWTP).

This chapter describes the characteristics of direct and indirect releases as reported under the European Pollutant Release and Transfer Register (E-PRTR) and also the evidence available on the potential impacts on receiving water bodies as a result of industrial releases. The assessment of potential impact is complicated by the fact that some industrial effluents receive treatment at an UWWTP before being released to water, and thus the final potential impact of the industrial effluent can be difficult to determine. Through analysis of available data, this chapter looks at key trends in releases in terms of mass emissions, and it also examines the eco-toxic significance of emissions of each of the pollutant groups and how this is changing over time. This chapter also examines the potential to link industrial emission data to the level of treatment applied at the UWWTP and also to the status of corresponding European water bodies.

2.1 The interface between industrial indirect releases and waste water treatment

The collection systems and UWWTPs generally form part of the public infrastructure in Europe. Their design focuses primarily on treating domestic waters and then, as far as possible, they must take into account the challenges that industrial releases present.

The main aspects in which industrial waste water may impact the collection system and the waste water treatment plants are the following:

1. **Capacity issues:** UWWTPs operate according to a designed influent flow and typical concentration values of specific pollutants for such water flows. Industrial waste waters can generate an excess of flow, but this is considered to be uncommon. The fraction of the effluent mass loading to an UWWTP originating from industry will vary significantly across UWWTPs and there can be local scenarios, e.g. an UWWTP in a highly industrialised area, which result in the majority of the influent mass loading being related to industrial emissions.

2. **Integrity and operational issues:** Industrial waste water can hamper the integrity of the collection system by reducing its lifespan (e.g. by corrosion, acids and alkalis) and by causing clogging of the sewer pipes. Industrial waste water can also impact the mechanical elements of the treatment plant.

   In addition, industrial effluent can affect the performance of the plants by hindering their biological functioning, particularly in cases where the UWWTP was not designed to accept particular types of industrial effluent and/or where the characteristics of industrial effluents change over time. Toxicity, a higher nutrient content and a higher concentration of organic matter can induce changes in the balance of bacteria in various steps of the treatment.

3. **Treatment-level issues:** UWWTPs are normally designed to cope with a content of organic matter and nutrients typical of domestic effluents. The biological steps of the treatment may not be efficient in dealing with other pollutants such as heavy metals or anthropogenic organic substances, resulting in these pollutants being present in the discharge from the UWWTP or being transferred to sludge. For the UWWTP to be able to cope with effluents that differ from domestic ones, additional techniques and steps must be applied that are not always technically or economically feasible.

4. **Sustainability issues:** UWWTPs generate greenhouse gases (GHGs) both directly as a result of the biological processes and indirectly as an energy-intensive installation. UWWTPs are also of relevance with regard to circular economy initiatives (e.g. sludge reuse, water reuse, energy reuse).

   The generation of industrial waste water can be a factor that hampers sustainability by both increasing the GHG generation and diminishing the possibility for the reuse of water or sludge (e.g. heavy metal-induced toxicity in the sludge).

2.1.1 Pressures from industry on the capacity of urban waste water treatment plants

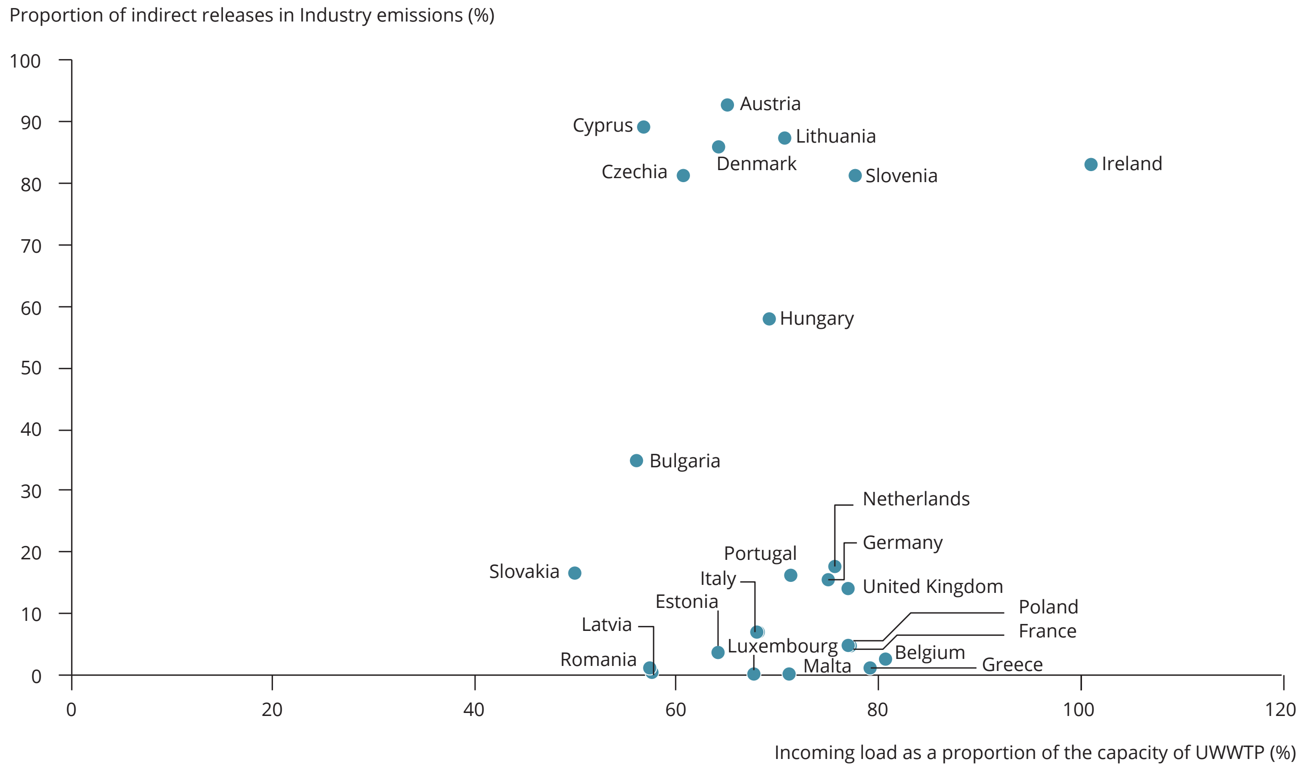
UWWTPs in all Member States operate at loads of 50 % or more of their capacity as shown in Figure 2.1 (Member States for which data were available). Only for plants in Ireland does the sum of the incoming loads exceed the total capacity of the UWWTPs. In Belgium, France, Germany, Greece, the Netherlands, Poland, Slovenia and the United Kingdom, the total incoming loads to the waste water treatment plants constitute more than 75 % of the design capacity. The clustering of Member States does not suggest a clear relationship between the proportion of transfer and capacity: all Member States, except Ireland, operate at between 50 and 80 % of their UWWTP capacity whether or not the transfer of industrial waste water is significant.

In addition to the incoming load to UWWTPs, the Urban Waste Water Treatment Directive (UWWTD) database also provides the load generated by the agglomerations, which is, on average, 82 % of the total capacity (without Spain and Finland, for which data are inaccurate or missing). This shows that domestic effluents are generally the main part of the incoming load to the UWWTPs.

It can be concluded that only a few Member States currently face capacity issues and that for the majority there is some spare capacity to accommodate population and/or industrial growth.

However, according to the data reported under the UWWTD, the analysis at the individual plant level suggests that there are more than 3 000 UWWTPs that could be inadequately sized (the reported entering load is above the capacity of the plant) and thus are likely to face difficulties in processing the waste water streams they are receiving. In the largest UWWTPs (above 100 000 population equivalent, p.e.) exceedances are

Figure 2.1 Load to and capacity of UWWTPs and indirect releases, national totals, 2014



Notes: For Finland no data are available on the capacity of UWWTPs; for Sweden and Croatia no information is available on the incoming loads to UWWTPs. Outliers make data from Spain unusable.

Source: EEA, 2016b.

less common than in medium-sized plants (capacity between 10 000 p.e. and 100 000 p.e.). The largest number of plants with capacity exceedances across Europe is in the smaller plant size category, with capacity lower than 10 000 p.e. However, for around one quarter of plants in this size category, the load exceeds the capacity by less than 10 % ([6]).

While industrial indirect releases may not necessarily be a significant capacity challenge for UWWTPs, they can contribute to these problems when combined with urban waste water and storm water. A common issue faced by UWWTPs relates to capacity overloads during storm events (Qasim, 2017). This problem derives from the fact that many urban areas have combined sewer systems that handle sanitary, industrial and storm water flows together (Qasim, 2017). Besides the increase in load quantity, the effluent entering the UWWTPs during storms has initially higher pollutant concentrations that are then diluted. Some pollutants that are likely to increase in concentration during storm events include heavy metals (Färm, 2002), nitrogen and phosphorus (Rycewicz-Borecki, 2015). Since UWWTPs are unable to deal with the increased load, some of the effluent is released untreated into receiving waters (Qasim, 2017) despite its potentially higher pollutant content.

2.1.2 *Pressures from industry on the performance requirements for waste water treatment*

There are different options for treatment depending on the specific characteristics of the waste water effluent. Table 2.1 gives an idea of the treatment needed to remove each pollutant group.

Some industrial activities transfer a larger share of waste water effluent to UWWTPs than others (e.g. food and drink, and chemicals). The Industrial Emissions Directive (IED) (and associated BREFs) focuses primarily on direct releases to water bodies and only one BREF (tanneries) sets specific BAT-AELs on transfers (indirect releases) from industry to UWWTPs. Notwithstanding

Table 2.1 Treatment required per pollutant group regarding industrial waste water

Pollutant group	Common monitoring parameters	Treatment techniques required to remove pollutants from waste water	Industrial sector emitting high concentration of these pollutants
Other organic substances	COD, TOC	If biodegradable: secondary treatment such as activated sludge treatment, membrane bioreactor or biological trickling filters. If recalcitrant: complex treatment (tertiary) such as ozone, oxidation, etc.	Most industrial sectors e.g. pulp, paper and wood, food and drink
Chlorinated organic substances	AOX	Secondary treatment such as activated sludge treatment, membrane bioreactor or biological trickling filters. Specific treatment options are highly dependent on compound nature, e.g. extraction, oxidation, etc.	Chemicals, pulp, paper and wood
Heavy metals	Hg, Ni, Zn, Cu, Cd	Tertiary treatment such as chemical precipitation, advanced oxidation or coagulation (electrocoagulation), filtration.	Non-ferrous metals, Glass manufacturing, tanneries
Inorganic	TN, TP	Tertiary treatment such as nitrification/denitrification, chemical precipitation (TP).	Energy supply, iron and steel, chemicals

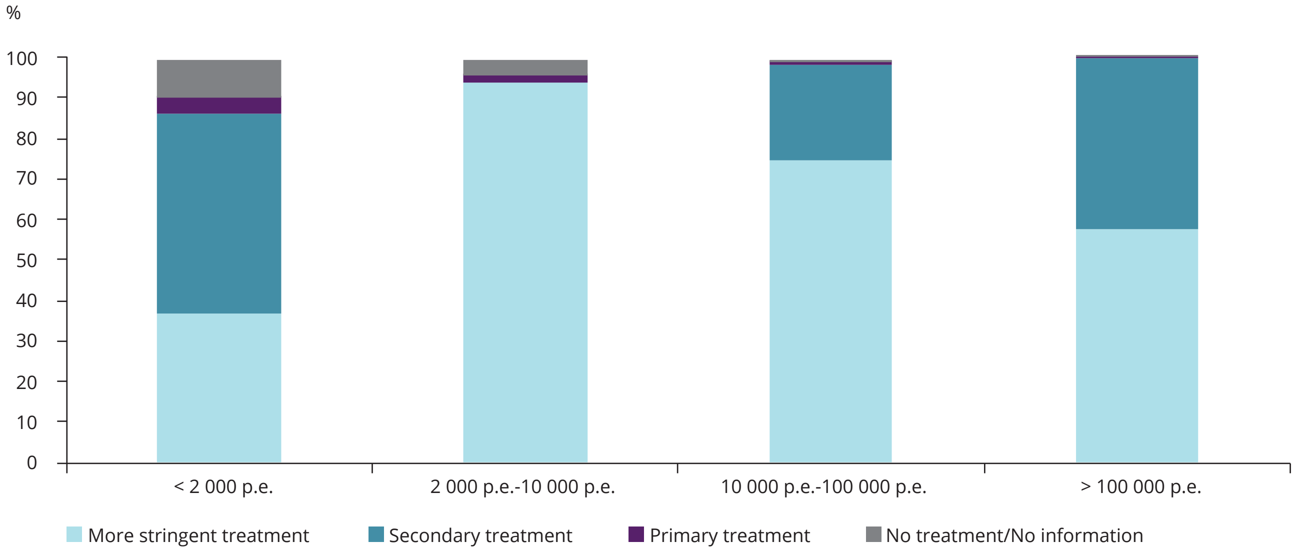
Notes: TOC and COD are used to express organic content.

TOC, total organic carbon; COD, chemical oxygen demand; AOX, adsorbable organically bound halogens (halogenated organic compounds); TN, total nitrogen; TP, total phosphorus.

Source: Based on various best available techniques reference documents (BREFs) 2010-2018.

([6]) Note that 17 % (5 227) of the UWWTPs in the database do not have any entering load and/or capacity data or have data that would require further investigation, which suggests there is a need for data reporting improvements.

Figure 2.2 **Highest level of treatment applied in UWWTPs in the EU-28, disaggregated by plant capacity, 2014**



Source: EEA, 2016b.

the provisions in Article 15(1) of the IED, there may be benefit in future BREFs giving more consideration to indirect releases.

Figure 2.2 presents the overview of the treatment available at waste water treatment plants in the EU depending on the plant capacity. It shows that every category of UWWTP offers some capacity for 'more stringent' treatment; however there remains a sizeable fraction of plants that have only secondary treatment in place. Without specific information on which UWWTPs are receiving industrial emissions, it is not possible to comment on the suitability of plants for accepting industrial effluent loads.

The design of UWWTPs is based on common characteristics of waste water from the domestic, commercial and services sectors. Industrial indirect releases impose pressures on UWWTPs when these streams have compositions different from those of domestic waste waters, which comprise primarily nitrogen, phosphorus, chlorides and other organic content. Transfer from industry may require different and specific treatments, leading to lower performance of the existing waste water treatment techniques (and thus larger releases from UWWTPs) and/or higher operational or investment costs required for these assets. That is why many countries have implemented a system of discharge permits. Some of the pollutants present in industrial transfers may require treatment different from those commonly present at UWWTPs (Annex 2).

The type of pressures that these transfers generate will depend on the waste water characteristics (as explained in Section 1.5). Some industrial transfers will generate limited impacts on UWWTP infrastructure, such as those with mainly organic contents. Other waste water types will place much higher burdens on UWWTPs. For example, acidic waste waters may corrode metal components of the infrastructure if no neutralisation step is available upstream of the plant. Furthermore, toxic compounds may limit the disposal options for the sludge.

2.2 Assessing direct and indirect releases from industry and urban waste water treatment plants

The E-PRTR receives data on releases to water from a range of large industrial activities and from large UWWTPs. In some cases the releases can be indirect, which means that the pollution is released from the site of generation but is then subject to further downstream treatment. Indirect releases are primarily industrial releases (there are generally not indirect releases from UWWTPs). In other cases, waste water releases are directly into a receiving surface water body, referred to as a direct release. Figure 2.3 is a simplified representation of these releases.

Section 2.2.1 provides contextual information on the waste water releases reported to the E-PRTR, including information on the number of reported releases, the magnitude of releases, the breakdown between direct and indirect releases, variations between E-PRTR reporting countries and trends in releases over time.

Section 2.2.2 goes on to provide a more in-depth analysis of the data, particularly in terms of the eco-toxic loading associated with different pollutant groups. This provides an indication of which pollutants present the most significant environmental pressure on receiving water bodies.

Section 2.2.3 includes a review of the pressures on water bodies as reported by Member States and also assesses whether any relationship can be established between direct industrial waste water releases and the status of European water bodies. The variation in effluent treatment levels across Member States is also examined.

2.2.1 Large facilities releasing waste water

Overview of nature and quantity of waste water releases

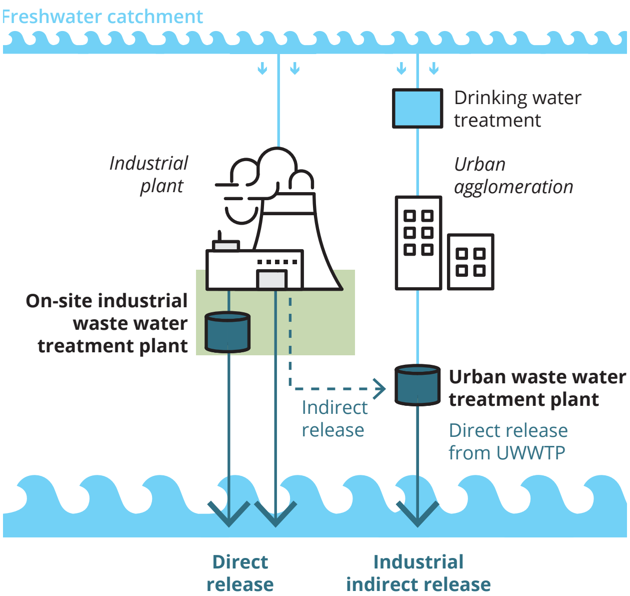
The E-PRTR captures the largest facilities in Europe in terms of their size and emission levels. Facilities are only required to report releases that are above the pollutant threshold values in Annex II of the E-PRTR Regulations (for example the threshold for reporting total nitrogen is 50 000 kg). In 2016, 34 555 facilities reported E-PRTR data; however, this includes data on releases to air, land and water, and also pollutant and waste transfer. Specifically, in relation to direct and indirect releases to water, the reported data can be summarised as follows:

- Only **2 236 facilities reported a direct release to water** for at least one pollutant (1 085 UWWTPs and **1 151 industrial facilities**). Overall there were 11 457 reports of direct releases to water, as some facilities reported a direct release for more than one pollutant.

- Only **1 457 facilities reported an indirect release** to water for at least one pollutant. Overall there were 2 796 reports of indirect releases to water, as some facilities reported an indirect release for more than one pollutant. Practically all facilities that report indirect releases are industrial facilities, with very few UWWTPs.

Figure 2.4 presents summary data for direct and indirect E-PRTR releases for 2016. These data indicate that:

Figure 2.3 Simplified representation of direct and indirect releases to water from industrial plants



Source: EEA.

- Inorganic substances represent **more than 98 % of total direct releases** in mass (including 99 % chlorides for industry and 90 % for UWWTPs).

- Direct releases of inorganic substances from UWWTPs are over three times greater than indirect releases of this pollutant group. Assuming that typical domestic waste water comprises primarily nitrogen, phosphorus and chlorides and other organic content (total organic carbon, TOC, organic content expressed by biological oxygen demand, BOD, and chemical oxygen demand, COD), it can be concluded that the scale of emissions of inorganic substances from UWWTPs could be primarily driven by **domestic waste waters** rather than by industry.

- The second most prevalent pollutant group is the '**other organic substances**', which account for 2 % of total releases for industrial activities and 8 % for waste water treatment plants. TOC, halogenated organic compounds and benzene are released to the water environment in the largest quantities in this group. The total mass of releases of chlorinated organic substances and heavy metals is relatively small in comparison.

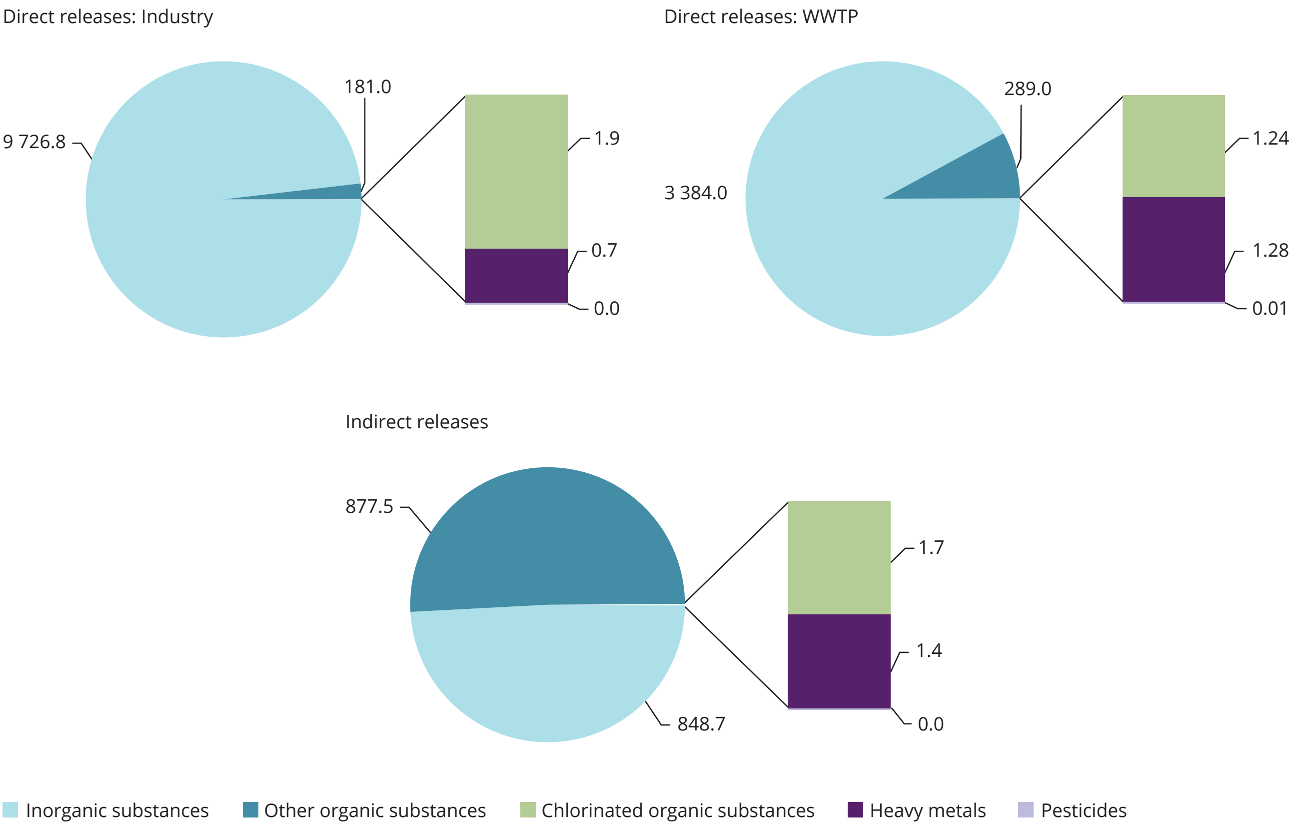
The largest quantities transferred from industrial activities to UWWTPs are for TOC (other organic substances: 51 %) and chlorides (inorganic substances : 47 %). The other pollutants (transferred in quantities greater than 0.1 % of the total indirect releases) are nitrogen, phosphorus, phenols, halogenated organic compounds and fluorides. We can observe a **similar ranking of these substances in the direct releases** from industrial activities and UWWTPs.

Figure 2.5 shows the quantities of direct and indirect releases for each pollutant group.

Figure 2.5 indicates that the nature of the reported emissions also varies across the different pollutant groups, as discussed below:

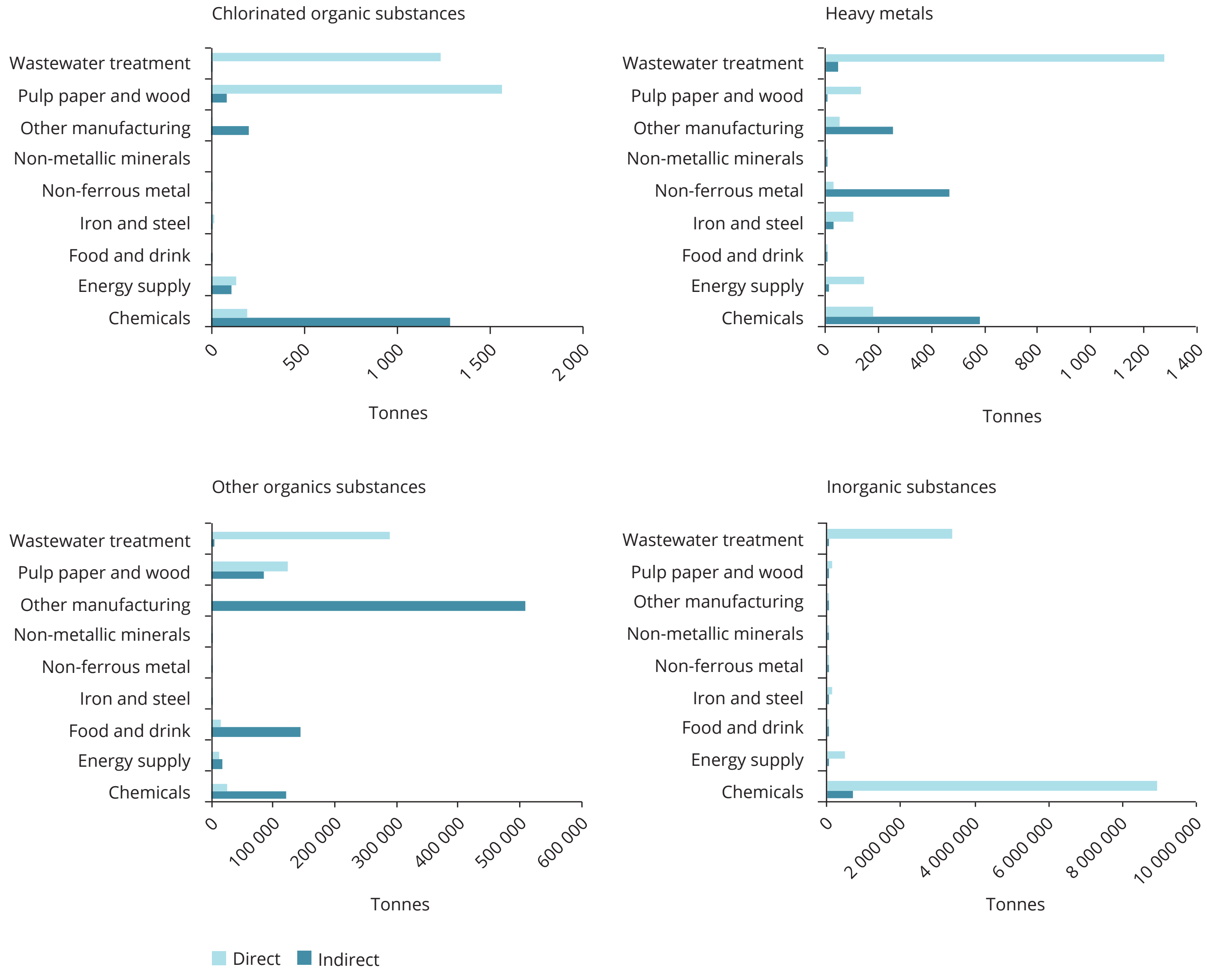
- Inorganic substances: The inorganic substances pollutant group represents more than 90 % of total reported direct releases, by mass. There are relatively smaller but still important reported quantities of indirect releases of inorganic substances. Overall releases of inorganic substances are dominated by direct releases from the chemical and waste water treatment sector.
- Other organic substances: The biggest releases are indirect releases from the other manufacturing sector (including textiles, surface coating/treatment and tanning industries), while food and drink, and chemicals also have significant indirect releases. The main direct releases are from the waste water treatment and pulp, paper and wood sectors.
- Heavy metals: Heavy metals account for a small percentage of reported total releases, by mass, but the toxicity of some of these substances means that their potential impact can still be significant. Direct releases are dominated by those from UWWTPs, while the primary sources of indirect releases are the chemicals, non-ferrous metals and other manufacturing sectors.
- Chlorinated organic substances: The relative reported emissions of this pollutant group are small compared with inorganic substances and other organics. Direct releases are dominated by the waste water and pulp, paper and wood sectors. The chemical sector is the primary source of indirect releases.

Figure 2.4 Emissions from European industrial facilities and UWWTPs in 2016, by pollutant group (kilotonnes)



Source: EEA, 2018b.

Figure 2.5 Overview of quantities of direct and indirect releases by sector and pollutant group for 2016



Source: EEA, 2018b.

Indirect releases are expected to be discharged into a sewer system and receive treatment at an UWWTP. In theory it should therefore be possible to link reported indirect releases and UWWTP releases of the same compound; however this is not possible in practice because only plants with a capacity above 100 000 p.e. report releases under the E-PRTR. In addition, the E-PRTR does not collect information on the nature of the receiving waste water treatment plant for indirect releases, e.g. the level of treatment, the capacity of the plant or the overall input of effluent from industry. Because of this, no direct relationship can be assumed between E-PRTR reported indirect releases and direct releases from UWWTPs.

Figure 2.6 illustrates the variation by sector between direct and indirect releases, in terms of the number of reported releases by sector. The pulp, paper and wood, energy, iron and steel, and non-ferrous metal sectors report mostly direct releases. These releases would therefore be directly regulated and controlled through the implementation of the IED in each Member State. This includes applying best available techniques (BATs) to minimise direct releases of relevant pollutants for each sector.

In contrast, chemicals, food and drink, and other manufacturing report a high proportion of indirect releases. The food and drink sector releases mostly organic substances but also significant quantities of other organic substances. Other manufacturing activities report releases of pollutant groups such as other organics and heavy metals, which could potentially present difficulties to typical UWWTP infrastructure in terms of effective pollutant removal. The chemical sector also reports a significant number of indirect releases and this includes substantial reported releases of heavy metals and chlorinated organic substances, which can again present difficulties if the receiving UWWTP is not optimised for their treatment.

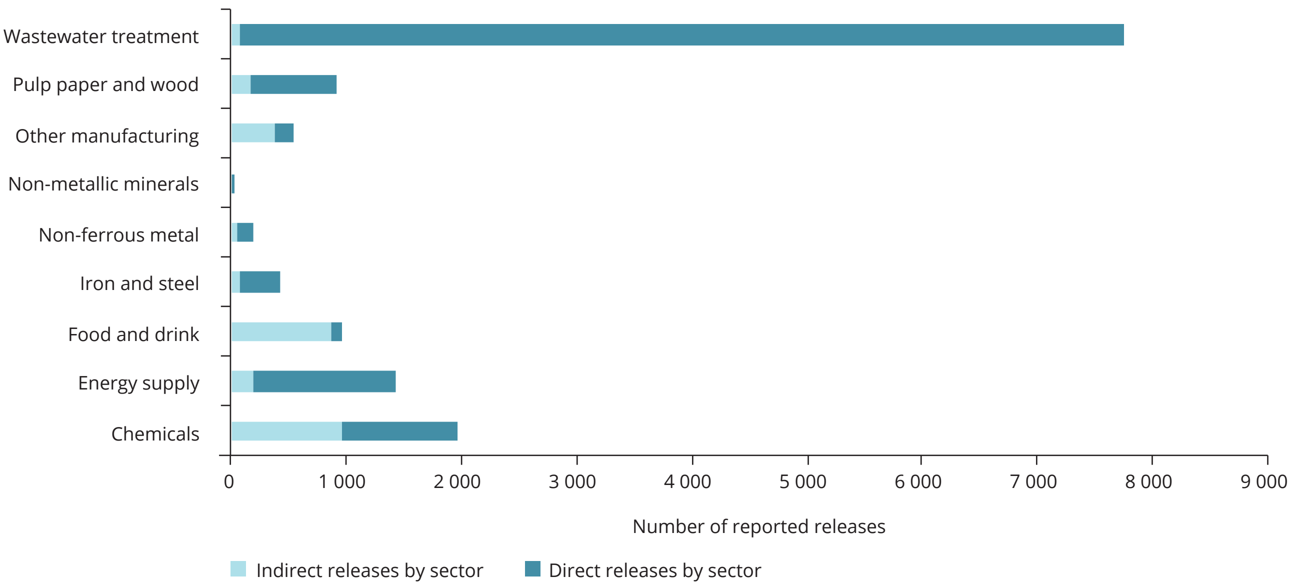
Across EU Member States there is a variation in the proportion of industrial releases that are direct/indirect. This is illustrated in Figure 2.7, which shows a significant divergence in the proportion of indirect releases between countries. For example, in Germany, approximately 15 % of the mass of industrial releases are reported as indirect releases, with similar low indirect release masses reported for countries such as Italy, France, Poland, Spain and Belgium. Conversely, other countries such as Austria, Ireland, Denmark, Slovenia and Lithuania report more than 80 % of the mass of industrial waste water releases as indirect releases.

These proportions are influenced to some extent by the relatively small number of facilities reporting releases to water under the E-PRTR. For example, Denmark has only 23 facilities reporting direct releases and 35 facilities reporting indirect releases under the E-PRTR, while the corresponding figures for Slovenia are eight and seven, respectively. Owing to the reporting thresholds imposed by the E-PRTR Regulations, the data gathered on releases to water represent data from a small number of relatively large emitters.

The data presented in Figure 2.7 are also influenced by the fact that releases of inorganic substances tend to be the largest releases by mass. This can result in national variations in direct and indirect releases within each pollutant group being concealed by the releases of inorganic substances.

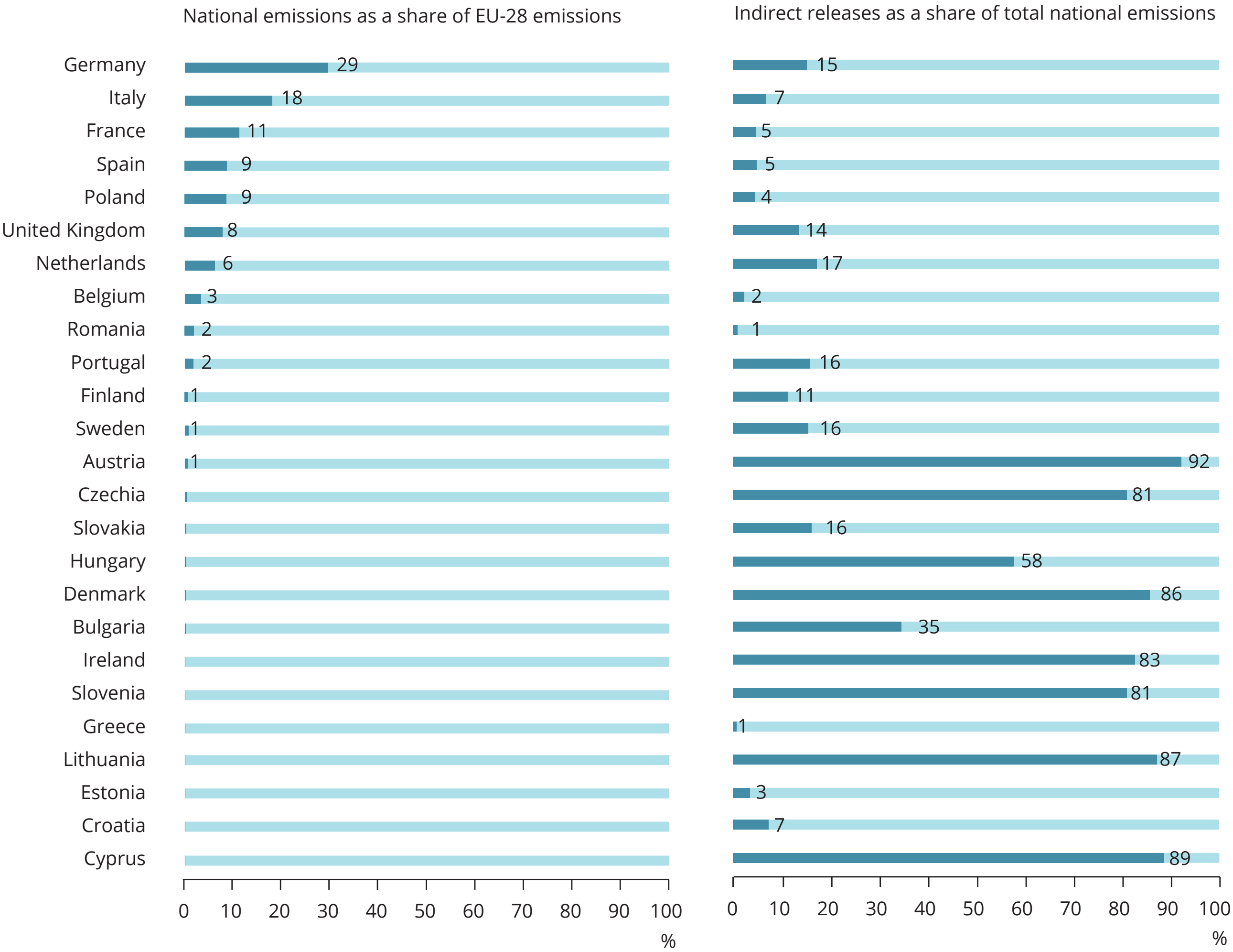
For comparison, the percentages (by mass) of indirect releases by pollutant group for each country are presented in Figure 2.8. This shows, for example, that most countries have a high percentage of indirect industrial releases for other organic substances and a slightly lower percentage for heavy metals. The figure also shows that for most countries, releases of industrial inorganic substances are direct releases. Variations across pollutant groups are also obvious within some countries, for example Spain has a higher percentage of indirect releases for other organics than for heavy metals and chlorinated organics. In Figure 2.7 the percentage of total industrial indirect releases is low (~6 %) for Germany; however, Figure 2.8 shows that indirect releases are significant for chlorinated organics, other organics and heavy metals, and hence the overall indirect release reported in Figure 2.7 is influenced mainly by a large reported mass of industrial inorganic emissions.

Figure 2.6 Number of reported direct and indirect releases by sector, 2016



Source: EEA, 2018b.

Figure 2.7 Proportion of industrial indirect releases by country and overall country contribution to the EU total releases (2008-2016), expressed as mass (data exclude UWWTPs)



Notes: Latvia, Luxembourg and Malta are excluded because of a lack of reported data. The term emission is used to designate the total amount of pollutants released directly and indirectly. The values below 1% are not indicated in the graph.

Source: EEA, 2018b.

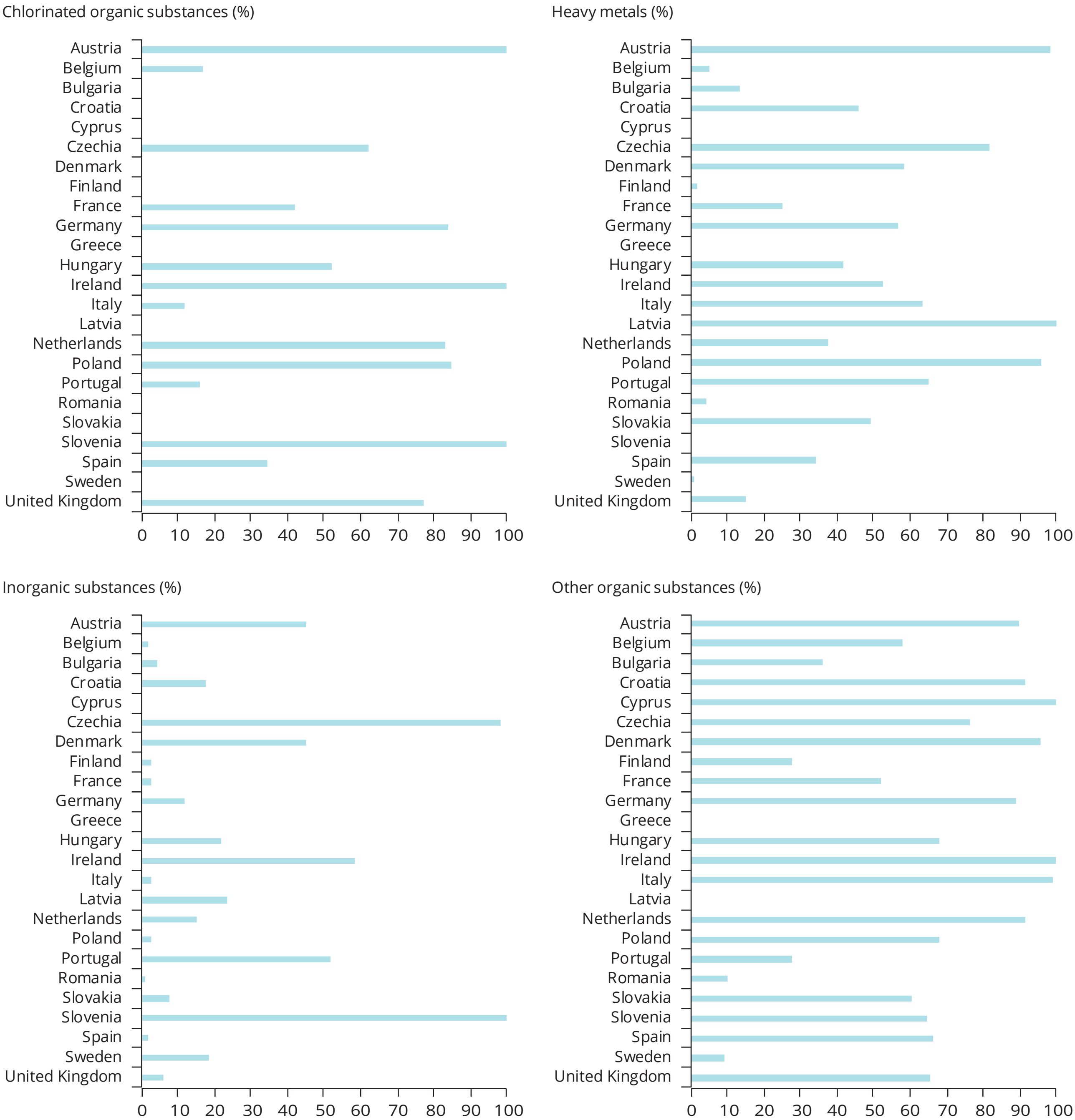
Trends in annual waste water emissions quantities and characteristics

Figure 2.9 presents trends in emissions to water (direct and indirect releases) from industrial activities and UWWTPs, by mass. Figure 2.10 presents the percentage of emissions of each pollutant group associated with direct, indirect and UWWTP releases in the years 2008 and 2016. Because of some uncertainties about the quality and completeness of the indirect release data in the E-PRTR, the results presented should be interpreted with caution. Further analyses of these data are provided below.

Direct releases from industry: For direct releases from industry, the underlying trend for most pollutant groups is downwards. Reported releases of heavy metals are decreasing steadily. The scale of this apparent reduction may be enhanced by releases from some facilities dropping below the reporting threshold. For example, the reporting threshold for nickel releases to water is 20 kg. Therefore, if a facility reported a release of 23 kg one year, and the following year the release decreased to 18 kg, this second release would not be reported at all. Direct releases of chlorinated and other organics are also decreasing, with the exception of a spike in emissions in 2015, which may be related to incorrect data being reported. The trend for direct releases of inorganics is relatively consistent from 2011 onwards, though there were reductions in reported releases in 2015/2016.

Reductions in direct releases are also likely to be influenced by the fact that, as shown in Figure 2.10,

Figure 2.8 Percentage (by mass) of industrial emissions reported as indirect releases per country, 2016



Source: EEA, 2018b.

the percentage of overall releases reported as direct releases decreased between 2008 and 2016.

Indirect releases from industry: Trends in reported emissions are more variable for indirect releases, particularly for other organic substances, potentially related to outliers in reported data. Indirect releases of heavy metals show an underlying downward emission trend, with emissions of chlorinated and other organics being relatively consistent from 2010 to 2016. However, variations in year-to-year data are also likely to be influenced by operational changes at facilities that result in waste water releases being diverted for further treatment at UWWTPs (i.e. indirect releases) rather than being directly released. Figure 2.10 indicates that the percentage of releases reported as indirect has increased between 2008 and 2016, particularly for chlorinated organics, other organics and inorganics.

Direct releases from UWWTPs: UWWTP release trends are consistently downwards for other organics, with an overall downward trend for heavy metals, although there is some variability between reporting years. Reported releases of inorganic substances from UWWTPs increased between 2008 and 2016. This could be related to increased indirect releases of inorganics (see Figure 2.9), leading to greater loading of UWWTPs. In addition, the number of reported releases of inorganics from UWWTPs increased marginally from 2 249 to 2 315 over the period 2008-2016. Releases of chlorinated organic substances have a high level of variability from year to year, but total annual releases are now greater than in 2008. Increased indirect releases from industry (see Figure 2.9) may also be influencing UWWTP releases of chlorinated organics.

2.2.2 Analysis of reported substance releases

While the mass emissions of pollutant releases to water are generally dominated by the inorganic substances pollutant group, the use of the total mass of emissions is not always a good indicator of the environmental significance of a pollutant or group of pollutants. This section of the report first analyses the contribution of different activity sectors to the mass emissions of each pollutant group. It then provides an overview of how industrial (direct and indirect) and UWWTP releases contribute to the overall eco-toxic loading for each pollutant group.

Analysis of emissions by mass and by eco-toxicity

Figure 2.11 illustrates the relative contribution in mass of different activities to direct releases of waste water as reported under the E-PRTR.

UWWTPs contribute more than 50 % of total mass emissions of other organic substances but also of heavy metals declared in the E-PRTR. These may originate from the transfer of emissions from industrial facilities but also from municipal waste water and surface run-off. Conversely, industrial sources are the main contributor for both chlorinated organic substances (pulp, paper and wood mainly) and inorganic substances (chemicals mainly).

A number of different industrial activities contribute to emissions of heavy metals, with the majority of industrial releases originating from metal processing facilities (iron and steel, and non-ferrous metals production).

Figure 2.12 illustrates the relative contribution in mass of different activities to indirect releases of waste water as reported under the E-PRTR. This shows that a limited number of industrial sectors (chemicals, food and drink, non-ferrous metals, and pulp, paper and wood) are responsible for the majority of indirect releases. Chemical manufacturing is the main contributor to

Figure 2.9 Trends in water emissions between 2008 and 2016 (indexed, 2008 = 1) in the EU-28

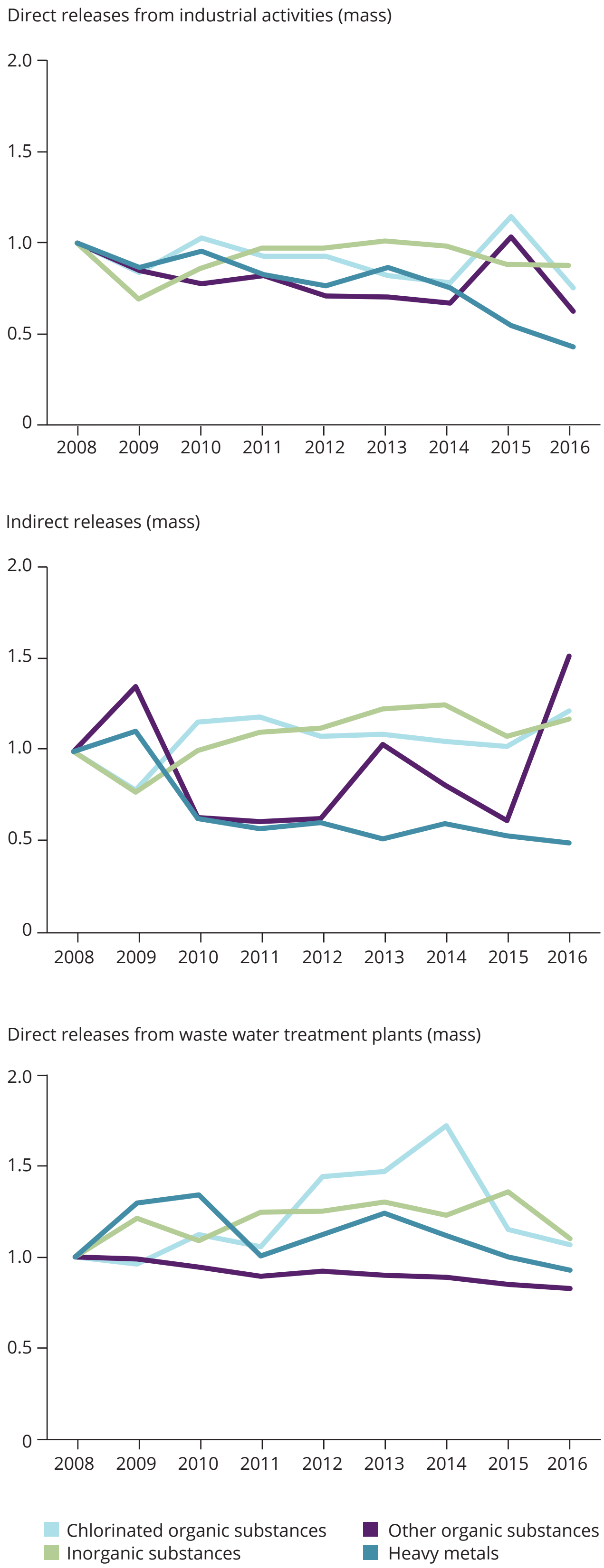
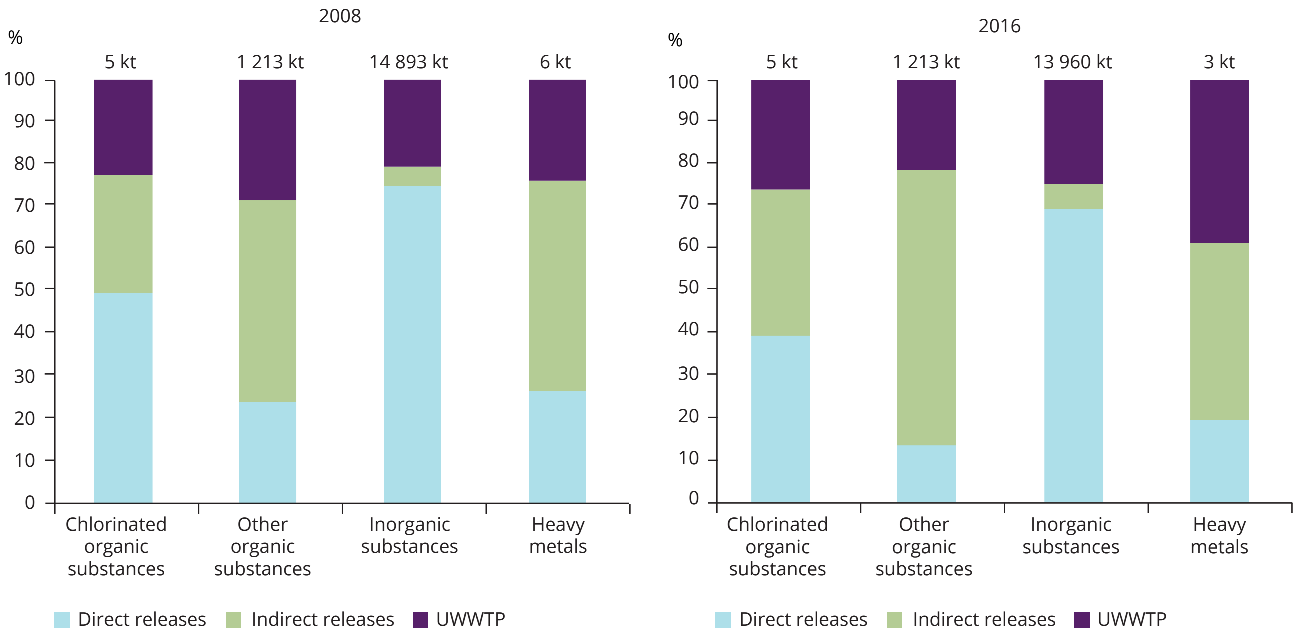


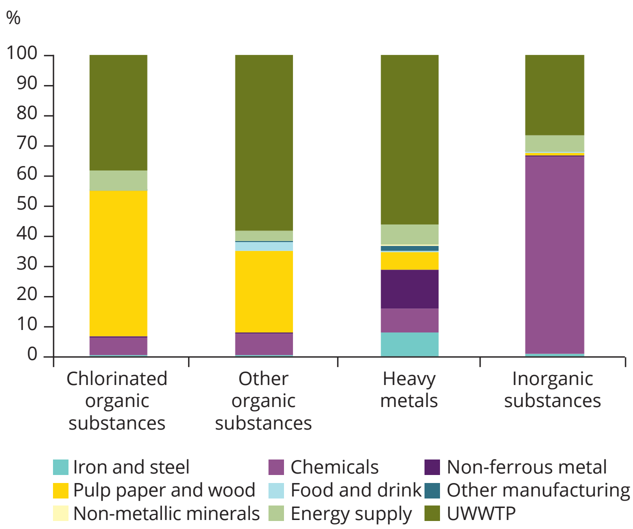
Figure 2.10 Share of reported emissions to water per pollutant group for 2008 and for 2016 (mass) in the EU-28



Notes: For chlorinated organic substances, two outliers have been removed from the data: emissions of pentachlorophenol (PCP) and polychlorinated biphenyls (PCBs) from facility ID 2329861 (Italy — Italiana Energia e Servizi S.p.A.).

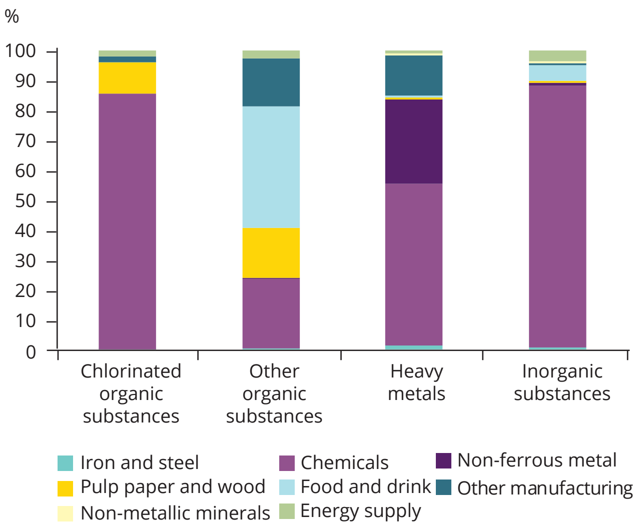
Source: EEA, 2018b.

Figure 2.11 Direct releases by sector and sub-sector, expressed as percentages of total mass emissions, between 2008 and 2016



Source: EEA, 2018b.

Figure 2.12 Indirect releases by sector and sub-sector, expressed as mass emissions, between 2008 and 2016



Source: EEA, 2018b.

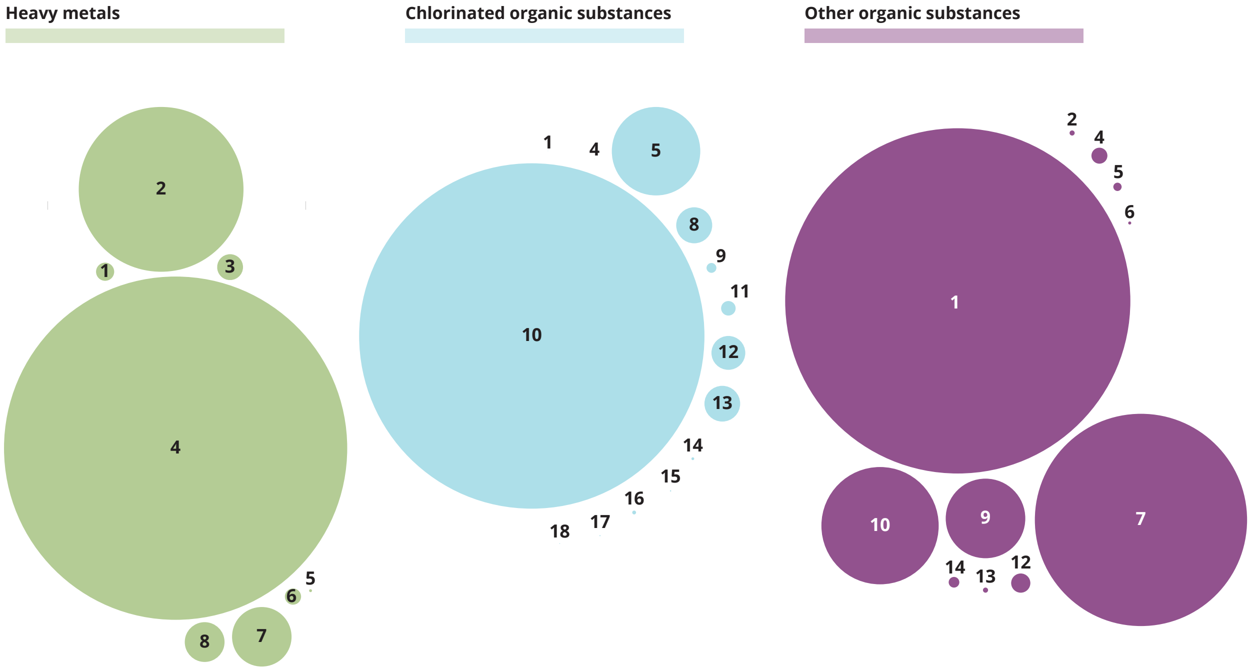
indirect releases of chlorinated organic substances, heavy metals and inorganic substances. The food and drink sector is responsible for a large share of indirect releases of total other organic substances but has not been identified as a large direct emitter of these substances, as illustrated in Figure 2.11. The other manufacturing sub-sector transfers other organic substances and heavy metals for off-site treatment and this sector generally reports greater indirect releases than direct.

In terms of eco-toxicity, the pressures associated with different pollutant groups are significantly influenced by a small number of higher toxicity pollutants.

According to the developers of the USEtox approach, it is not accurate to compare toxicity levels across different pollutant groups. Hence, the analysis is based on assessment within each individual pollutant group.

Figure 2.13 illustrates, for each pollutant group, the relative toxicity associated with the key pollutants in each group. For example, within the metals group, copper has the largest toxicity factor, and mass emissions of copper are also relatively significant, hence copper tends to dominate the overall reported toxicity for the metals group.

Figure 2.13 Overview of USEtox toxicity factors per pollutant group for a same mass unit



1 Arsenic and compounds (as As)
2 Cadmium and compounds (as Cd)
3 Chromium and compounds (as Cr)
4 Copper and compounds (as Cu)
5 Lead and compounds (as Pb)
6 Mercury and compounds (as Hg)
7 Nickel and compounds (as Ni)
8 Zinc and compounds (as Zn)

1 1,2-dichloroethane (EDC)
2 Brominated diphenylethers (PBDE)
3 Chloro-alkanes, C10-C13
4 Dichloromethane (DCM)
5 Dieldrin
6 Halogenated Organic Compounds (AOX)
7 Hexabromobifenyl
8 Hexachlorobenzene (HCB)
9 Hexachlorobutadiene (HCBD)
10 PCDD+PCFD (Dioxins+furans) (as Teq)
11 Pentachlorobenzene
12 Pentachlorophenol (PCP)
13 Polychlorinated biphenyls (PCB)
14 Tetrachloroethylene (PER)
15 Tetrachloromethane (TCM)
16 Trichlorobenzenes (TCBs) (all isomers)
17 Trichloroethylene
18 Trichloromethane
19 Vynil chloride

1 Anthracene
2 Benzene
3 Benzo(g,h,i) perylene
4 Di-(2-ethyl hexyl) phthalate (DEHP)
5 Ethyl benzene
6 Ethylene oxide
7 Fluoranthene
8 Naphthalene
9 Nonylphenol and Nonylphenol ethoxylates (NP/NPEs)
10 Octylphenols and octylphenol ethoxylates
11 Organotin compounds (as total Sn)
12 Phenols (as total C)
13 Toluene
14 Xylenes (all isomers)

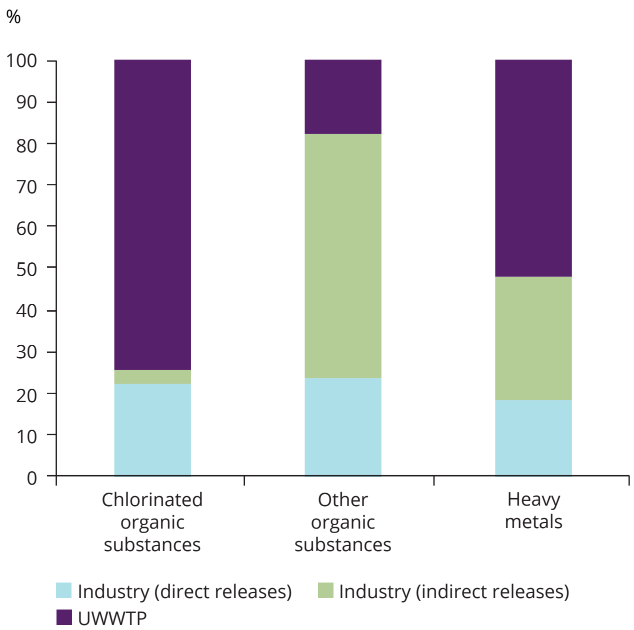
Source: Based on USEtox (2017).

Figure 2.14 illustrates the contribution of industrial and UWWTP releases (direct and indirect) to total emissions in each pollutant group in 2016, expressed as eco-toxicity. It should be noted that USEtox toxicity factors were not available for inorganic substances so they are not presented in the figure. The findings of the following toxicity analysis are limited to the chosen pollutants and to the USEtox toxicity factors available (see Annex 2).

By comparing Figure 2.10 with Figure 2.14 (the share of 2016 emissions per pollutant group, in mass), as summarised in Figure 2.15, it is clear that:

- Only chlorinated organic substances show very significant differences when comparing mass and toxicity loading in terms of the share between industry and UWWTPs. UWWTPs are responsible for about one quarter of the mass releases of chlorinated organic substances. However, the eco-toxic loading from UWWTPs (Figure 2.14) is much higher, at more than 70 %. This indicates that reported UWWTP releases contain a higher proportion of more toxic chlorinated organic substances. This may be due to the contribution of municipal waste waters (possibly as a result of waste water received from non-E-PRTR industrial facilities such as dry cleaners) or to more toxic chlorinated organic substances being sent to UWWTPs by industry than being directly released to water.
- Regarding other organic substances and heavy metals, the ranking regarding the emissions between UWWTPs and industry is similar for mass and toxicity.
- We cannot compare the distribution in mass and in toxicity for inorganic substances (no USEtox eco-toxicity factors are available).

Figure 2.14 Total emissions to water per pollutant group, expressed as eco-toxicity, 2016



Notes: For chlorinated organic substances, two outliers have been removed from the data: emissions of pentachlorophenol (PCP) and polychlorinated biphenyls (PCBs) from facility ID 2329861 (Italy — Italiana Energia e Servizi S.p.A.).

Sources: EEA, 2018b; USEtox, 2017.

Importantly, the toxicity assigned to indirect releases cannot be considered a direct pressure on water bodies, as these indirect releases will receive treatment in a waste water treatment plant, hence the final eco-toxic loading on the receiving water body will be lower. The use of eco-toxic values allows the aggregation of different substance releases into a single parameter, the main objective of applying this approach.

Further analysis of the eco-toxic pressure associated with each individual pollutant group is presented in the following section of the report. This provides a breakdown of which industrial activities are contributing to the toxic loading associated with each pollutant group.

Analysis of pressures from selected pollutant groups

Despite the dominance of heavy metals as an environmental pressure in the analysis presented in the above section, the actual pressures will be influenced by geographical and temporal issues as well as the type of local industry and the characteristics of the receiving waters. For that reason, this section provides further analysis of the pressures (expressed as eco-toxicity) from direct and indirect releases of heavy metals, chlorinated organic substances and other organic substances. Analysis of inorganic substances was not conducted because emissions could not be correlated with appropriate USEtox eco-toxicity factors.

Heavy metals

Heavy metals are not easily removed in a standard waste water treatment plant configuration. They require tertiary treatment such as chemical precipitation, oxidation or coagulation techniques. In 2016, 68 % of industrial emissions (1 402 tonnes) of heavy metals reported in the E-PRTR were transferred to UWWTPs.

Figure 2.15 Summary of the main contributing sub-sectors in direct releases for each pollutant group

Mass

	Iron and Steel	Chemicals	Non-ferrous metal	Pulp paper and wood	Food and drink	Other manufacturing	Non-metallic minerals	Energy supply	UWWTP
Heavy metals	+	+		+				+	+++
Chlorinated organic substances		+		+++					++
Other organic substances		+		++					+++
Inorganic substances		+++							++

	< 5%
+	5-20%
++	20-40%
+++	40-70%
++++	> 70%

Ecotoxicity

	Iron and Steel	Chemicals	Non-ferrous metal	Pulp paper and wood	Food and drink	Other manufacturing	Non-metallic minerals	Energy supply	UWWTP
Heavy metals		+		+				+	++++
Chlorinated organic substances		+							++++
Other organic substances								+++	+++

	< 5%
+	5-20%
++	20-40%
+++	40-70%
++++	> 70%

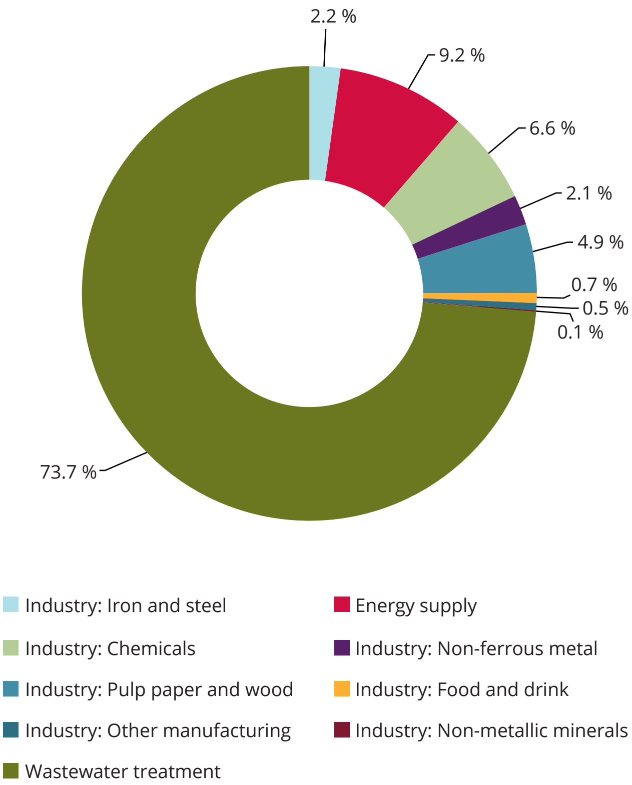
Sources: Based on EEA (2018b) and USEtox (2017).

The UWWTPs, which also receive some input from municipal waste water, released 1 276 tonnes of heavy metals directly to the environment.

Figure 2.16 illustrates the sectors and sub-sectors with the highest estimated pressure on the water environment from direct releases of heavy metals in terms of eco-toxicity. The dominance of the waste water treatment sector is due to the larger direct releases of most heavy metals, except for mercury and chromium, when compared with the releases from industrial activities. This is because waste water treatment plants receive effluents from industry but also from surface run-off from impervious surfaces (such as roofs and roads) and domestic waste water, which can both be rich in heavy metals. Despite larger direct releases of heavy metals in terms of mass (see Figure 2.11), the estimated environmental pressure of emissions from metal processing industries is lower relative to other industry sub-sectors. That is due to the high emissions of copper from the energy supply sector and the high eco-toxicity of copper in freshwater.

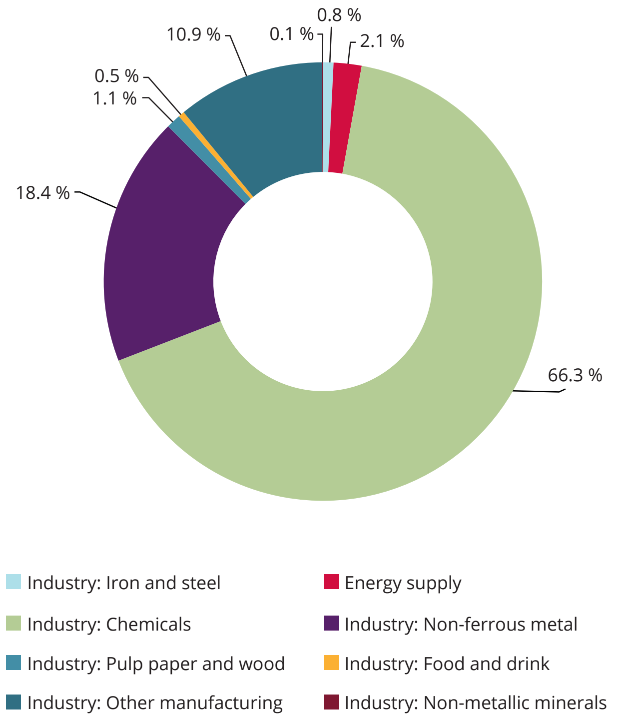
Based on the data reported, the largest industrial contributor of indirect releases of heavy metals is chemicals manufacturing, followed by non-ferrous metal processing and other manufacturing. Among industry, the energy supply sector is one of the highest direct emitters of heavy metals to water but does not appear to transfer much of the load off site for treatment by UWWTPs. The shares of non-ferrous metal and other manufacturing sub-sectors in direct releases of heavy metals are low, yet these sub-sectors are responsible for 18 % and 11 % of indirect releases of heavy metals by industry. This suggests that the transfer of emissions is more common in sectors with a large number of smaller facilities than in sectors with a smaller number of larger facilities.

Figure 2.16 Direct releases of heavy metals by sector and sub-sector, expressed as eco-toxicity, 2016



Sources: Based on data from EEA (2018b) and USEtox (2017).

Figure 2.17 Indirect releases of heavy metals by sector and sub-sector, expressed as eco-toxicity, 2016



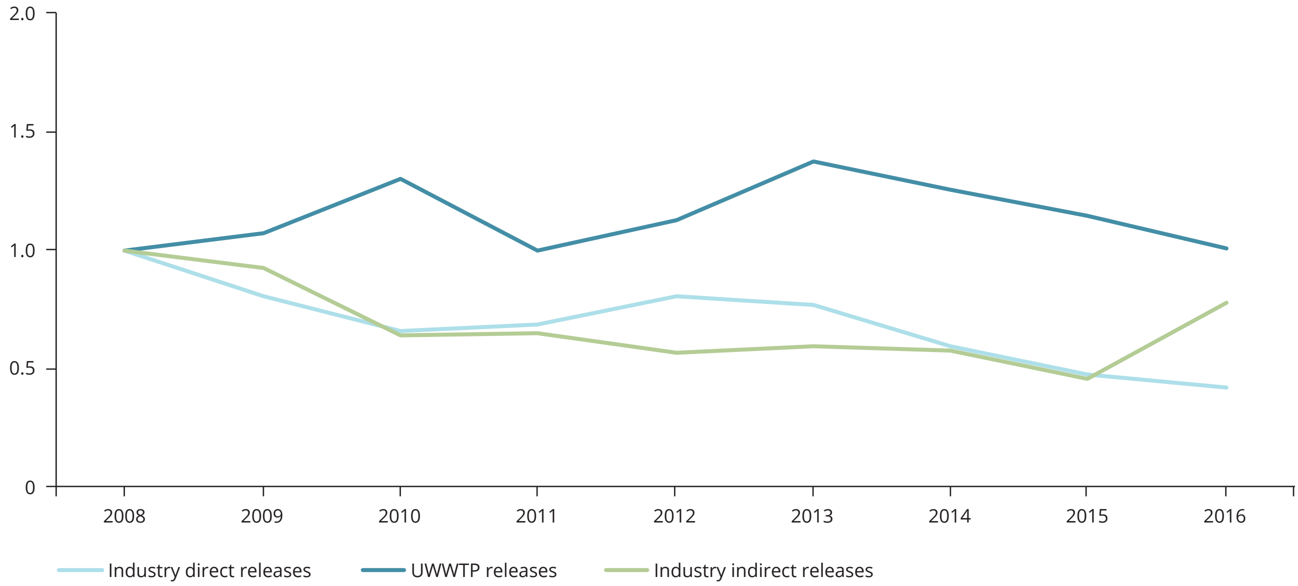
Notes: 61 % of industrial emissions of heavy metals are indirect releases (expressed as ecotoxicity).

Sources: Based on data from EEA (2018b) and USEtox (2017).

The pressure on the environment from industrial activities is greatest where there are large-scale individual chemical or metal manufacturing sites, power plants or clusters of facilities with relatively small emissions, for example the chemical manufacturing plants in western Germany and northern Italy and the power plants in northern Spain and Germany. Furthermore, the pressure of heavy metals from waste water treatment plants is highest near large cities such as London and Birmingham in the United Kingdom, Sofia in Bulgaria, Barcelona in Spain, Munich and Cologne in Germany and Thessaloniki in Greece. Some parts of Europe particularly exposed to pressures from heavy metal emissions generated by both manufacturing and power plants include regions in northern England, western Germany, the Benelux countries, northern Italy and Spain. These pressures may be exacerbated by legacy heavy metal contamination issues and old mining areas.

Figure 2.18 presents trends over time in eco-toxicity associated with emissions of heavy metals from industry. Since 2008, eco-toxicity due to direct releases of heavy metals from industry has decreased, showing a clear downward trend from 2012 to 2016. Pressures from the transfer of heavy metals from industry to UWWTPs has also decreased since 2008, following a downward trend until 2015. However, the trend since 2008 of direct releases to water from UWWTPs is not so clear.

Figure 2.18 Trends over time in emissions of heavy metals from industry and UWWTPs, expressed as eco-toxicity, 2008-2016



Note: Indexed (2008 = 1),

Sources: Based on data from EEA (2018b) and USEtox (2017).

Chlorinated organic substances ([7])

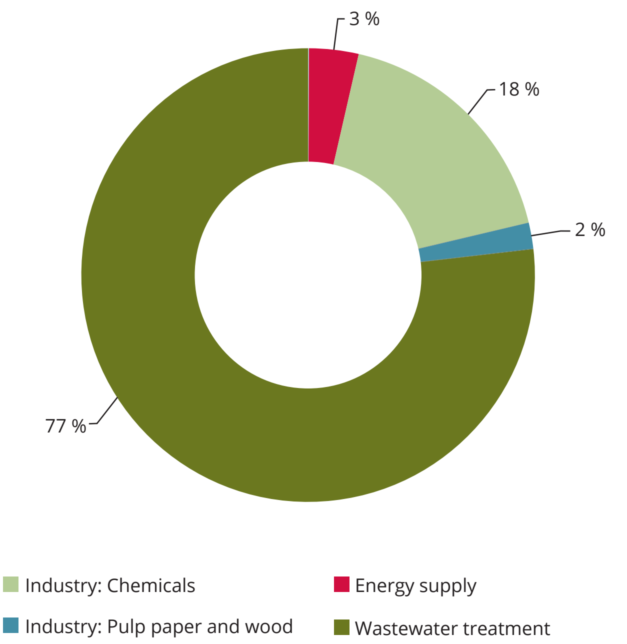
The chlorinated organic substances group comprises 18 individual substances reported in the E-PRTR. The USEtox eco-toxicity factors were not available for six of them ([8]). The choice of techniques to remove these pollutants depends on the nature of the chemical species present in influents: some being removed by standard waste water treatment plant measures but others (recalcitrant) requiring specific techniques such as extraction or oxidation. In 2016, 47 % of emissions from industry (expressed as mass) of **chlorinated organic substances** was transferred off site to be treated by a waste water treatment plant.

As shown in Figure 2.19, the main sector contributing to environmental pressure from this group of pollutants is energy supply (although it represents only a 7 % contribution in direct releases from industry and UWWTPs by mass), followed by waste water treatment and chemicals manufacturing. The substances responsible for the largest share of the environmental pressures in this pollutant group are pentachlorophenol (PCP), polychlorinated biphenyls (PCBs) and hexachlorobutadiene (HCBD). In contrast, the largest eco-toxicity of indirect releases of chlorinated organic substances originates from chemicals manufacturing, followed by pulp, paper and wood, energy supply and other manufacturing.

([7]) Analysis in this section covers: dichloromethane (DCM), 1,2-dichloroethane (DCE), polychlorinated dibenzodioxins (PCDD) + polychlorinated dibenzofuran (PCDF) (dioxins + furans) (as toxic equivalent [Teq]), trichloromethane, tetrachloroethylene (PER), trichloroethylene, trichlorobenzenes (TCBs) (all isomers), pentachlorophenol (PCP), polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), hexachlorobutadiene (HCBD), pentachlorobenzene.

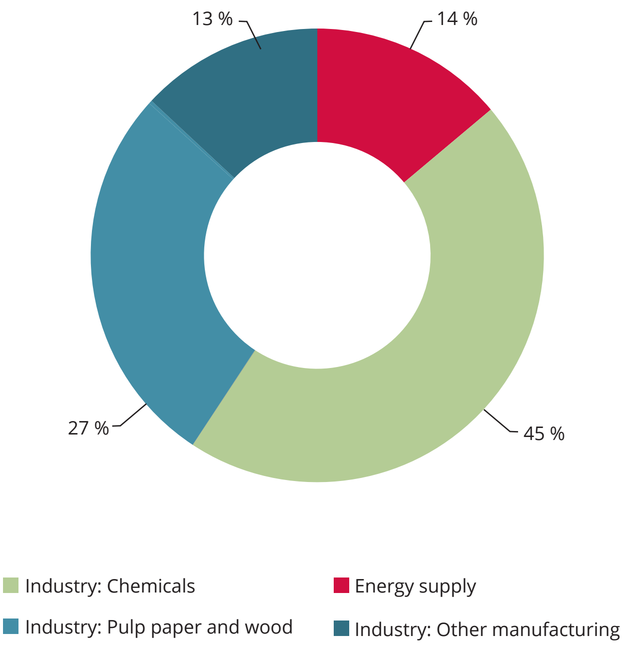
([8]) Brominated diphenylethers (PBDE), chloro-alkanes C10-C13, halogenated organic compounds (as AOX), hexabromobiphenyl, tetrachloromethane (TCM), vinyl chloride.

Figure 2.19 Direct releases of chlorinated organic substances by sector and sub-sector, expressed as eco-toxicity, 2016



Sources: Based on data from EEA (2018b) and USEtox (2017).

Figure 2.20 Indirect releases of chlorinated organic substances by sector and sub-sector, expressed as eco-toxicity, 2016



Note: 12 % of industrial emissions of chlorinated organic substances are indirect releases (expressed as eco-toxicity).

Sources: Based on data from EEA (2018b) and USEtox (2017).

The pressure on the environment associated with industrial emissions of chlorinated organic substances is greatest where there are large-scale refineries or chemical manufacturing plants. Specifically:

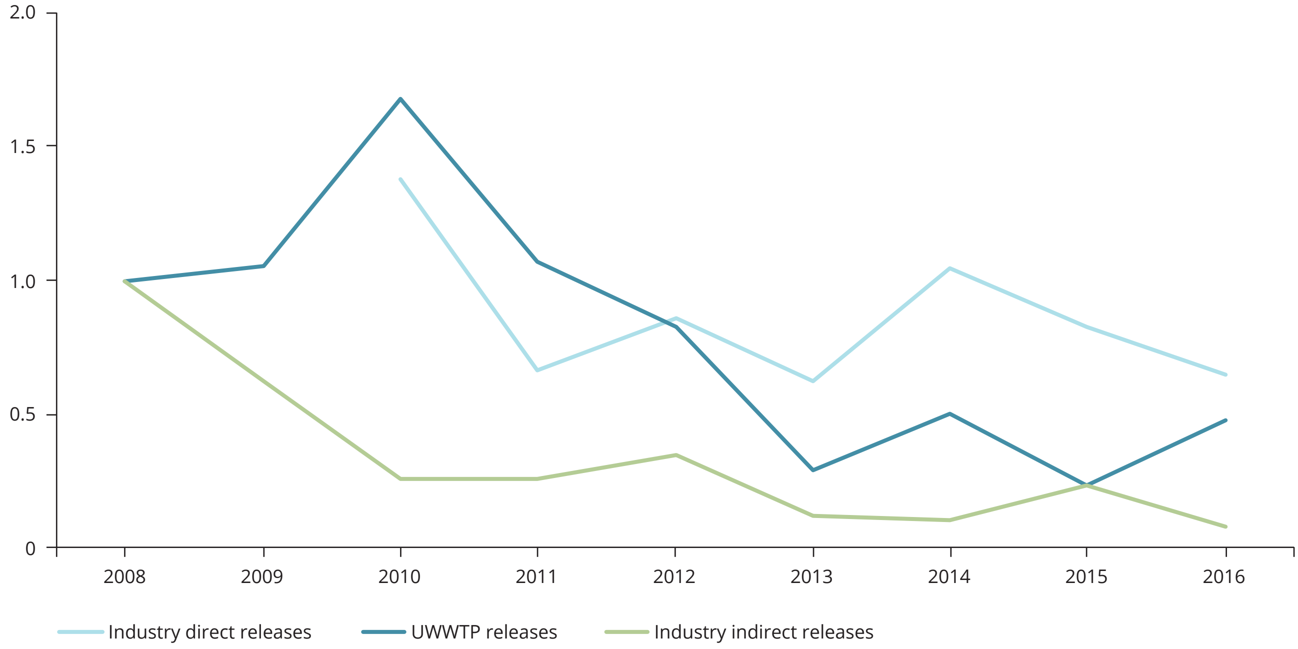
- The largest pressure can be observed in northern Italy. The refinery located in the region of Lombardy reported the largest emissions of PCP and PCBs in 2016 across the EU-28 ([9]).
- The second largest pressure originates from a chemical manufacturing plant in France, which in 2016 reported the highest emissions of HCBD in the EU-28.

The estimated eco-toxicity of chlorinated organic substances emissions from UWWTPs is lower than that from industry. The largest pressure is visible in northern Italy as a result of emissions reported by an UWWTP in the region of Piedmont, followed by three UWWTPs in Germany and one plant in southern Poland.

Figure 2.21 presents trends over time in the environmental pressure of direct releases of chlorinated organic substances from industry and waste water treatment, and indirect releases from industrial facilities. The reported data suggest that for chlorinated organic substances the pressure from UWWTPs has decreased over time, showing a clear downward trend from 2010 to 2015. Pressures from indirect releases from industry also followed a downward trend from 2008 to 2016. However, the pressure from direct releases remained relatively stable between 2008 and 2016.

([9]) The facility reported 333 kg pf PCP and 166 kg of PCBs but neither pollutant was reported by the facility in the previous years. The scale of reported emissions may suggest a data quality issue.

Figure 2.21 Trends over time in emissions of chlorinated organic substances from industry and UWWTPs, expressed as eco-toxicity, 2008-2016



Notes: Indexed (2008 = 1). Outlier values from energy supply and industry in 2009 and 2016 have been removed for presentation purposes.

Sources: Based on data from EEA (2018b) and USEtox (2017).

Other organic substances ([10])

The other organic substances group comprises 16 individual substances reported in the E-PRTR. The eco-toxicity factors were not available for five of them ([11]). In 2016, **83 % of emissions to water (expressed as mass) of other organic substances** was transferred off site for treatment by UWWTPs.

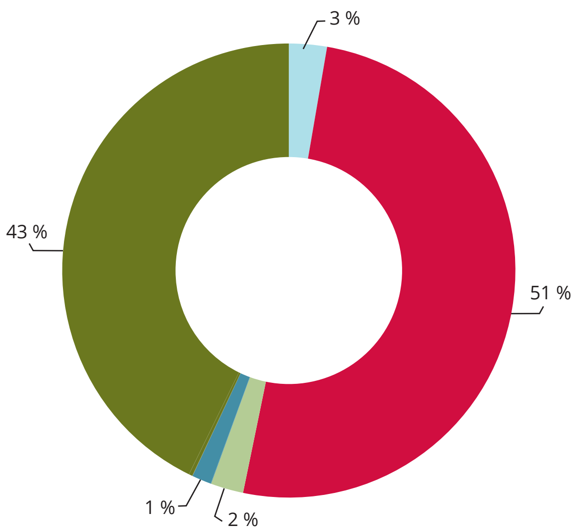
Figures 2.22 and 2.23 highlight sectors and sub-sectors with the highest pressure on the water environment from other organic substances in terms of ecotoxicity, based on the reported data and the USEtox eco-toxicity factors. This shows that **energy supply facilities contribute over half of the eco-toxicity associated with direct releases of other organic substances** (specifically due to emissions of phenols), with the second largest contributor being UWWTPs. Energy supply is also responsible for the largest **indirect releases of other organic substances** (again due to the transfer of phenols). Manufacturing of iron and steel, and chemicals make smaller contributions to the overall environmental pressure of direct and indirect releases. While phenols are also emitted from UWWTPs, most of the environmental pressure in this sector is related to emissions of nonylphenol (NP) and nonylphenol ethoxylates (NPEs).

The largest environmental pressure in terms of eco-toxicity due to industrial emissions of other organic substances is associated with **combustion facilities** on the off-shore platforms in the North Sea. The potential impacts across Europe are located primarily in coastal areas, with multiple hotspots in the United

([10]) The analysis in this section covers: phenols (as total C), nonylphenol and nonylphenol ethoxylates (NP/NPEs), di-(2-ethyl hexyl) phthalate (DEHP), octylphenols and octylphenol ethoxylates, toluene, xylenes, benzene, ethyl benzene, fluoranthene, anthracene, ethylene oxide.

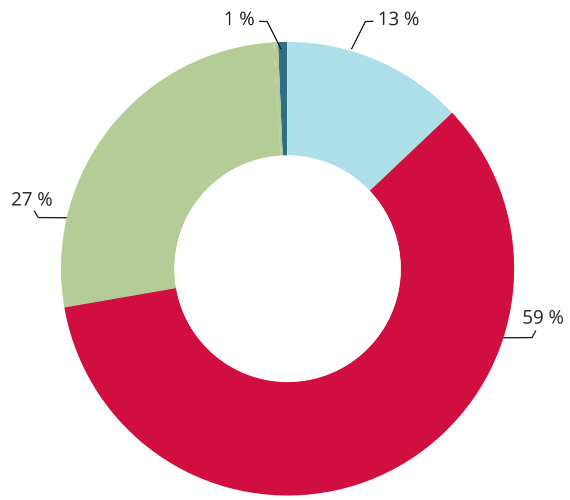
([11]) TOC (as total C or COD/3), polycyclic aromatic hydrocarbons (PAHs), naphthalene, benzo(g,h,i)perylene and organotin compounds (as total Sn).

Figure 2.22 Direct releases of other organic substances by sector and sub-sector, expressed as eco-toxicity, 2016



Sources: Based on data from EEA (2018b) and USEtox (2017).

Figure 2.23 Indirect releases of other organic substances by sector and sub-sector, expressed as eco-toxicity, 2016



Note: 71 % of industrial emissions of other organic substances are indirect releases (expressed as ecotoxicity).

Sources: Data based on EEA (2018b) and USEtox (2017).

Kingdom arising from thermal power stations or other combustion installations, mineral oil and gas refineries, and basic organic and inorganic chemicals production. The environmental pressure of other organic substances is also visible in Mallorca, due to a thermal power plant, and in northern Italy, due to the clustering of chemical manufacturing, refineries and iron and steel facilities. The largest environmental pressure from indirect releases is associated with the operation of coke ovens in Poland and Germany (transfer of phenols) and chemical manufacturing in the Netherlands and Belgium.

For waste water treatment plants, the largest pressure appears to be in northern Italy and this is predominantly associated with emissions of phenols. The high potential pressure in Austria is primarily due to emissions of NP/NPEs and that across the United Kingdom is primarily due to emissions of NP/NPEs but also of di-(2-ethyl hexyl) phthalate (DEHP), fluoranthene and phenols.

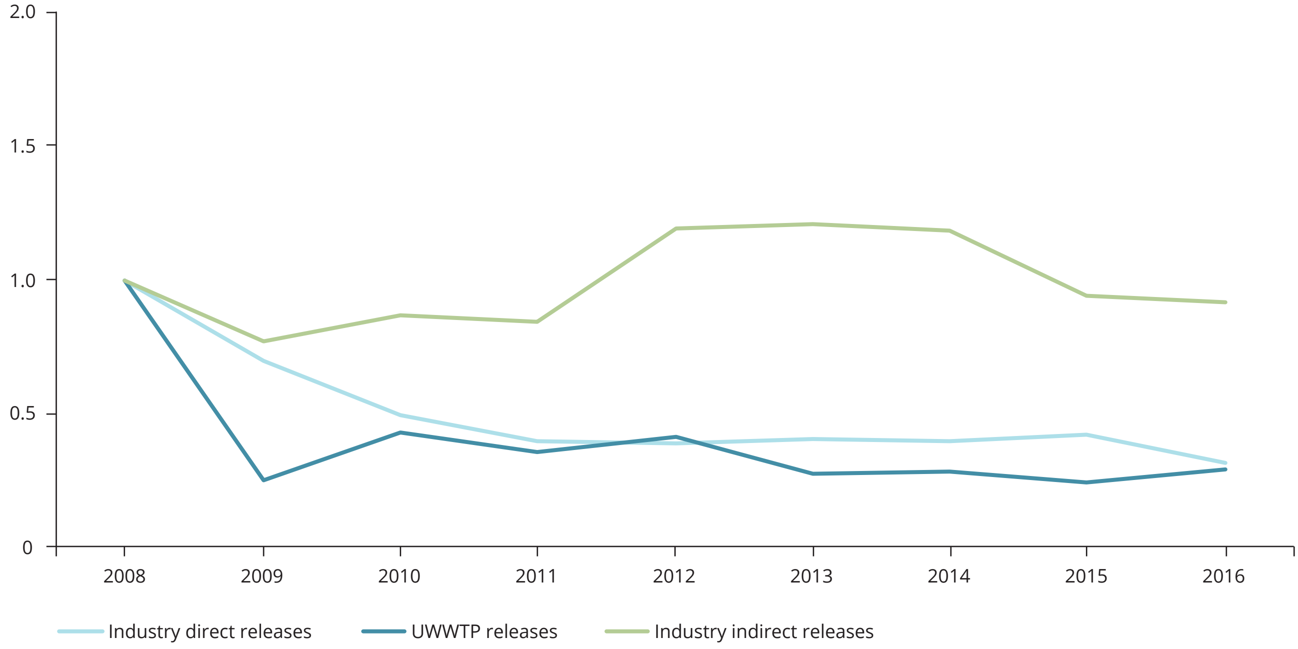
Figure 2.24 illustrates trends between 2008 and 2016 in eco-toxicity associated with direct releases of other organic substances from industrial activities and waste water treatment, and with indirect releases. Direct releases from both industry and UWWTPs decreased between 2008 and 2016, with releases from industrial activities remaining relatively stable between 2011 and 2015. The data on indirect releases appear to have been relatively stable since 2008.

2.2.3 Potential impact on water bodies

Analysis of data from river basin management plans

According to the EEA report *European waters: assessment of status and pressures 2018* (EEA, 2018d), **around 60 % of surface water bodies** did not achieve good ecological status in the second reporting of river basin management plans (RBMPs) (see Section 1.4). Chemical pollution is one of the main pressures on

Figure 2.24 Trends over time in other organic substances from industry and UWWTPs, expressed as eco-toxicity, 2008-2016



Note: Indexed (2008 = 1).

Sources: Based on data from EEA (2018b) and USEtox (2017).

surface water bodies failing to achieve good water status, affecting, according to the latest EEA analysis, **18 % of surface water bodies in the EU-28**. Of all surface water bodies reporting point source pollution as a pressure, urban waste water releases were identified as a pressure in 13 608 out of 111 105 surface water bodies (12 %), and industrial sites were identified as a pressure in 5 % of them. Therefore, direct and indirect releases from industry are contributing factors to the poor ecological status of European waters.

As part of the assessment of ecological status of surface water bodies, Member States report river basin-specific pollutants (RBSPs) causing failure to achieve good ecological status. In the latest plans, there were 150 different RBSPs reported as causing failure to achieve good ecological status in at least one water body. The most frequently reported substances were **zinc and copper**, followed by ammonium, arsenic and selenium.

46 % of surface water bodies in the EU-28 do not achieve good chemical status, mainly related to the presence of a few key priority hazardous substances that are categorised as uPBTs (ubiquitous, persistent, bioaccumulative and toxic). These pollutants persist in the environment and are mainly associated with legacy pollution. They are mercury, polybrominated diphenylethers (pBDEs), tributyltin and polycyclic aromatic hydrocarbons (PAHs) ([12]), with mercury and pBDEs being the main substances leading to failure to achieve good chemical status (EEA, 2018d). Without the influence of these uPBTs, the failure rate would drop

([12]) Specifically: benzo(a)pyrene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, benzo(b)fluor-anthene and benzo(k)fluor-anthene.

to just 3 % of surface water bodies. Apart from these uPBTs, metals are also responsible for a significant number of failures, with cadmium, nickel and lead together resulting in failure in over 2 100 surface water bodies.

Failure to achieve good chemical status has been caused by pressures such as atmospheric deposition of pollutants released to the air from human activities (associated, for example, with mercury release to air) and inputs from UWWTPs (leading to contamination with PAHs, mercury, cadmium, lead and nickel). The origin of these substances is a result of industrial processes and, therefore, industry is a significant factor that can contribute to improving this issue.

The main pressures on groundwater are diffuse pollution of nitrates and pesticides. These substances enter the environment predominantly from the agricultural sector. Other chemicals that may be associated with industrial use and have been recognised as a cause of failure to achieve good chemical status of groundwater are, for example, tetrachloroethylene (solvent), and metals, such as arsenic, nickel and lead, arising from activities such as mining, contaminated sites and waste water discharges.

EEA analysis (EEA, 2018a) indicates that the main pressures on surface water bodies reported by Member States in the second RBMPs are:

- hydromorphological pressures (40 % of water bodies) — physical alterations to the water bodies such as dams, embankments and flow regulation;
- diffuse pollution sources (38 % of water bodies) — agriculture and the atmospheric deposition of pollutants;
- point sources (18 %) — UWWTPs, storm overflows and industrial emissions covered and not covered by the IED;
- water abstraction (7 %).

Figure 2.25 presents the share of water bodies for which point sources (IED, non-IED installations and UWWTPs) were reported as pressures in the second RBMPs.

Based on the second RBMP, in most countries industrial point sources are identified as a relatively small source of pressure. Figure 2.25 shows the percentage of water bodies for which pressure from specific point sources, namely industrial and UWWTP emissions, was reported in the second RBMP. For each water body, several pressures can be reported (hence the total may be greater than 100 %). The data suggest that industrial point sources not regulated by the IED may exert greater pressure on the quality of water than the IED plants. This suggests that the IED regulatory process is effective in controlling industrial pollution and that measures to control pollution from smaller industry may be less effective. Depending on the industrial policy in each Member State, emissions from these facilities are likely to be less strictly controlled than those from IED plants. Under current EU water legislation, a facility not regulated under the IED should be subject to measures if its emissions are affecting a Member State's ability to achieve EU water policy objectives (EC, 2014). The highest pressure from non-IED plants (31 % of water bodies) has been reported by Belgium. Slovenia reported the second largest figures with non-IED plants reported as a pressure for 22 % of water bodies. Spain, Bulgaria and Croatia also reported it as considerable pressure.

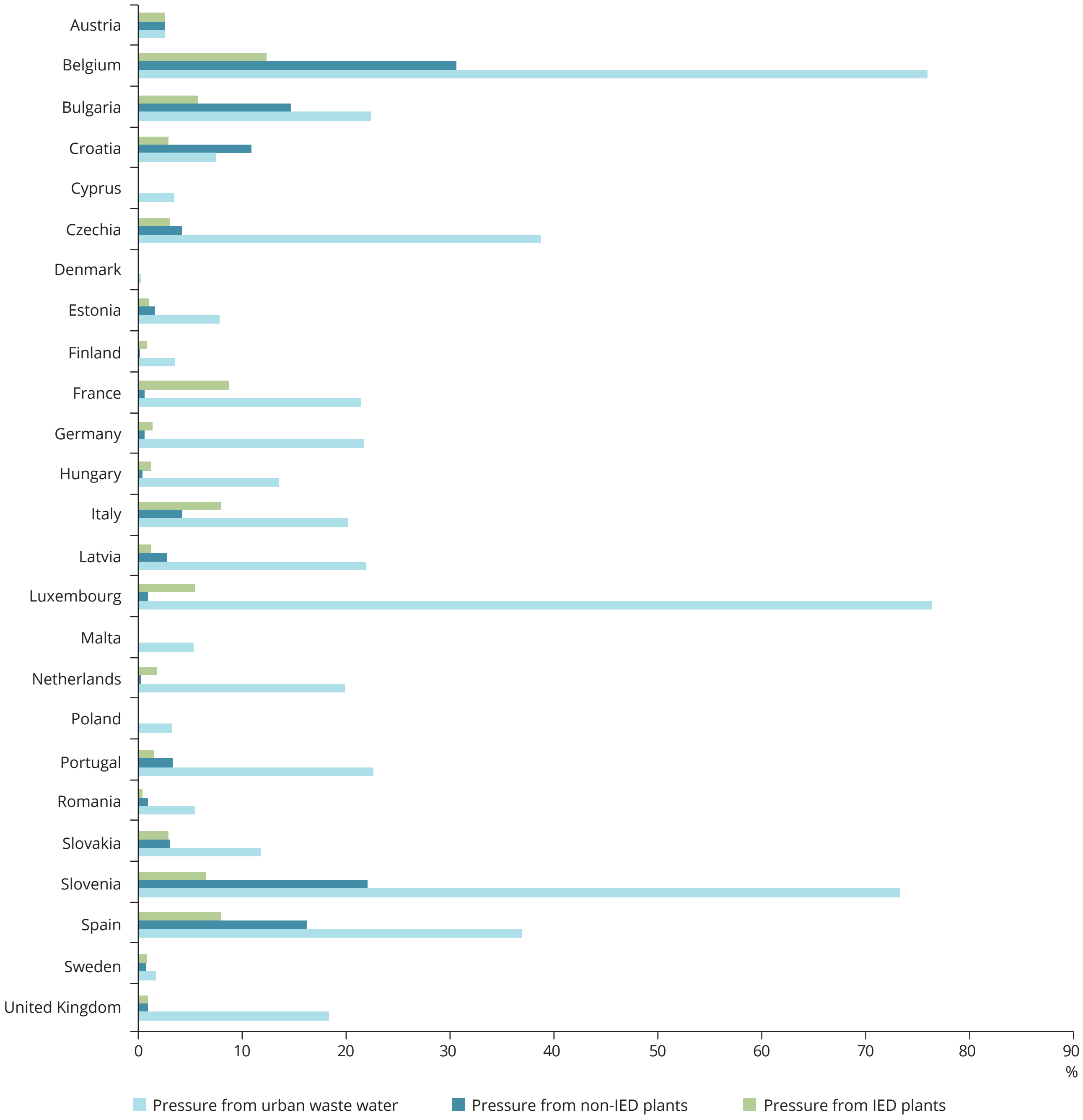
While there is no single source of data on emissions from industrial installations below the IED thresholds, the study *(Contribution of industry to pollutant emissions to air and water,* EC, 2014) attempted to estimate the scale of emissions from such activities. The study concluded that emissions from activities regulated under the IED are responsible for around 20 % of total emissions to water, by mass (based on the E-PRTR estimates). The largest share of emissions by mass originates from agro-industrial activities not captured by the IED (as well as from UWWTPs), emissions from which may or may not be covered by the requirements of other EU legislation.

UWWTPs that accept industrial effluents from both IED and non-IED industrial sites in addition to domestic waste water are reported as a more significant pressure. Belgium, Luxembourg and Slovenia indicated UWWTPs as a pressure for more than 70 % of their water bodies. Bulgaria, Czechia, Spain, France, Latvia and Portugal also report it as a pressure for more than 20 % of their water bodies.

Linkage between pressures from industrial waste water releases and water body status

The main purpose of this comparison is to assess whether any meaningful relationship can be identified between E-PRTR data on discharges to water and the chemical/ecological status of water bodies as defined under the Water Framework Directive (WFD). The assessment is not intended to be a comprehensive assessment of overall pressures on water bodies or to assess the significance of industrial emissions in the context of other relevant pressures on water bodies. The assessment does therefore not take into account other factors that may influence the status of water bodies, such as geographical location,

Figure 2.25 Share of eco-toxic load exerted to water bodies per type of point source, second RBMP



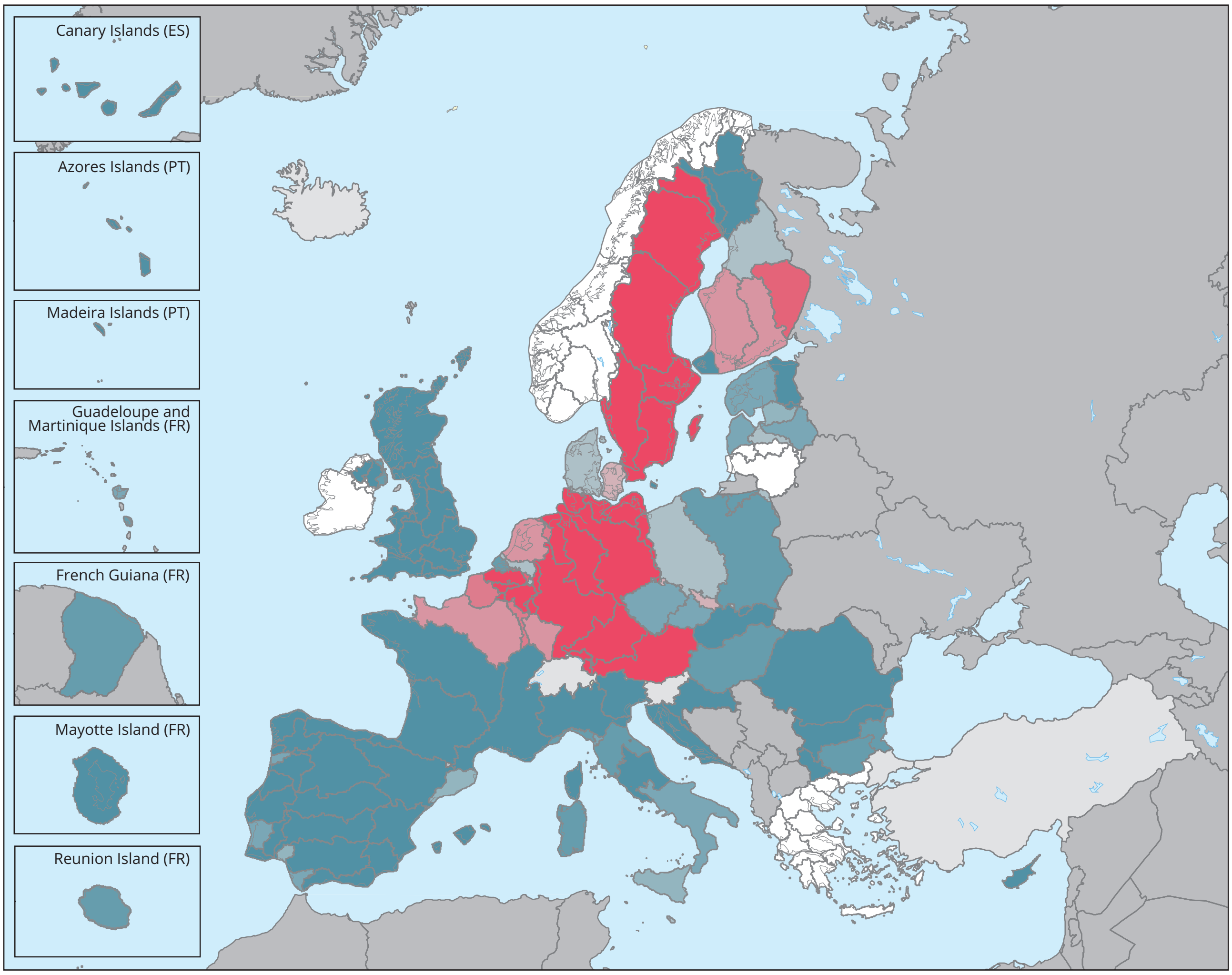
Source: EEA, 2018a.

geology/hydrogeology, population density or climate change effects. The EEA is aware that the assessment of compliance with the WFD is a complex area, impacted by many different factors that require detailed analysis, while the purpose of this report is primarily focused on the assessment of industrial waste water emissions and their impacts.

Figure 2.26 shows the share of water bodies failing to achieve good chemical status in the EU. It is not possible to draw correlations between discharges from industry and the high share of surface water bodies failing to achieve good chemical status from comparisons at the macro-scale. This is because the pressures on the water bodies are multiple and varied, and depend on the characteristics of the receiving water body as well as of the discharge. For that reason, it is appropriate to assess such correlations only at the level of individual water body or river basin, which is outside the scope of this report. Specific issues that prevent any reliable comparison between waste water release data and the status of water bodies under the WFD include:

- The significance uPBT compounds have for water body compliance rates, as discussed in more detail in Box 2.2. These compounds originate from a variety of sources and release routes and are often related to historical activities rather than recent environmental releases.

Figure 2.26 Water bodies failing to achieve good chemical surface water status, by river basin district



Percentage of number water bodies not in good chemical status with uPBT per river basin district (RBD) in second RBMPs

0% 100% RBD areas without data No data Outside coverage

Note
uPBT: "ubiquitous, persistent, bioaccumulative and toxic" substance

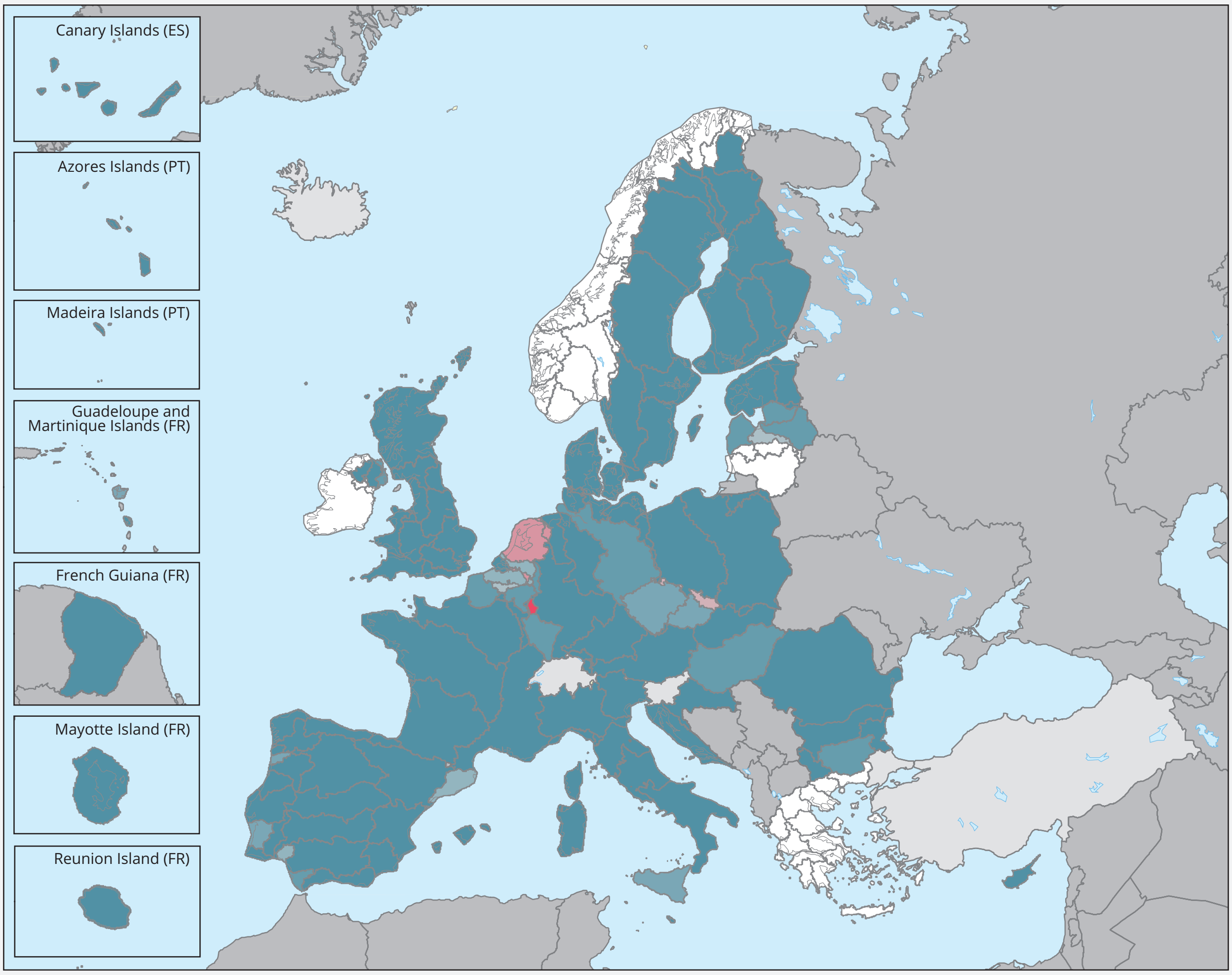
Notes: Results are based on the Water Information System for Europe State of Water (WISE-SoW) database including data from 24 Member States (EU-28 except Greece, Ireland, Lithuania and Slovenia). Link to tableau tool: Surface water bodies failing to achieve good chemical status by river basin district. Caution is advised when comparing results of Member States as the results are affected by the methods that Member States have used to collect data and often cannot be compared directly.

Source: EEA, 2018a.

Box 2.2 Impact of uPBTs on the assessment of water quality status

The map in Figure 2.27 shows the chemical status of water bodies without uPBTs (which include mercury, pBDEs, tributyltin and certain PAHs). The widespread presence of mercury and, to a lesser extent, pBDE causes frequent failure to achieve good chemical status (EEA, 2018d). These pollutants persist in the environment and are mainly associated with **legacy pollution**. By comparing Figure 2.27 with Figure 2.26, it can be seen that excluding uPBTs from the assessment results in only a small share of the EU water bodies failing to achieve good chemical status (3 % overall). The largest pressure of uPBTs on water quality status can be seen for Austria, Belgium, Finland, France, Germany, Malta, Poland, Slovenia and Sweden. One reason for such discrepancies is the approach taken by Member States to chemical status reporting, as discussed in detail in the EEA report *European waters: assessment of status and pressures 2018* (EEA, 2018d).

Figure 2.27 Water bodies failing to achieve good chemical status, without uPBTs by river basin district



Percentage of number water bodies not in good chemical status without uPBT per river basin district (RBD) in second RBMPs

0% – 100% RBD areas without data No data Outside coverage

Note:
uPBT: "ubiquitous, persistent, bioaccumulative and toxic" substance

Notes: The map shows the chemical status of water bodies without uPBTs. Results are based on the WISE-SoW database, including data from 24 Member States (EU-28, except Greece, Ireland, Lithuania and Slovenia). Link to tableau tool: Surface water bodies: chemical status with and without uPBT maps, by river basin district. Caution is advised when comparing results of Member States as the results are affected by the methods that Member States have used to collect data and often cannot be compared directly.

Source: EEA, 2018d.

- Member States apply different approaches in determining compliance with the criteria that define whether a water body achieves good status. This is further explained in an EEA report on WFD compliance reporting (EEA, 2018a), but essentially it means that compliance rates between different countries are not directly comparable.

Linkage between water body status and level of treatment applied at urban waste water treatment plants

The different stages of waste water treatment are listed in Figure 2.28 in terms of purposes and techniques used (most common ones). Within the EU, UWWTPs are required to apply tertiary (i.e. more stringent) treatment if they are larger than 10 000 p.e. and they discharge into sensitive areas, the catchment of sensitive areas.

Figure 2.29 presents the level of treatment applied across the EU, based on information reported under the UWWTD [13], and the proportion of water bodies that fail to achieve good water status. Most reporting countries apply 'more stringent' treatment (i.e. greater than secondary treatment) to more than 80 % of the incoming effluent loading to UWWTPs. A number of countries apply only secondary treatment to a significant (> 20%) proportion of the incoming load, including Ireland, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and the United Kingdom. The UWWTD reporting data for 2014 indicate that 14 countries report applying primary treatment only; however, the numbers are generally low, with only five countries reporting more than 10 UWWTPs with only primary treatment (Croatia, Italy, Poland, Romania and Spain).

In practical terms, the level of treatment applied by Member States in 2014 cannot be readily linked to the reported status of water bodies for which pollution pressure is significant, for two main reasons:

- Firstly, as previously discussed, a high percentage of failures to achieve good status are related to the assessment of uPBTs in the water bodies. These uPBTs can be related to many different anthropogenic sources, including historical human activities and as a result of atmospheric deposition.

- Secondly, different Member States apply different interpretations in determining compliance with chemical status criteria in water bodies, as explained in the EEA report on the WFD reporting (EEA, 2018d).

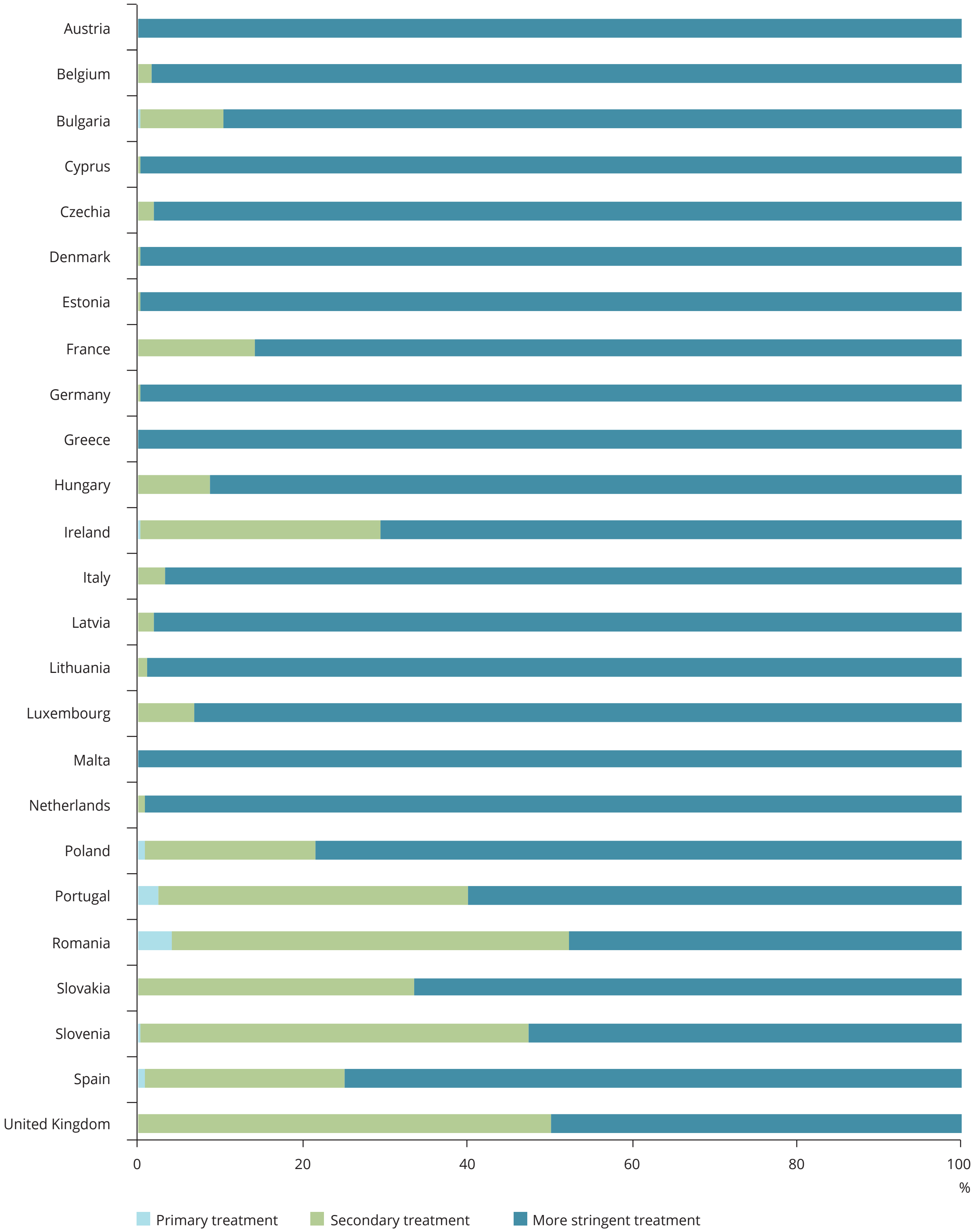
In addition, there is no information available to link indirect industrial releases to UWWTPs with lower levels of treatment (e.g. only primary or secondary). Hence, while UWWTPs with lower levels of treatment may indeed be a significant pressure on the receiving water bodies, it is not possible to make any statement about whether industrial effluent is contributing to this pressure.

Figure 2.28 Common techniques used in each waste water treatment stage

Pre-treatment	Primary	Secondary	Tertiary (more stringent)
Removal of large particles	*Removal of small particles*	*Biological processes*	*Advanced removal/ disinfection (advanced oxidation and chemical processes)*
• Screening • Grit separators • Fats, oil and grease separator (FOG) • Primary settlements tanks	• Filtration • Sedimentaion • Equalisation • Neutralisation • Flotation • Filtration • Coagulation and floculation	• Activated sludge treatment • Membranes • Biorotor • Fixed film • Trickling filter • Moving bed biofilm reactor	• N and P removal • Advanced oxidation techniques • Reverse osmosis • Chemical precipitation • UV treatment • Ozone desinfection • Rapid gravity filter • Reverse osmosis
Sludge processing (e.g. aerobic technology, natural drying processes)			

[13] This analysis is based on the data 'Distribution of treatment plants (capacity) and treatment types at country or NUTS level' which was downloaded from the EEA Urban waste water directive treatment plants data viewer on September 2018: https://www.eea.europa.eu/themes/water/water-pollution/uwwtd/data-viewer-urban-wastewater-treatment-directive-1/urban-waste-water-directive-treatment

Figure 2.29 Level of treatment applied at UWWTPs in EU Member States, expressed as a share of entering load



Note: No data were available in the database for Croatia, Finland and Sweden.

Source: EEA, 2018e.

In conclusion, it is very difficult to draw any correlations between the emissions from industrial activities and the status of water bodies as defined under the Water Framework Directive. In addition, gaps in the UWWTD data set also make it difficult to identify any relationship between plant performance/capacity issues and the status of water bodies. This is clearly an area in which further data gathering is required in order to be able to make a more focused assessment of the links between these different data sets.

2.2.4 Emerging issues and potential responses

Although the implementation of legislation targeting waste water treatment across the EU has led to improvements in water quality, emerging contaminants are still detected in treated municipal and industrial effluents that are subsequently discharged to surface waters across Europe (EEA, 2011; JRC, 2015a). This could be explained by the variation in levels of treatment between UWWTP installations, and in the difference in the operational performance of the plants and the permitted discharge concentrations. While possible removal efficiencies in UWWTPs can be high, additional costs associated with higher energy consumption and the need for hazardous waste management may discourage UWWTP operators from deploying more advanced treatment techniques to remove emerging pollutants from urban waste water.

Emerging contaminants are natural or synthetic substances that have the potential to enter the environment causing **adverse ecological or human health effects** (De la Cruz et al., 2012). As a result of the poor understanding of their fate and impacts, these pollutants are currently largely unregulated in and outside the EU (EC Science Hub, 2018). Since the definition of emerging contaminants is very broad, **many chemicals** could be attributed to this category (Sauvé and Desrosiers, 2014). Nevertheless, a number of compounds have been prioritised on the first European watch list (Decision 2015/495) developed under the guidance of the NORMAN research and exchange of information project (Dulio et al., 2018). These could broadly be divided into **pharmaceuticals and personal care products** (PPCPs) and **pesticides**. Microplastics are also considered thanks to the initiative of several European countries to ban them (e.g. the Environmental Protection (Microbeads) (England) Regulations 2017; Norwex Movement, 2017).

It should be noted that data on pesticides have generally been excluded from this report, as they are not a significant feature of industrial releases (less than 0.1 % for both direct and indirect releases by mass) and only low environmental pressure is associated with these emissions (less than 0.2 % of the total environmental pressure of direct releases from waste water treatment in 2016). However, pesticides are a common component of releases from UWWTPs and a range of compounds have been identified in UWWTP measurement studies (EC, 2012).

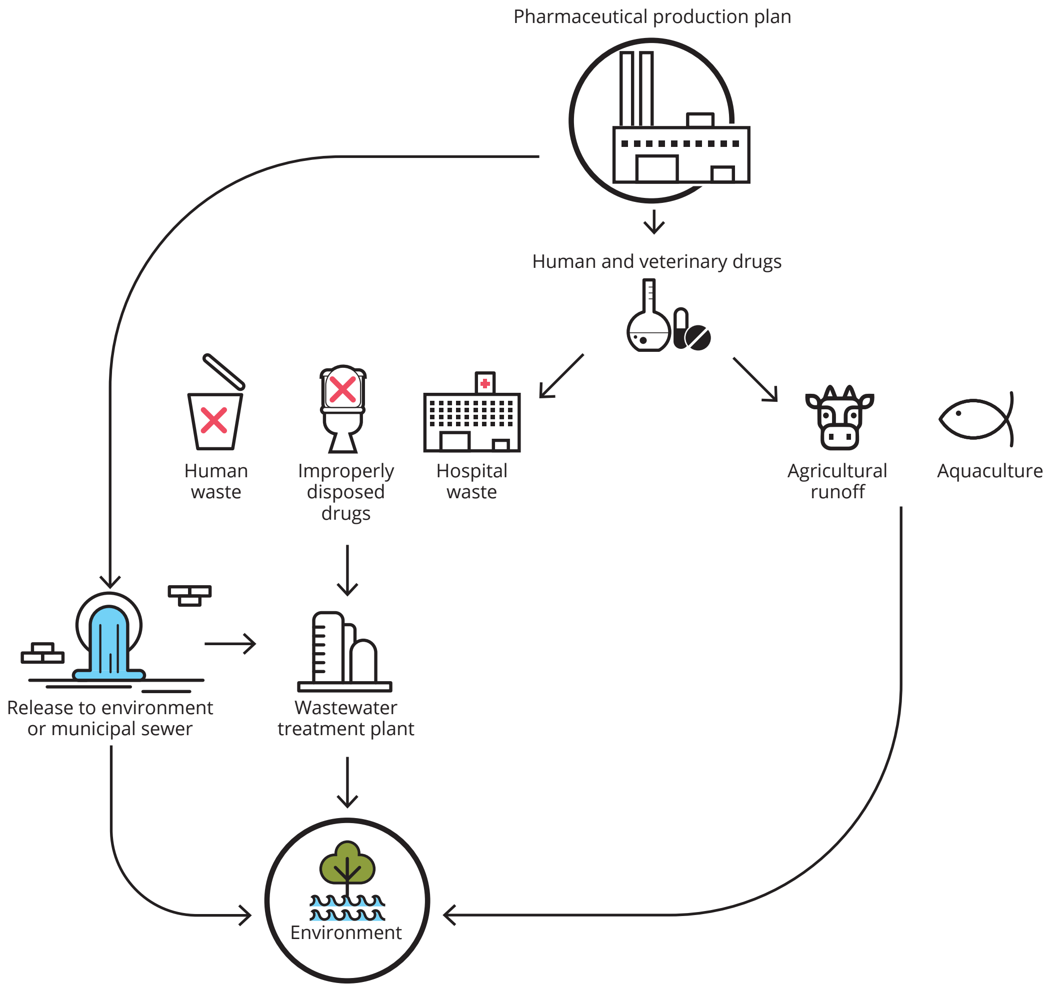
Active pharmaceutical ingredients and personal care products

This category of emerging contaminants has the widest scope, with over 3 000 different pharmaceutical compounds on the EU market (Deloitte et al., 2016). These include antibiotics, endocrine disrupting compounds, hormones, beta blockers, steroids, antiepileptic drugs, UV filters (used in sun protection products) and others. Until recently, it was accepted that the main source of pharmaceuticals in water was domestic sewage, while emissions from manufacturing were considered negligible (Deegan et al., 2011). However, recent studies have identified direct and indirect releases from drug manufacturing as a source of potentially high discharge compared with emissions from consumption, especially in areas that are considered drug manufacturing hubs (Larsson, 2014).

While the understanding of the impacts of pharmaceuticals on the biota and on humans is still developing, studies have already established some adverse effects. Notably, hormones and endocrine disrupting compounds have been revealed to lead to reproductive impairment in fish populations (Thomas et al., 2007) and beta blockers are a potential long-term risk for non-target organisms of both fresh and marine water species (Godoy et al., 2015). In addition, antibiotics have been demonstrated to be toxic to algae and water fleas (Bielen et al., 2017) and to cause bacteria including pathogens to develop resistance to them (Andersson and Hughes, 2014). Regarding human health risks from pharmaceuticals in the environment, there is little evidence of risks imposed by drinking water (Executive Agency for Health and Consumers, 2013) but consuming food products irrigated with reclaimed water could be a potential risk (Malchi et al., 2014).

Most EU regulations concerning water quality and waste water treatment do not currently include provisions on pharmaceuticals. But three pharmaceuticals — the natural hormone oestradiol (E2), the anti-inflammatory diclofenac and the synthetic hormone ethinyl oestradiol (EE2), used in contraceptives were listed in the first European watch list (Decision 2015/495) that aims to facilitate the determination of appropriate measures to address the risk posed by those substances. In addition, following a decision of the European Court of

Figure 2.30 Routes of pharmaceutical entry into the environment



Source: EEA.

Justice (case T-521/14), the European Commission has started developing a regulation dealing with endocrine disrupting compounds (EC, 2016). Finally, under the IED, the organic fine chemicals BREF outlines best available techniques that could be used for biomonitoring of effluent containing active pharmaceutical ingredients. The application of these techniques could provide valuable information about the quantity and toxicity of these components in industrial effluent from manufacturing plants.

In terms of possible technological response, advanced oxidation has proven to successfully remove active pharmaceutical ingredients from water, and can be used close to the main emitters (e.g. hospitals and clinics) together with actions to limit the input to waste water.

Microbeads

Microbeads are small particles (< 5mm) intentionally added to products such as cosmetics, toothpastes and cleaning products by manufacturers, and used in industries such as oil and gas exploration, textile printing and automotive moulding (EC, 2017a). They are also produced during the life cycle of products such as tyres, textiles and by pellet spills. They can enter the environment through industrial and urban treated waste water effluent (Talvitie et al., 2015; Juliano and Magrini, 2017). Similar to pharmaceuticals, the impacts of microplastics on the aquatic biota and on humans when consumed through food is still under research. So far, over 220 species have been identified that consume microbeads in nature (FAO, 2016), many of which (e.g. fish and shellfish) are used for commercial purposes. Plastic debris can cause ecological harm, entanglement of marine animals and, when ingested by animals negative physical effects or even starvation (Wardrop et al., 2016). In addition, plastic absorbs and concentrates pollutants from the surrounding environment and transfers them to aquatic species (Wardrop et al., 2016).

While it is clear that microbeads have some adverse impacts on marine species, it remains unclear whether consuming seafood contaminated with microbeads poses any risks to human health (EFSA, 2016). On account of the uncertainty regarding the impacts of microbeads, their treatment in industrial and urban waste water is not currently regulated in the EU. Microplastics intentionally added in products are part of a proposal for restriction under the chemicals Regulation (REACH). The process should be finalised by 2020, banning some of the uses of microplastics and imposing monitoring and reporting obligations for other uses.

Therefore, no specific waste water treatment or monitoring technologies have been developed and employed at this stage. Nevertheless, it has been shown that primary and secondary treatments are successful in removing approximately 50 % of the microbeads from waste water (Kalčíková et al., 2017).

3 Information gaps and limitations

The assessments carried out as part of this report have highlighted a number of gaps and limitations in the data sets that were utilised. This section of the report examines these issues and provides some potential recommendations for generating data sets that provide a more coherent and complete view of the links between industrial emissions, urban waste water treatment plant (UWWTP) performance and the potential impacts on European water bodies.

3.1 The design of the European Pollutant Release and Transfer Register

The European Pollutant Release and Transfer Register (E-PRTR) Regulation was adopted in 2006, and the first data sets were reported for the calendar year 2007. Currently the E-PRTR data sets contain 10 years of data, and based on the ongoing review of these data by the EEA (e.g. as part of annual data quality assessments performed by EEA), it is clear that there are certain limitations within the data set, that, if addressed, could provide a more complete and representative data set on industrial pollution in Europe. In summary, these issues include:

- The E-PRTR applies capacity thresholds for activities, thus does not capture emissions from smaller industrial facilities. Specifically for UWWTPs, the E-PRTR captures emissions only from plants with capacities greater than 100 000 population equivalent (p.e.). The findings of this report indicate that including UWWTPs with capacities greater than 10 000 p.e. would increase coverage of the E-PRTR to approximately 93 % of the reported capacity.

  In relation to industrial releases, coverage could be increased by aligning the E-PRTR activities with the activities regulated under the Industrial Emissions Directive (IED). This would improve the environmental effectiveness of both regimes.

- The E-PRTR applies emissions reporting thresholds based on the level of annual emissions of a substance (i.e. a pollutant threshold). This means that the E-PRTR does not capture all emissions of each pollutant from industrial sectors. In 2016, over 34 000 facilities reported data to the E-PRTR, but only 2 236 facilities reported direct releases, and 1 457 facilities reported indirect releases, above the E-PRTR pollutant thresholds. As many of the key pollutants are released in relatively small quantities (metals, chlorinated organics) and the performance of industrial plants is improving and pollutant releases declining, it may be timely to evaluate the suitability of the existing pollutant reporting thresholds, perhaps taking into consideration the toxicity of the pollutants. Reducing or removing these thresholds would provide a more complete understanding of the magnitude of industrial releases for these pollutants.

  Applying pollutant thresholds may also mean that facilities do not report each year, thus limiting the scope for consistent analysis of emissions from a single facility over time.

- Pollutants of concern that have emerged since the adoption of the E-PRTR Regulation are not being captured in the E-PRTR data set. This is of particular concern in relation to waste water releases. Individual countries have chosen to add additional pollutants to their national PRTR; however, this is not consistent across reporting countries. A review of these emerging pollutants should be carried out to identify any additional pollutants to be added to the scope of E-PRTR reporting (and any that should be removed).

- Regarding indirect releases, the E-PRTR does not provide information on the UWWTP to which waste water is directed or the level of treatment received. Robust analysis of the relationship between indirect emissions and subsequent emissions from waste water treatment plants is thus not possible using data reported in the E-PRTR.

Despite these limitations, the E-PRTR still offers the best available Europe-wide source of information on direct and indirect releases from industrial and waste water treatment plants in Europe, but there is clearly potential for enhancement of the data set.

3.2 Data quality issues in European Pollutant Release and Transfer Register reporting

The EEA, in cooperation with the European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) and the European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM), reviews, each year, the data submitted by countries to the E-PRTR in order to identify potential under-reporting or errors.

This process, known as the E-PRTR informal data review, included in 2018 a more detailed exercise on direct and indirect releases of water, comprising four elements:

1. cross-checking Urban Waste Water Treatment Directive (UWWTD) data and the E-PRTR to find potential missing UWWTPs in either of the two data sets;
2. cross-checking UWWTD data and the E-PRTR to identify potentially missing direct releases from UWWTPs in the E-PRTR;
3. identifying outliers that could potentially be reporting errors;
4. identifying potentially missing pollutants by establishing correlations with other reported substances.

The main conclusion of this work is that the quality of waste water data in the E-PRTR could benefit from improvement. A summary of the findings of each of these elements is presented below:

1. The report estimated that for 2016 there were 266 UWWTPs equal or greater than 100 000 p.e. that were not included within the E-PRTR data set. One possible explanation of this difference could be that the scope of the E-PRTR is determined by substance thresholds. However, using accepted emission factors, in general, for UWWTPs greater than 100 000 p.e., it is expected that releases would be well above the substance thresholds of the E-PRTR; hence, it seems unlikely that thresholds are the reason for this discrepancy. Another possible explanation is that the UWWTPs have been reported under an activity code other than 5.(f).
2. In terms of potentially missing release reports, the exercise also used the data on incoming loads to UWWTPs from the UWWTD reporting and a set of emission factors based on previous E-PRTR reports. A wide margin of error was included so that only the most important data points were flagged to the countries. For the 12 pollutants ([14]) considered in this exercise, the number of potentially missing data points was 148 in 2016. The overall number of reported data for the same 12 substances under the activity corresponding to UWWTPs (5.(f)) was 5 835 for the same reference year.
3. The report also used UWWTD reporting data on incoming loads to look for potential additional outliers within the E-PRTR data set (a comparison of the reporting with the previous year is already carried out by the checks in place). For each of the releases, an expected range of emissions was determined and reported E-PRTR data were flagged that were above or below this range. Once again, **a wide range** was set up to limit the number of data points flagged to the countries. The analysis identified 123 additional outliers for 2016.
4. Finally, the identification of potentially missing pollutants, by establishing correlations with other reported substances in the E-PRTR, was an exercise that went beyond UWWTPs but was only technically sound for a limited number of activities and substances. In particular, the check was based on a statistical approach and, therefore, only activities with more than 500 facilities reported, as well as a high correlation between at least two pollutants, qualified for this check. These criteria limited the check to only two activities in E-PRTR (3.(a) and 8.(b)). This check resulted in flagging 14 values for 2016 data for EU-28 countries.

In summary, the key issues of concern relate to significant under-reporting, both in terms of the number of UWWTPs greater than 100 000 p.e. that are reporting to E-PRTR and with regard to the total number of releases that are being reported. There are less significant concerns in relation to the quality of the data that are being reported, in terms of the magnitude of emissions being reported and also with respect to missing pollutants.

The European Commission and the EEA are in contact with the countries to remedy these issues as far as possible.

([14]) Total nitrogen, total phosphorus, TOC, di-(2-ethyl hexyl) phthalate (DEHP), arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc, which are frequently reported by Member States.

3.3 The design of the Industrial Emissions Directive and best available techniques reference documents

The best available techniques reference document (BREF) review cycle provides the opportunity to update requirements (including emission levels) for industrial installations regulated under the IED, reflecting changes in the sector and technological advances. To minimise the future pressure of waste water from industry on UWWTPs and water quality, it is recommended that the future BREF reviews:

- Consider systematic coverage of industrial indirect releases transferred to UWWTPs: This would help ensure that the scale of the problem and the pressure are better understood (e.g. by using improved monitoring requirements) and controlled (e.g. by appropriate pre-treatment or by setting minimum BAT requirements for waste water).

- Consider giving greater attention to water issues in sectors and sub-sectors contributing to the greatest pressure on UWWTPs and the water environment more generally: Improved data collection on water and waste water management in industrial facilities would not only provide more robust evidence for establishing emission limit values but would also provide additional information for regulators at a national level to support environmental permitting.

It has been shown that IED regulation significantly contributes to the control of industrial emissions, and the BREF documents will provide a comprehensive coverage of industrial activities. However, the exchange of information for drafting BREFs does not address the treatment of effluents from IED installations transferred to UWWTPs. There may be merit in organising an information exchange in a similar way to the 'Sevilla process' to identify abatement efficiency and techniques for tackling indirect releases for IED installations to water.

The significance of emissions from industrial facilities currently not regulated under the IED is a data gap. Given that aggregated EU data sources do not provide relevant emission data, a dedicated study examining this issue could be valuable to better understand the full extent of pressures on UWWTPs. To narrow down the scope of an extensive data collection exercise that may be required for such a project, the focus could be on the Member States reporting non-IED industrial plants as a significant pressure on their water bodies and on industrial sectors with probably the highest emissions to water.

In addition, Article 11 of the UWWTD requires Member States to have a national regulatory system in place to manage industrial effluent loading to UWWTPs; however, there are no specific performance requirements detailed in the Directive. In order to better deal with both IED and non-IED effluent loadings to UWWTPs, there may be merit in providing more focused requirements for the management of such effluents, including defining the scope of the pollutants that should be considered and setting emission limits and/or performance standards (e.g. removal efficiency) for a broader range of pollutants. As part of the ongoing evaluations of the EU water policy it would be imperative to consider Article 11 of the UWWTD and how its requirements may be better enforced and its implementation monitored.

3.4 Limitations of water data reporting

The information on the water quality status in the Water Information System for Europe (WISE) results from the use of different methodologies for data collection across Member States. The data on the status and pressures on water bodies use different metrics and compilation methodologies and, thus, caution is needed when comparing the results between Member States and over time.

The latest EEA report on the status of European water bodies (EEA, 2018d) provides greater detail on these variations, highlighting that Member States take different approaches to monitoring, modelling and extrapolating results for Water Framework Directive (WFD) assessments. These variations influence the reported status of water bodies across Member States. Until a consistent approach is adopted across all reporting countries it will not be possible to make comparisons between different countries or to attempt to determine the relationship between E-PRTR reported waste water releases and WFD status.

Another key limitation of the data reported under the UWWTD relates to incomplete information on the capacities and loads of UWWTPs and the specific treatment technologies used. Information on the incoming load to and capacity of UWWTPs in the data set is available for around 80 % of all UWWTPs (data are completely missing for some Member States).

4 Recommendations on data reporting

The design, frequency and reliability of the available data was a significant limitation for this analysis. Most of the issues found are raised and discussed in the previous chapters of this report. This chapter, in turn, includes possible policy actions to remedy the issues found.

4.1 Horizontal improvements (streamlining)

A certain degree of overlap was found between the data reported under the Urban Waste Water Treatment Directive (UWWTD) and the European Pollutant Release and Transfer Register (E-PRTR). There is an opportunity to streamline these two reporting processes and, maybe, simply integrate some of the UWWTD reporting into the E-PRTR. This streamlining should take into account several considerations:

- The scope of the E-PRTR in terms of urban waste water treatment plants (UWWTPs) is more limited than that of the UWWTD, capturing only very large plants. The streamlining exercise could consider a compromise between the two.

- The parameters reported to the UWWTD apply both at the point of entry to the plant (entering load) and at the point of discharge (emissions) but are reported only on a voluntary basis. These parameters could therefore be added as mandatory fields to the E-PRTR for these plants.

- The parameters used in the UWWTD also include design capacities and operation descriptions that are not part of the E-PRTR. However, this can be dealt with by including these in the EU Registry on Industrial Sites, a reporting mechanism that will collect information on industrial entities regulated by several pieces of EU law (including E-PRTR and the Industrial Emissions Directive, IED) into a single system. This system will be in place from 2019 with reference to reporting year 2017 and will receive updates every year thereafter (whereas the UWWTD requires reporting every 2 years).

It was also apparent that the state of the environment data (i.e. the Water information System for Europe, or WISE) and the emission data (i.e. E-PRTR and UWWTD) were difficult to correlate. The patterns found in emission data did not correlate with the issues reported in terms of ecological and chemical status. This is due to a wide range of issues, among them the following:

- There is no consistent methodology used to assess ecological and chemical status at European level, with different Member States adopting different approaches to assessing compliance. This also limits the possibility of correlating pressures and status, as the underlying data used to allocate status levels are not available.

- The reporting of causes behind the failures on state of the environment is not systematic in terms of specific causes and is not harmonised across countries or even within countries.

- The aggregation level of the reporting on ecological and chemical status is very high. Pressures on the water bodies are multiple and varied, and depend on the characteristics of the receiving water body as well as the discharge. For that reason, it is only appropriate to assess such correlations at the level of an individual water body or a river basin. WISE data do not allow for such analyses.

- A significant proportion of reported failures to achieve good chemical status under the Water Framework Directive (WFD) were due to the presence of persistent pollutants, for example mercury and brominated diphenyl ethers (pBDEs). For persistent pollutants, the releases are likely to have occurred (at least partly) historically. The assessment of links between E-PRTR data and the status of water bodies is also complicated by the fact that waste water releases are not the only contributors to pollutant concentrations in the water bodies, as releases to air from industrial and non-industrial sources can significantly contribute to pollution in water bodies through atmospheric deposition.

These factors make it difficult to define any correlation between reported releases to water and water body status. This also presents difficulties in determining whether the level of treatment applied at UWWTPs (as reported under the UWWTD) is impacting on the status of the receiving waters.

Improving state of the environment reporting could include the following actions:

- harmonising assessment methodologies across countries to increase comparability;
- developing a systematic approach to the reporting of underlying factors (e.g. concentration levels of key chemicals) to allow for a more direct correlation between pressures and status data;
- lowering the level of aggregation to allow for a more direct comparison;
- improving the quality of data being reported in relation to UWWTPs (under the UWWTD) through the introduction of additional quality assurance checks;
- providing more analysis on the likely sources and entry pathways for the individual pollutants responsible for not achieving good status.

4.2 Specific recommendations for European Pollutant Release and Transfer Register and Urban Waste Water Treatment Directive reporting

Sections 3.1, 3.2 and 3.4 highlight some potential issues in relation to both E-PRTR, UWWTD and state of the environment reporting. Box 4.1 summarises actions that could be taken to improve the usability of the reported data in each case.

Box 4.1 Actions to streamline reporting mechanisms

Actions to improve E-PRTR reporting

- Review the reporting thresholds for individual pollutants.
- Consider additional relevant pollutants for inclusion within the scope of the E-PRTR (and remove the obsolete ones), with reference to other relevant pollutant lists such as priority substances under the WFD.
- Align the scope of the activities reported to the E-PRTR with the activities regulated under the IED, increasing the overall coverage of industrial emissions.
- Reduce the activity threshold for UWWTPs, to increase the percentage of discharges that are included within the scope of the E-PRTR.
- Address the issue of potential non-reporting of E-PRTR data points by providing reporters with guidance or tools for accurately determining and cross-checking pollutant releases (e.g. potential alternative approaches to relying on a single data point to calculate annual emissions).
- Require in the reporting the identification of the receiving UWWTP for indirect releases. This allows tracking of industrial pollutant releases to their ultimate discharge location (this is already the case for hazardous waste in E-PRTR reporting, where the disposal destination is required).

Actions to improve data on UWWTP and state of the environment reporting

- Streamline the reporting of UWWTP data to include it within the scope of E-PRTR reporting. In the absence of streamlining UWWTD data, capture the UWWTP identifier within the scope of E-PRTR reporting, to allow greater cross referencing between E-PRTR and UWWTD data sets.
- Develop improved quality assurance checks on the UWWTD reporting data flow so that key data are reported in all cases.
- Apply a consistent approach across Member States to the determination of compliance with the required ecological and chemical status of surface water bodies.

Glossary of terms

Preferred/selected term	Description	Similar (not identical)
BAT conclusions	Decisions on best available techniques (per source) that become legally binding	Measures
Waste water stream	Waste water stream discharged from a process, an installation or a site	Effluent
Indirect release	Waste water stream that an industrial installation emits to urban waste water treatment plants	Transfer
Direct release	Waste water stream that an industrial installation emits to the environment	Release
Industrial waste water treatment unit	Waste water treatment plant owned/operated by industrial operators	Private waste water treatment unit
Independently operated waste water treatment plant	A private company that provides waste water treatment services	
Primary technology	Type of technology that refers to a different manufacturing design aiming to minimise or avoid generating emissions	Process design, primary measures
Secondary technology	A technique that reduces final emission or consumption levels but that does not change the fundamental operation of the core process	Abatement technique, end-of-pipe technique, secondary measures
Recovery at source	Technology that recovers pollutants close to the emitting source and minimises emissions to shared treatment units	
River basin	Natural geographical and hydrological unit	
Process integrated	Improvements of industrial processes to minimise the effluent	Primary measures
Pre-treatment	Specific technologies that are used upstream of the standard shared (final) waste water treatment steps	
Final treatment	Group of technologies applied as secondary measures (abatement) on the shared/common waste water stream prior to indirect or direct release	
Primary treatment	Key step of the final treatment that involves equalisation, neutralisation or physical separation	Preliminary treatment
Secondary treatment	Key step of the final treatment that involves biological treatment to reduce biodegradable organic compounds	Biological treatment
Tertiary treatment	Key step of the final treatment that involves eliminating inorganic compounds	
Eutrophication	Excessive nutrient richness in a lake or other water body, frequently due to run-off from the land, which causes dense growth of plant life	
Xenobiotic	Relating to or denoting a substance, typically a synthetic chemical, that is foreign to the water body or to an ecological system	
Persistent	Continuing to exist or occur over a prolonged period	
Bioaccumulative	Description of a substance that could become concentrated inside the bodies of living things	
Point source pollution	Pollution from stationary locations or fixed facilities from which pollutants are discharged	
Diffuse pollution	Pollution from widespread activities with no one discrete source such as acid rain, pesticides, urban run-off and others	

List of abbreviations

Abbreviation	Name	Reference
BAT	Best available techniques	http://eippcb.jrc.ec.europa.eu/reference
BOD	Biochemical oxygen demand	
BREF	BAT reference document	http://eippcb.jrc.ec.europa.eu/reference
COD	Chemical oxygen demand	
EEA	European Environment Agency	www.eea.europa.eu
E-PRTR	European Pollutant Release and Transfer Register	http://prtr.ec.europa.eu/#/home
EU-28	The 28 EU Member States	
GHG	Greenhouse gas	
HCBD	Hexachlorobutadiene	
IED	Industrial Emissions Directive	http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm
IOWWTP	Independently operated waste water treatment plant	
NP	Nonylphenol	
NPEs	Nonylphenol ethoxylates	
PAHs	Polycyclic aromatic hydrocarbons	
pBDEs	Brominated diphenylethers	
PCBs	Polychlorinated biphenyls	
PCP	Pentachlorophenol	
p.e.	Population equivalent	
RBMP	River basin management plan	http://ec.europa.eu/environment/water/participation/map_mc/map.htm
RBSP	River basin-specific pollutant	
SoW	State of water	
TOC	Total organic carbon	
uPBT	Ubiquitous, persistent, bioaccumulative and toxic	
UWWTD	Urban Waste Water Treatment Directive	https://www.eea.europa.eu/themes/water/water-pollution/uwwtd
UWWTP	Urban waste water treatment plant	
WFD	Water Framework Directive	http://ec.europa.eu/environment/water/water-framework/index_en.html
WISE	Water Information System for Europe	

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Annex 1 Sector mapping of industry

EEA sector	EEA sub-sector	E-PRTR activity code
Manufacturing Industry	Iron and steel	2.(a)
		2.(b)
		2.(c)
		2.(d)
	Non-ferrous metal	2.(e)
	Other manufacturing	2.(f)
		9.(a)
		9.(b)
		9.(c)
		9.(d)
		9.(e)
	Non-metallic minerals	3.(c)
		3.(d)
		3.(e)
		3.(f)
		3.(g)
	Chemicals	4.(a)
		4.(b)
		4.(c)
		4.(d)
		4.(e)
		4.(f)
	Pulp, paper and wood	6.(a)
		6.(b)
		6.(c)
	Food and drink	8.(a)
		8.(b)
		8.(c)
Energy	Energy supply	1.(a)
		1.(b)
		1.(c)
		1.(d)
		1.(e)
		1.(f)
Waste	Waste water treatment	5.(f), 5.(g)

Annex 2 Eco-toxicity factors according to the USEtox model

This annex includes the USEtox eco-toxicity factors used in the calculations provided in this report. The data sources available required taking certain assumptions and, for certain substances, it was not possible to use the USEtox model. To illustrate this variety of situations, the following colour coding is applied:

Code	Legend
Blue	USEtox can be applied: data available
Orange	USEtox can be applied but with low accuracy
Red	USEtox cannot be used

Substances within the scope of the study and the USEtox eco-toxicity factors used		
E-PRTR parameter	**USEtox endpoint ecotoxicity (Continental emissions to freshwater — Potentially Disappeared Fraction of species/kg)**	**Comments**
Chlorinated organic substances		
Dichloromethane (DCM)	7.30	
Halogenated organic compounds (as AOX)	-	This group includes too many compounds to enable a toxicity factor to be developed
Tetrachloromethane (TCM)	-	No USEtox factor available
Chloro-alkanes, C10-C13	-	No USEtox factor available
1,2-dichloroethane (DCE)	7.55	
PCDD + PCDF (dioxins + furans) (as Teq)	4 721 860.86	Based on toxicity of 2,3,7,8-TetraCDD
Trichloromethane	20.57	
Vinyl chloride	-	No USEtox factor available
Tetrachloroethylene (PER)	303.41	
Trichloroethylene	41.52	
Trichlorobenzenes (TCBs) (all isomers)	570.01	
Pentachlorophenol (PCP)	45 312.87	
Polychlorinated biphenyls (PCBs)	50 459.19	Based on 4,4’-Dichlorobiphenyl
Hexachlorobenzene (HCB)	51 262.16	
Hexachlorobutadiene (HCBD)	3 829.00	
Hexabromobiphenyl	-	No USEtox factor available
Pentachlorobenzene	8 334.50	
Brominated diphenylethers (PBDE)	-	No USEtox factor available

Substances within the scope of the study and the USEtox eco-toxicity factors used		
E-PRTR parameter	**USEtox endpoint ecotoxicity (Continental emissions to freshwater — Potentially Disappeared Fraction of species/kg)**	**Comments**
Other organic substances		
Total organic carbon (TOC) (as total C or COD/3)	-	No USEtox factor available
Phenols (as total C)	466.23	Based on phenol
Nonylphenol and nonylphenol ethoxylates (NP/NPEs)	8 013.70	Based on nonylphenol
Polycyclic aromatic hydrocarbons (PAHs)	-	This group includes too many compounds to enable a toxicity factor to be developed
Di-(2-ethyl hexyl) phthalate (DEHP)	322.08	
Octylphenols and octylphenol ethoxylates	17 404.82	
Toluene	27.96	
Xylenes	110.37	Based on o-xylene
Benzene	32.98	
Ethyl benzene	87.43	
Fluoranthene	57 008.94	
Anthracene	150 798.79	
Naphthalene	-	No USEtox factor available
Benzo(g,h,i)perylene	-	No USEtox factor available
Organotin compounds (as total Sn)	-	This group includes too many compounds to enable a toxicity factor to be developed
Ethylene oxide	11.68	
Inorganic substances		
Total nitrogen	-	No USEtox factor available
Fluorides (as total F)	-	No USEtox factor available
Total phosphorus	-	No USEtox factor available
Chlorides (as total Cl)	-	No USEtox factor available
Cyanides (as total CN)	-	No USEtox factor available
Asbestos	-	No USEtox factor available
Heavy metals		
Chromium and compounds (as Cr)	28 125.00	Average value: 4.05E+03 (Cr III) and 5.22E+04 (Cr VI)
Nickel and compounds (as Ni)	149 093.46	
Zinc and compounds (as Zn)	66 579.77	
Arsenic and compounds (as As)	13 845.00	Average value: 7.59E+03 (As III) and 2.01E+04 (As V)
Lead and compounds (as Pb)	344.31	
Mercury and compounds (as Hg)	11 039.28	
Copper and compounds (as Cu)	4 962 139.49	
Cadmium and compounds (as Cd)	1 143 478.59	

Notes: AOX, adsorbable organically bound halogens; COD, chemical oxygen demand; PCDD, polychlorinated dibenzodioxin; PCDF, polychlorinated dibenzofuran; Teq, toxic equivalent.

Annex 3 Pressures from industrial waste water on urban waste water treatment plants, based on effluent typology

Category	Pollutants	Relevance of pressure	Type of pressure on UWWTPs
Minimal contamination (can be landspread)	Nutrients: nitrogen, phosphorous	Unlikely	• Larger feed than biological reactor was designed for (higher COD emissions)
Equivalent to domestic-type effluents	Degradable organics (BOD, COD)	Unlikely	
Low flow and non-domestic-type pollutants at low concentrations	Different from common UWWTP pollutants: e.g. pesticides, hormones, nano-plastics or endocrine disrupters	Medium	• Difficulties for sludge disposal/valorisation • Reliability issue (if plugging with micro-plastics) • Higher monitoring requirements • Buffer tank in inlet to ensure dilution (to avoid peaks)
Metals	Metals	High	• Difficulties for sludge disposal/valorisation
High nutrient loading	Substances increasing eutrophication	Medium	• Larger feed for biological reactor • Higher TN and/or TP emissions
Effluent streams requiring pH adjustment	Acids or alkali	High	• Corrosion (equipment damage) • Reliability • Lower biological reactor performance
Persistent organics content	Not easily degradable organics	High	• Difficulties for sludge disposal/valorisation (e.g. dioxins)
Emerging substances	New parameters and compounds not frequently measured, e.g. antibiotics	Unknown	• Reliability issue (if plugging with micro-plastics) • Lower biological reactor performance (pharmaceuticals)

Notes: Typical domestic waste water comprises primarily of nitrogen, phosphorus and chlorides and other organic content (total organic carbon, organic content expressed with BOD and COD). BOD, biological oxygen demand; COD, chemical oxygen demand; TN, total nitrogen; TP, total phosphorus.

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