Study on:
"Contribution of industry to pollutant emissions to air and water"

AMEC Environment & Infrastructure UK Limited

in partnership with Bio Intelligence Service, Milieu,

IEEP and REC

September 2014

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European Commission (DG Environment)

Contribution of industry to pollutant emissions to air and water



Final Report

AMEC Environment & Infrastructure UK Limited in partnership with Bio Intelligence Service, Milieu, IEEP and REC

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European Commission (DG Environment)

Contribution of industry to pollutant emissions to air and water

Final Report

AMEC Environment & Infrastructure UK Limited

September 2014

Report for

European Commission
Directorate-General Environment
Directorate C – Sustainable Resources Management, Industry and Air
Unit ENV C.3 – Industrial emissions, air quality and noise
Brussels B-1049
Belgium

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Summary

Introduction

The implementation of Directive 2010/75/EU on industrial emissions (IED) from 7 January 2013 onward will result in tighter regulation of pollutant emissions to air and water from industrial installations operating in EU Member States. Under the IED, new conclusions will be adopted for Best Available Techniques (Commission Implementing Decisions on BAT conclusions) and their application will lead to further reductions in pollutant emissions. However, industrial activities subject to IED make up only one component of Europe's emission profile and there is a need to understand the share and extent of emissions that are deemed to be regulated and 'unregulated' by current EU legislation. This report forms part of the evidence base to answer that question as well as quantifying the contribution of (agro-)industrial activities to the overall pollutant load on air and water when judged against all anthropogenic emission sources.

Scope and Source Data

The scope of this study was the EU-27; Croatia was not yet a Member State of the EU when this study was commissioned and there was recognition that key source references were unlikely to contain the necessary data on pollutant emissions from Croatia's (agro-)industrial activities.

The analysis reviewed and extracted data from a range of sources and apportioned pollutant emissions by source into one of four categories:

- **category i** : activities that are regulated under the IED,
- **category ii** : activities where pollutant emissions are regulated under other EU legislation (e.g. EU-ETS, the Nitrates Directive and the Urban Waste Water Treatment Directive),
- **category iii** : activities currently not subject to EU legislation affecting pollutant emissions; and
- **category iv** : all other anthropogenic sources of pollution, e.g. transport, domestic, commercial.

In estimating the split of emissions between these categories, the following data sources have been used:

	Air emissions	**Water emissions**
Category i	E-PRTR	E-PRTR and Waterbase
Category ii	E-PRTR, LRTAP, Sectoral studies	E-PRTR and Waterbase
Category iii	E-PRTR, LRTAP, Sectoral studies	E-PRTR and Waterbase
Category iv	LRTAP	E-PRTR and Waterbase

In recognition that no single source of data was likely to provide the relevant level of detail covering all Member States and activities, the study sought to fill gaps in current knowledge and to highlight issues by comparing, merging and resolving data.

A reference year of 2010 was chosen to provide a snapshot of air and water pollutant emissions and to bring some focus to the collection and analysis of data from multiple sources. The compilation of water pollutant emissions data for 2010 with the requisite coverage of Member States and activities proved exceedingly problematic, and methodological concessions were made to ensure analytical outputs could be presented.

The sources data for this study were gathered from existing databases and supplemented with research and data contained in published EU air and water studies and sector-based analytical research on pollutant emissions. Modelled data (e.g. GAINS) was not used directly in this study. Data was gathered on 17 air pollutants and 22 water pollutants.

Finally, the report is based on data reported by Member States. It has been assumed that what is not reported is not regulated. However, it is likely that for some sectors and some pollutants (e.g. ammonia from agriculture), the 'unregulated' emissions (category iii) presented in this report are over-estimates. This is most probably due to incomplete reporting of pollutant emissions from activities in category i and ii.

Results

There remains unresolved uncertainty and incomparability between some of the data-points used in the study, which is manifested as uncertainty in the results. Therefore any conclusions drawn are subject to the limitations outlined in Section 1.5 of the report and should be taken as being indicative rather than absolute. In addition, a limitation resides in the presentation of pollutants and data in mass terms. The analysis of pollutant data in mass terms was selected because of the availability of mass emissions data and the ability to compare between pollutants, groups of pollutants and categories of activities using a common metric. The limitation to this approach is that the results do not account for the relative environmental or human health impacts caused as a result of the pollutant releases. However, the results do show common patterns that provide confidence in the overarching conclusions drawn from the data.

Analysis of air emissions

Figure 1 presents the sum and relative splits (based on mass) of total emissions to air for the 17 air pollutants examined across the four different categories. Key conclusions drawn from this are:

- Almost one quarter (23%) of air pollutant emissions emitted across the EU by mass originate from (agro-)industrial sources that fall within the IED (Category i).
- The majority of air emissions (60%) come from sources that fall outside of the definition of (agro-)industrial activities (Category iv); and
- Emissions from those activities deemed to be regulated by other EU legislation (Category ii) and those 'unregulated' under current EU legislation (Category iii) are a relatively small, but not

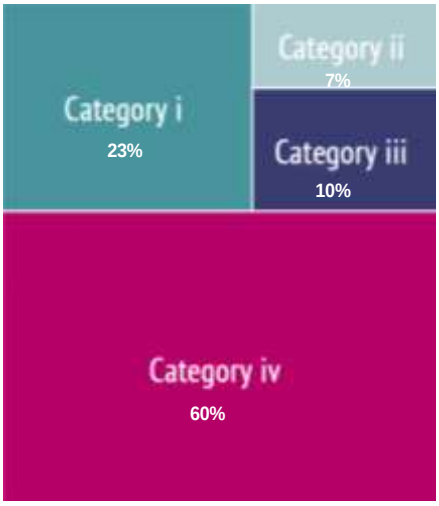


Figure 1 – Partition of air emissions

negligible, (7% and 10% respectively) amount of the total.

The headline partition of emissions across the four categories hides substantial variance at a pollutant level, at the level of groups of (agro-)industrial activities and at a Member State level.

Analysis of air emissions – by pollutant groups

Figure 2 presents the partition of emissions for **combustion pollutants** (CO, NO_X, PM_{10} and SO_X).

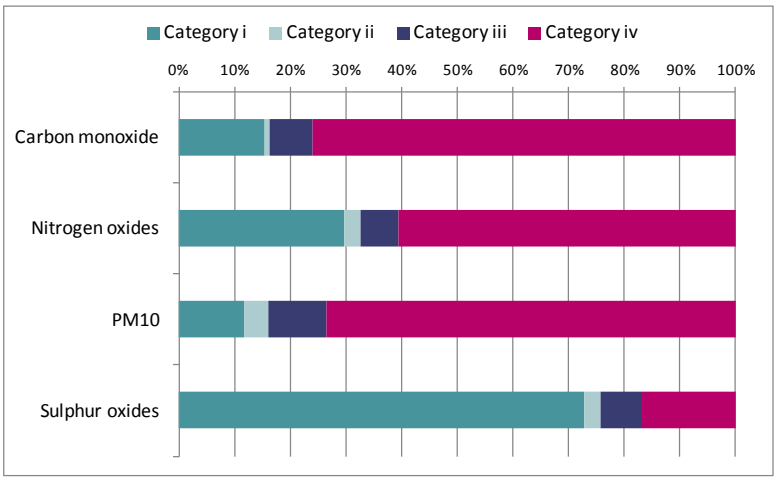


Figure 2 – Partition of air emissions for combustion pollutants

- The activities within category iv (i.e. non-(agro-)industrial) are a major source of combustion pollutants for carbon monoxide, PM_{10} (more than 70% in both cases), and nitrogen oxides;
- The share of the emissions considered 'unregulated' (category iii) is relatively small as a proportion of all emissions but, particularly for PM_{10} and CO, is substantial when anthropogenic sources are excluded; and
- Combustion plants below 50 MWth form most of category ii and iii emissions of NO_X, PM_{10} and SO_X. The vast proportion of SO_X is emitted from activities regulated under IED.

Figure 3 presents the partition of pollutant emission emissions for **heavy metals**:

- For the following pollutants: arsenic, chromium, lead, mercury and nickel, the analysis indicates the majority (50-60%) of emissions are from category i activities (IED). The smallest share of the total is from category ii (0–5%), a small proportion from category iii (5-15%) and the balance from category iv (30-40%).
- For cadmium and zinc, the split of emissions between categories is similar. More than half of the emissions are emitted by non (agro-)industrial activities in category iv, including sources such as transport. Almost all copper emissions arose from category iv (95%), which has been reported as copper emissions from road transport and mainly from (normal) automobile tyre and brake component wear. Finally, the majority of zinc emissions are from non-industrial activities (category iv), which are reported as being due to the production of iron and steel and surface treatment (e.g. zinc galvanising) below the IED thresholds.

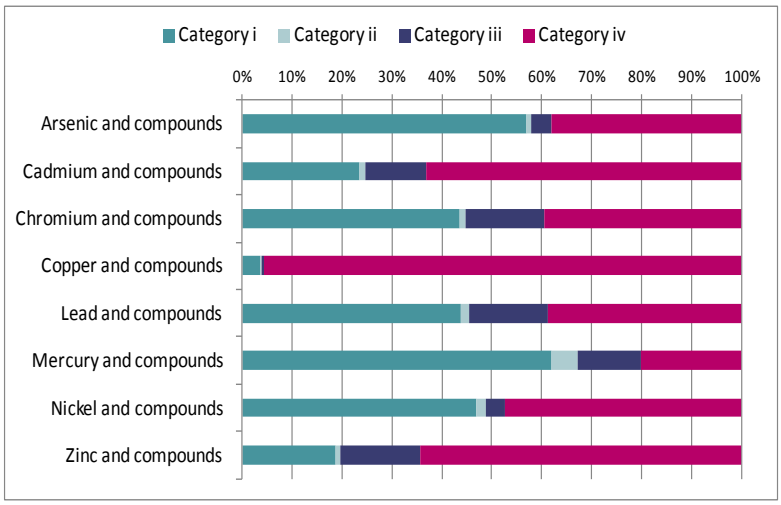


Figure 3 – Partition of air emissions for heavy metals

Figure 4 presents the partitions for the **'other pollutants'** grouping. Whilst it is difficult to identify common patterns, the following observations are highlighted:

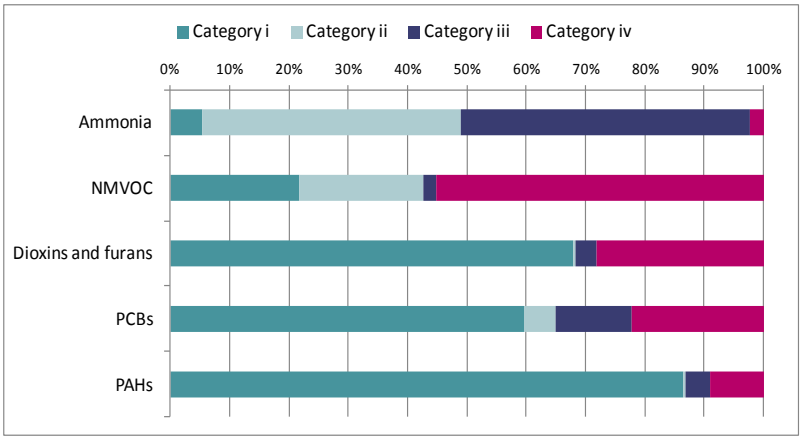


Figure 4 – Partition of air emissions for other pollutants

- The majority of ammonia emissions (95%) arise from agriculture, of which most is reported as being emitted by activities in category ii or category iii. Although only a small proportion are shown to be from IED-regulated agricultural activities, the conclusions of this study suggest that category i emissions are under-reported and a substantial part of category iii should lie in category i (although the data sources do not directly confirm this);
- For dioxins, furans and PAHs emissions, the results are relatively similar with most of the emissions originating from category i activities (more so for PAHs), and the majority of the balance from category iv; and
- Emissions of NMVOC and PCBs are similar in the fact that the majority of the emissions (50-60%) are emitted from activities that fall within category iv.

As can be seen in the previous figures, emissions from other anthropogenic sources (e.g. road transport, domestic, commercial services, shipping) can represent an important share of the overall emissions. To better understand the emissions arising only from (agro-)industrial activities, calculations have been made using data representative of activities in categories i, ii and iii only. Figure 5 presents the partition of emissions between category i, ii and iii for each pollutant focusing solely on (agro-)industrial activities (i.e. excluding all category iv emissions).

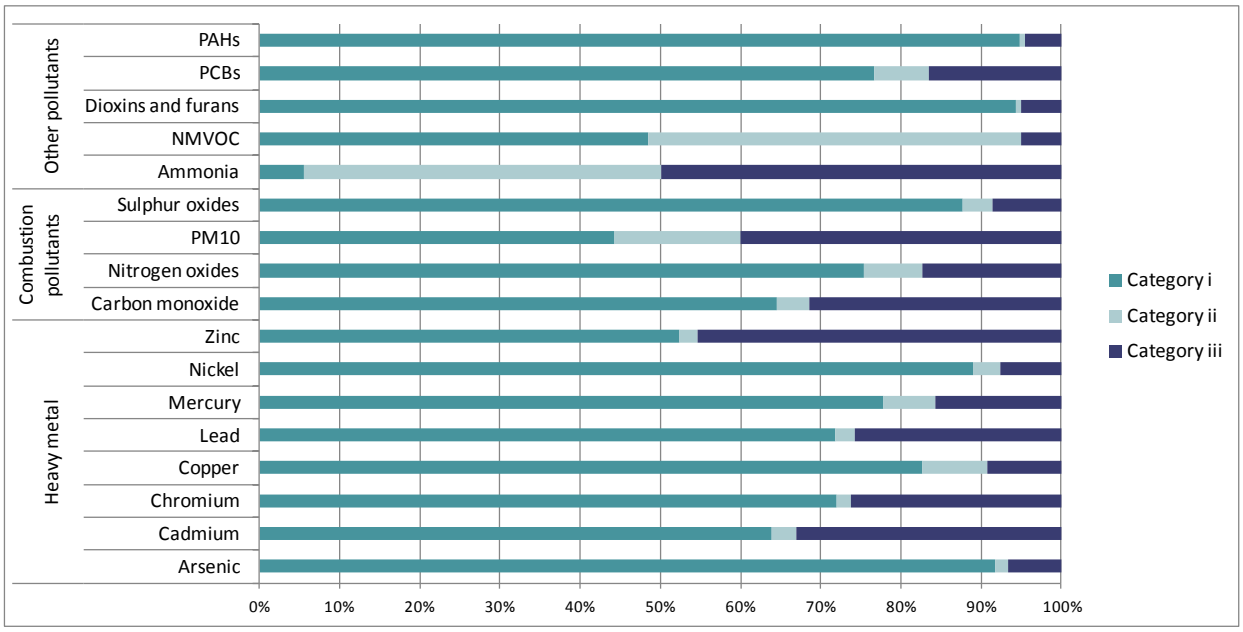


Figure 5 – Relative partitions for air emissions for all (agro-)industrial activities (i.e. excl. category iv)

Figure 5 illustrates that the share of emissions regulated by the IED is far more significant when the contribution of other anthropogenic sources is removed. For most pollutants (with the exception of ammonia, zinc and to a lesser extent PM_{10} and NMVOCs), the emissions from category i represent at least 60% of total emissions. The conclusion from the analysis of (agro-)industrial emissions only is that the IED is a highly effective legislative instrument at capturing and subsequently preventing, reducing and controlling pollutant emissions from industrial activities being undertaken within the EU. However, there are several notable exceptions:

- Concerning the percentages of ammonia emissions in categories ii and iii, analysis of the various informative data sources and published reports (including modelled data) indicates that the share of emissions reported from category i activities (IED) are likely to be a substantial under-estimate. This could be due to installations within Member States either not meeting the reporting threshold set in E-PRTR or under-reporting at the Member State level;
- Zinc emissions located in category iii are mainly due to industrial processes involving the production of iron and steel and the subsequent treatments applied. The reported data suggest that emissions from this activity are from facilities that are operating below the IED production thresholds;
- Emissions of PM10 located in category ii and iii are mostly due to combustion plants below 50 MWth. It is expected that the new Directive proposed by the Commission as part of the Clean Air Policy Package in December 2013 will contribute to addressing the long-term reduction of these emissions; and
- Emissions from NMVOCs are mostly regulated with nearly 95% of emissions either in category i or ii.

Analysis of air emissions – by pollutant

In providing a comprehensive picture of the relative portions of pollutant emissions by category, Table 1 presents the splits for the air pollutants examined in this study and provides a very high level commentary on the main observations drawn from the analysis. For more detail refer to the individual pollutant results in Section 4.2.

Table 1 – Summary of the categorisation of air pollutants and headline observations from the analysis

Pollutant	Categorisation of pollutant emissions (2010 data)				Observations
	Cat i	Cat ii	Cat iii	Cat iv	
SOx	73%	3%	7%	17%	Total emissions of 3.9 M tonnes. Category i emissions are predominant. Total of category ii and iii is smaller (405 kt) due mainly to the activity of medium combustion plants. In category iv, emissions are from domestic sector (418 kt) and shipping (151 kt).
NOx	30%	3%	7%	60%	Total emissions of 8 M tonnes. Emissions from category iv are predominant (4.8 M tonnes), especially the road transport sector (3.7 M tonnes). Category i emissions are the second most important with 2.3 M tonnes, of which combustion activities in installations above 50 MWth represent more than half of these emissions (1.5 M tonnes). Category ii and iii total emissions are due mostly to the activity of combustion plants between 1-50 MWth (554 kt).
PM	12%	4%	11%	73%	Total emissions of 1.4 M tonnes. Emissions from category iv are predominant and more specifically by the domestic sector (700 kt) and road transport (280 kt). Emissions in category i are due mainly to combustion installations above 50 MWth (76 kt) and waste incineration (28 kt). Emissions in category iii are mainly due to the transport and storage of agricultural products (63 kt) and combustion plants below 20 MWth (37 kt).
CO	15%	1%	8%	76%	Total emissions of 22.2 M tonnes. The majority of emissions (16.9 M tonnes) are emitted by category iv activities such as domestic sector (8.8 M tonnes) and road transport (7.2 M

Pollutant	Categorisation of pollutant emissions (2010 data)				Observations
	Cat i	Cat ii	Cat iii	Cat iv	
					tonnes). Category i activities are also a significant source of emissions, with more than 3 M tonnes. Emissions from 'unregulated' activities (category iii) (1.6 M tonnes) are mainly due to the production of pig iron and steel below 2.5 tonnes per hour (more than1 M tonnes) and the field burning of agricultural wastes (442.7 kt).
Arsenic	57%	1%	4%	38%	Total emissions of 73.7 tonnes. Main source of emissions are in category i: combustion installations above 50 MWth (19.4 tonnes), waste incineration (9.9 tonnes) and the manufacture of glass (3.6 tonnes). Category iv accounts for 28 tonnes of arsenic, mostly from the domestic sector (20.9 tonnes). Category ii emissions are lower (0.7 tonnes) and arise from industrial activities below IED thresholds. Category iii emissions (2.8 tonnes) are mainly from the production of pig iron and steel below 2.5 tonnes per day.
Cadmium	24%	1%	12%	63%	Total emissions of 58.3 tonnes. Category iv emissions are 36.9 tonnes, originating from the domestic (27.6 tonnes), and the commercial sectors (5.7 tonnes). Category i emissions (13.7 tonnes) are due mostly to the production of pig iron and steel (4.8 tonnes). Under category ii, a small amount is emitted (607 kg) by industrial processes including pulp, paper and card and non-ferrous metals production below IED thresholds. A total of 7.1 tonnes is currently 'unregulated', of which 6.5 tonnes is emitted by the production of pig iron or steel below 2.5 tonnes per hour.
Chromium	44%	1%	16%	39%	Total emissions of 247.9 tonnes. Most emissions are from category i (108 tonnes) and more specifically from the production of pig iron and steel and from combustion plants above 50 MWth. Category iv is the source of 97.8 tonnes, mainly from the road transport and the domestic sectors. Category iii (39.4 tonnes) emissions are mainly from the production of pig iron or steel below 2.5 tonnes per hour (37.5 tonnes). Category ii is the smallest category (2.7 tonnes); of which 1.6 tonnes are from cement production below IED thresholds.
Copper	4%	0%	0%	96%	Total emissions of 3.3 kt. Most of these emissions are from activities in category iv (3.1 kt) and in particular from road transport (90% of the total i.e. 2.9 kt). Category i activities emit 121 tonnes of copper from the following main sources: production of pig iron and steel (31 tonnes), processing of non ferrous metals (31 tonnes) and combustion plants above 50 MWth (15 tonnes). Only a small amount (13.3 tonnes) was reported from category iii, of which the production of pig iron or steel with a capacity below 2.5 tonnes per hour is the most significantly emitting activity (12.4 tonnes).
Lead	44%	2%	16%	39%	Total emissions of 1.3 kt. Nearly half of these emissions (574.7 tonnes) are from activities included in category i, such as the production of pig iron or steel, the production of inorganic chemicals and waste incineration. Category iv emissions originate from the road transport and domestic sectors (almost 400 tonnes in total). Emissions from 'unregulated' activities represent 205.9 tonnes, due mostly (196.6 tonnes) to the production of pig iron or steel below 2.5 tonnes per hour. Emissions from category ii activities are 20 tonnes.
Mercury	62%	5%	13%	20%	Total emissions of 52.1 tonnes. The majority due to category i activities such as combustion installations above 50 MWth (16.2 tonnes), the production of pig iron and steel (3.7 tonnes) and waste incineration (3.4 tonnes). Notable category iv emitters are the domestic sector, commercial sector and shipping (approximately 3 tonnes from each). Emissions currently 'unregulated' (category iii) represents 6.5 tonnes, most of which originates from the production of pig iron and steel below 2.5 tonnes per hour. A total of 2.7 tonnes of mercury emissions are in category ii of which 1.8 tonnes are due to the production of cement below IED threshold.
Nickel	47%	2%	4%	47%	Total emissions of 585.7 tonnes. The operation of combustion plants above 50 MWth (113 tonnes), the refining of mineral oil and gas (106 tonnes) and the manufacture of organic chemicals (11 tonnes) are the main sources of emissions in category i. Category iv is equally significant with 276.7 tonnes, most of which arise from the domestic (117 tonnes) and the commercial sectors (94 tonnes). Emissions from category iii are smaller (23.4 tonnes) and are due to the manufacture of paper or cardboard under IED thresholds (9 tonnes) and the production of pig iron or steel below 2.5 tonnes per hour (14 tonnes).
Zinc	19%	1%	16%	64%	Total emissions of 5 kt. The majority of the emissions of zinc (3.2 kt) come from category iv activities and mainly from the road transport. The second most important share of emissions arise from category i (almost 1 kt) which is primarily due to the production of pig iron and steel (477 t) and combustion installations above 50 MW (188 t). Emissions under category iii are

Pollutant	Categorisation of pollutant emissions (2010 data)				Observations
	Cat i	Cat ii	Cat iii	Cat iv	
					almost exclusively due to the production of pig iron or steel below 2.5 t per hour
Ammonia	5%	44%	49%	2%	Total emissions of 3.59 kt. Agricultural activities in categories i, ii and iii are the dominant emitters (95%). Notable category iii emitters are the rearing of dairy cattle (464 kt), non-dairy cattle (469 kt) and the rearing of pigs below the IED threshold (391 kt). Category ii emissions are predominantly from fertiliser use and from manure.
Dioxins & Furans	68%	0%	4%	28%	Total emissions of 2.5 kg. The majority of emissions from metal production are already controlled under the IED. Emissions from a wide range of different activities with the energy (0.66 kg), chemical (0.48 kg) and category iv non-industrial sectors (in particular 0.6 kg of emissions from domestic sources such as home boilers) being key emitters.
NMVOCs	22%	21%	2%	55%	Total emissions of 4.3 M tonnes with 2.4 M tonnes from category iv activities. Emissions in category i (947 kt) and category ii (908 kt) are primarily from activities involving the use of organic solvents. The energy industry (all category i) is responsible for 181 kt, mostly from oil/gas refining (123 kt) and LCP (46 kt).
PAH	86%	1%	4%	9%	Total emissions 9.5 kt, of which over 8.2 kt are from category i activities, in particular paper and card production, which represents 82% of total emissions. PAH's from the domestic sector are notable (797 tonnes), as are emissions from the category iii activity field burning of agricultural waste (228 tonnes).
PCBs	60%	5%	13%	22%	Total emissions 3.4 tonnes with more than half from category i activities (2 t) primarily from waste incineration (1.2 tonnes). Emissions from non-industrial activities represent 0.7 tonnes of which 0.57 tonnes arise from the domestic sector. A small share of emissions come from category iii activities (440 kg) emitted by the production of pig iron or steel below 2.5 tonnes per hour. A total of 180 kg was emitted by category ii activities from the recovery of non-hazardous waste (62 kg) and activities using organic solvents (63 kg) below the IED thresholds.

Analysis of water emissions

Unlike air emissions, the source data for assessing the partition of water emissions between the different categories were not directly comparable and therefore a single unified dataset has not been derived. The results presented from analysis of the Waterbase data have limited Member State coverage (15 MS) and cannot therefore be taken as a fully representative picture of the EU as a whole.

Data reported in the E-PRTR provide a more comprehensive picture for (agro-)industrial emissions in category i, but representation of categories ii and iii is less complete than that in Waterbase. As a result, E-PRTR data are presented for categories i and ii; data from Waterbase are presented for category i, ii/iii and iv. Where IED activities discharge indirectly to water (i.e. via a sewer or off-site treatment works) the emissions will be captured in Category ii as opposed to Category i. As a consequence, the results in this report are likely to underestimate the total emissions captured under IED (Category i) and consequently overestimate the emissions from Category ii/iii. The main report discusses the relative merits and limitations of the two sets of data and, for specific pollutants, presents the results of both in order to allow comparison.

The structure of EU water legislation creates a situation where activities that are not regulated under the IED should, in theory, be subject to appropriate measures where it is assessed that the pollutant emissions as a result of that activity may affect the achievement of the objectives of EU water law. This premise, and the way in which data is reported, means that the majority of pollutant emissions arising from (agro-)industrial activities could be considered to be category ii (i.e. subject to EU legislation which affects emissions but which does not specifically

target them). The Directives on Urban Waste Water Treatment and on Nitrates are examples of EU legislation affecting emissions to water bodies by setting an overall regulatory framework but do not, at the installation level, set direct controls in a similar way to ELVs for an IED permitted facility. Due to the difficulty in partitioning these two categories it remains unclear to what extent these could be considered 'unregulated'. As a consequence, and distinct from this report's consideration of air emissions, water emissions are considered as a combined category ii / iii.

Figure 6 graphically presents the relative partitions (based on mass) of emissions to water for the pollutants examined using the Waterbase data. Observations drawn from this are:

- IED regulated activities (category i) make up only 2% of the total share using Waterbase data. E-PRTR data suggests this figure is higher and may lie at or above 20%;
- Non (agro-)industrial activities (category iv) make up only a small proportion (8%) as the water discharges from commercial, domestic and other activities should, in the main, be captured by the UWWTD; and
- (agro-)industrial activities in categories ii and ii/iii are the largest share of total emissions (90%).

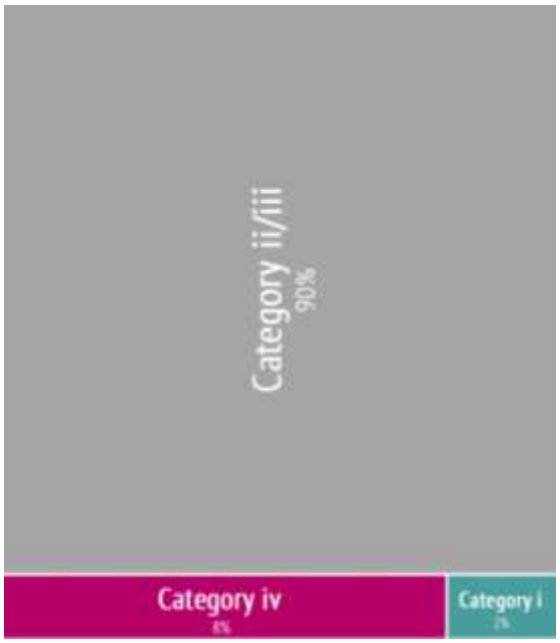


Figure 6 – Partition of water emissions (data from Waterbase reported by 15 MS)

Analysis of water emissions by pollutant groups

To facilitate the presentation of the analysis of the data, pollutants are presented in three generic groups. Figure 7 presents the splits of emissions using Waterbase data and Figure 8 using E-PRTR data. Pollutant groupings are the same but coverage of the categories is not.

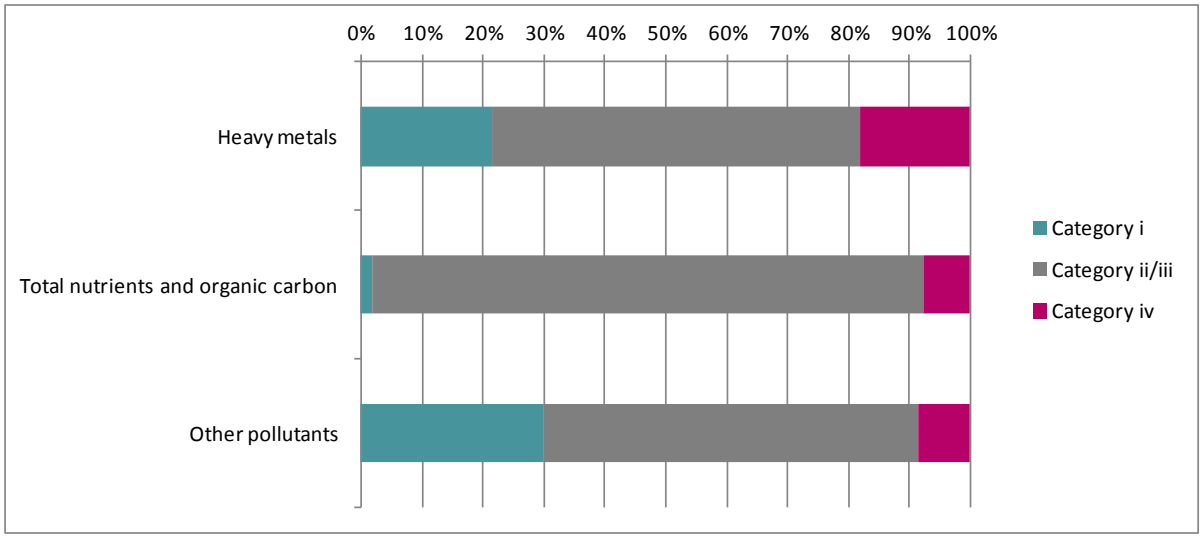


Figure 7 – Partition of water emissions in three pollutant groups (data from Waterbase reported by 15 MS)

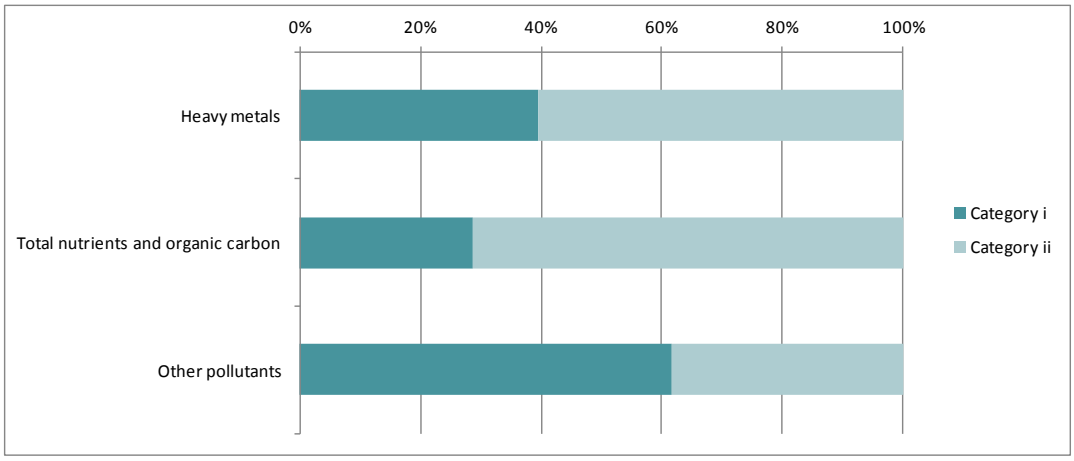


Figure 8 – Partition of water emissions in three pollutant groups (data from E-PRTR, 2010)

Both data sets report emissions from category ii/iii as being the most significant for heavy metals and for total nutrients and organic carbon. With regard to the 'other pollutants' (1,2-dichloroethane, chlorides, cyanides (as total CN), di (2-ethylhexyl) phthalate (DEHP), fluorides, halogenated organic compounds and phenols), E-PRTR data indicates a higher proportion of these emissions are from activities already regulated by the IED (category i). Using the Waterbase data, Figures 9, 10 and 11 show the partitions of emissions between the four categories for emissions of heavy metals, nutrients, TOC and other pollutants. Acknowledged limitations and limited geographical coverage frame the presentation of these results.

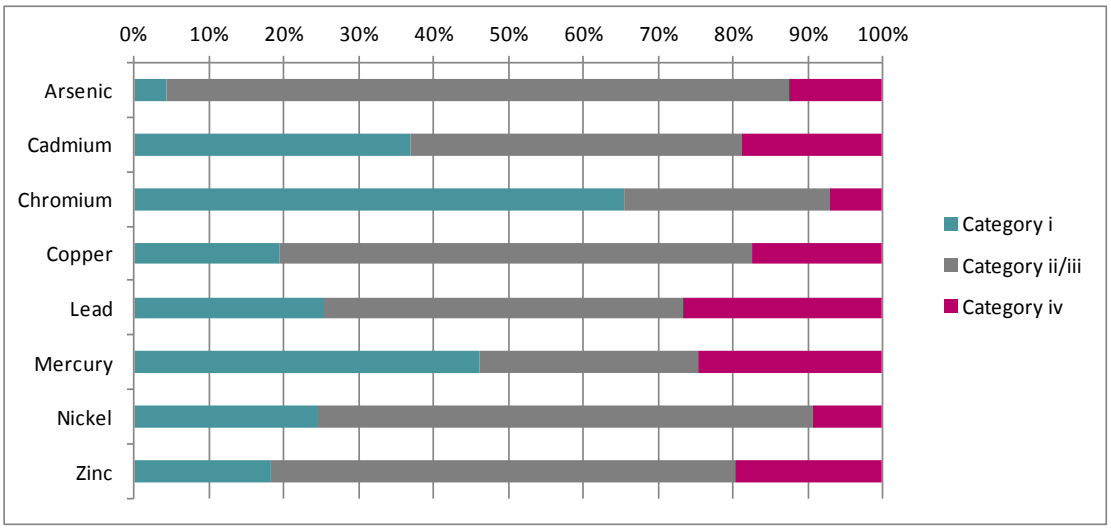


Figure 9 – Partitions for water emissions of heavy metal pollutants (Waterbase data, various years)

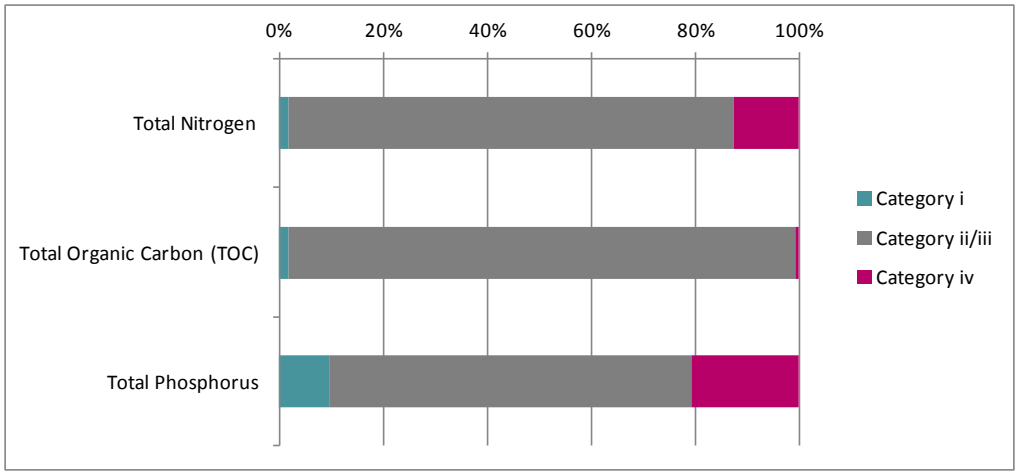


Figure 10 – Partitions for water emissions of nutrient pollutants and TOC (Waterbase data, various years)

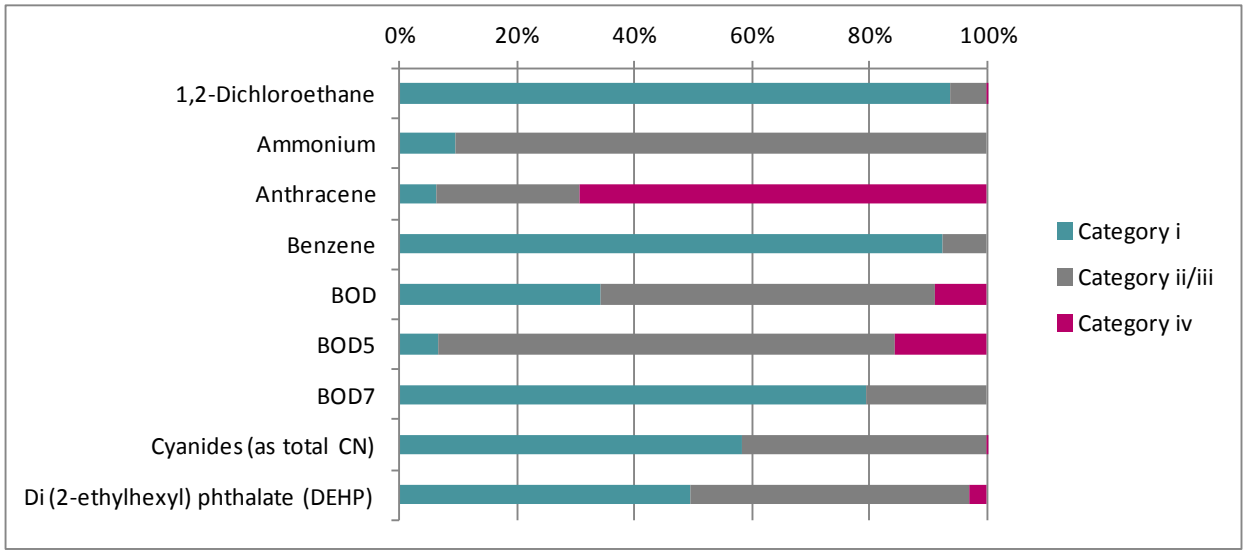


Figure 11 – Partitions for water emissions of other pollutants (Waterbase data, various years)

Analysis of water emissions – by pollutant

Table 2 (over page) presents the splits for the water pollutants examined in this study and provides a high level commentary on the main observations drawn from the analysis. For more detail, please refer to the individual pollutant results in Section 5.2. *Figures in the table within the different categories are E-PRTR (1st set) and Waterbase (2nd set).*

Table 2 – Summary of the categorisation of water pollutants and headline observations from the analysis

Pollutant Emissions to Water[1]				
Pollutants	Cat i	Cat ii / Cat ii/iii	Cat iv	**Observations**
1,2-dichloroethane	67%	33%	-	**E-PRTR**: IED emissions (4,733 kg) are entirely from installations manufacturing plastics and chemicals. All non-IED emissions (2,364 kg) are reported from wastewater discharges.
	94%	6%	0%	**Waterbase**: Emissions are almost entirely from industrial sources (17,835 kg). Emissions from category ii/iii activities (1,225 kg) are from unspecified (mixed) activities discharging via the common sewerage network.
Ammonium	-	-	-	**E-PRTR**: Not covered in the dataset.
	9%	91%	0%	**Waterbase:** Direct discharges from IED industrial activities make up only a small proportion based on reported data (16,015 kg), with non-specified emissions through sewerage networks and unspecified direct discharges (all category ii/iii) account for the vast majority (154,071 kg). It should be noted that no emissions are reported in Waterbase from the agriculture sector, although some might be expected, such as where ammonium sulphate is used as a fertiliser.
Anthracene	-	-	-	**E-PRTR**: Not covered in the dataset.
	6%	24%	69%	**Waterbase:** Anthracene is used in manufacturing processes, such as for dyes. However, the data reported shows only 6% of emissions are from industrial sources (category i, 77kg). Category ii/iii emissions amount to 306 kg and are from WWTPs (via sewerage systems) and direct unspecified discharges. The largest emissions (867 kg) are reported within category iv (diffuse and atmospheric sources).
Arsenic	51%	49%	-	**E-PRTR**: Category ii emissions amount to 26,335 kg, with substantial emissions from WWTPs. Small additional sources include sawmills and mining. A large range of category i installations report arsenic emissions (27,401 kg), including pulp and paper production.
	4%	83%	13%	**Waterbase:** Waterbase presents a very different picture for arsenic discharges, with far higher total values reported. Category i accounts for 10,415 kg emitted. By far the largest source of emissions recorded is riverine inputs to coastal waters (category ii/iii), which emitted 204,041 kg in total. Finally, 30,662 kg are reported for category iv.
Benzene	-	-	-	**E-PRTR**: Not covered in the dataset.
	92%	8%	0%	**Waterbase:** Benzene emissions in category i arise from a mix of industrial sources (35,984 kg). Most category ii/iii emissions (2,939 kg) are from WWTPs.
BOD	-	-	-	**E-PRTR**: Not covered in the dataset.
	34%	57%	9%	**Waterbase:** Category i emissions amount to 314,955 kg from industrial sources. Category iv (81,074 kg) accounts for a smaller share of reported emissions which mostly arise from urban diffuse pollution. Category ii/iii (521,721 kg) is mainly due to emissions from WWTPs. Agricultural emissions are also reported, but these are negligible compared to the overall emissions within category ii/iii.
Cadmium	34%	66%	-	**E-PRTR**: The main category i emissions were from different metal processing activities, glass manufacture, pulp, paper and waste activities, which in total emitted 6,203 kg of cadmium. Discharges via the sewerage network (WWTPs) are an important category ii source, as is mining.
	37%	44%	19%	**Waterbase:** Industrial discharges (category i) are a substantial source of emissions, with 13,606 kg of cadmium reported. Emissions from category ii/iii sources (16,315 kg) emanate mainly from treatment of sewage via WWTPs, which is the most significant source of emissions. Agriculture is also an important contributor, with nearly 9% of the total cadmium emissions. Category iv activities originate largely from urban diffuse sources (6,954 kg).
Chlorides	61%	39%	-	**E-PRTR**: Category i emissions (10,235 kt) are emitted by a wide range of installations, including oil/gas refineries, gasification, chemicals processes and metal processes. Within category ii (6,571 kt), the most commonly reported source is from WWTPs. However, where it is reported, mining is a major source, in particular for mining of underground salt.
	-	-	-	**Waterbase:** Not covered in the dataset.

Pollutant Emissions to Water[1]				
Pollutants	Cat i	Cat ii / Cat ii/iii	Cat iv	**Observations**
Chromium	60%	40%	-	**E-PRTR**: Category i emissions (154 tonnes) are due to the activity of thermal combustion processes, metal processes, pulp manufacture and some chemical processes. Within category ii, a range of sources are reported, emitting over 104 tonnes of chromium, with sewage treatment via WWTPs being the most significant.
	66%	27%	7%	**Waterbase** Category ii/iii activities reported 199 tonnes of emissions, mainly from WWTPs and a small contribution from agriculture. Other large sources are reported within category iv (52 tonnes), by far the largest of which are urban diffuse sources. However, the majority of emissions are reported under category i (478 tonnes).
Copper	20%	80%	-	**E-PRTR**: Within category ii (361 tonnes), the most commonly reported source was from the treatment of sewage (WWTPs), which accounted for the majority of emissions. Mining and aquaculture are also reported by some Member States and could be significant sources of emissions. The emissions from category i activities (92 tonnes) originate from diverse sources including thermal combustion processes, incineration, metal processes and chemical processes. Pulp processes are minor contributors.
	19%	63%	17%	**Waterbase:** The main activity within category ii/iii is sewage treatment (WWTPs), but agricultural emissions account for 8% of total emissions. Category ii/iii accounts for the majority of the emissions of copper with 1,442 tonnes. Contributions within category iv (395 tonnes) include urban diffuse sources and atmospheric deposition.
Cyanides	84%	16%	-	**E-PRTR**: Category i sources emitted a total of 166 tonnes from a wide range of installations such as refineries, metal processes, paper-board manufacture and chemical processes. Within category ii (31.7 tonnes) the largest contributor is sewage treatment (WWTPs). However, mining is also reported as being a source of some significance.
	58%	42%	0%	**Waterbase**: Industrial sources (category i) are the most important sources of emissions with 98.4 tonnes of emissions. Category ii/iii (70.4 tonnes) main emitters are direct discharges to coastal and transitional waters. They are followed by emissions from WWTPs. Category iv is represented by a negligible (6 kg) reported input from atmospheric deposition.
DEHP	2%	98%	-	**E-PRTR**: The overwhelming majority of emissions arise from category ii activities (24.3 tonnes), and more specifically from WWTPs. Small quantities are emitted by a range of category i installations (413 kg) which includes refineries, landfills, chemical manufacture, smelting and paper and paperboard manufacture.
	49%	48%	3%	**Waterbase:** Category i industrial emissions (3,153 kg) are an important proportion. In contrast to E-PRTR, category ii/iii emissions account for only 48% (3,044 kg), of which WWTPs are the largest contributor. Category iv emissions (196 kg) are of atmospheric origin.
Fluorides	69%	31%	-	**E-PRTR:** Emissions reported in category i (5 kt) are from a wide range of activities including thermal power stations, refineries, most metal processing and coating activities, manufacture of fertilisers and different chemical processes. Within category ii (2.2 kt), WWTPs are the most commonly and largest reported source of fluorides. However, other sources have reported emissions including both underground and open-cast mining.
	-	-	-	**Waterbase:** Not covered in the dataset.
Halogenated organic compounds	69%	31%	-	**E-PRTR**: WWTPs are the most important sources of category ii emissions (total 1.2 kt). The majority of the emissions arise from category i installations (2.8 kt) such as refineries, metal processes, surface treatment, chemicals manufacture (e.g. plastics, biocides), pulp and paper manufacture and landfills.
	-	-	-	**Waterbase:** Not covered in this dataset
Lead	26%	74%	-	**E-PRTR:** The most commonly reported source of emissions in category ii (114 tonnes) are WWTPs and underground and open cast mining. The remaining emissions are from category i (40.6 tonnes) and include activities such as thermal power stations, oil/gas refiners, metal processing activities, landfills, pulp manufacture and animal raw materials processing.
	25%	48%	27%	**Waterbase:** Most category ii/iii emissions (total 320.9 tonnes) are from WWTPs (sewage treatment), however almost 8% of total reported emissions are from the agriculture sector.

Pollutant Emissions to Water[1]				
Pollutants	Cat i	Cat ii / Cat ii/iii	Cat iv	**Observations**
				Category iv is responsible for 177.3 tonnes, mostly from urban diffuse sources.
Mercury	53%	47%	-	**E-PRTR:** The majority of emissions are from a wide range of category i activities (2,237 kg) including thermal power stations, refineries, hazardous waste facilities, metal processing, chemical processing, landfills and production of explosives. For category ii (1,980 kg), waste water treatment is the most commonly reported source of emissions. Underground and open-cast mining is reported as an important source but only by a few Member States. **Waterbase:** Direct discharges from activities regulated under IED (category i), representing 4,189 kg are the largest source of emissions. Category ii/iii emissions (2,656 kg) largely originate from the treatment of industrial sewage (WWTPs). Reported emissions from agriculture are negligible. Category iv emissions (2,244 kg) are mainly emitted by urban and other diffuse sources.
	46%	29%	25%	
Nickel	34%	66%	-	**E-PRTR:** Emissions from category i activities (99,587 kg) are reported from a wide range of activities including thermal power stations, refineries, hazardous waste facilities, metal processing, chemical processing of almost all types, landfills and surface treatment. For category ii (195,776 kg), WWTPs are the most significant source of emissions. **Waterbase:** Category ii/iii emissions (640,223 kg) are mostly from sewage sources and direct discharges of water containing nickel to coastal and transitional waters. Agricultural emissions within category ii account for 6% of total reported emissions.
	25%	66%	9%	
Phenols	80%	20%	-	**E-PRTR:** The majority of emissions are from a wide range of category i activities (818.6 tonnes) including thermal power stations, refineries, rolling mills, gasification, metal processing, polymer production, landfills, pulp and paper, production of explosives and surface treatment. For category ii (209.9 tonnes), waste water treatment is the most commonly reported source. **Waterbase:** Not covered in the dataset.
	-	-	-	
Total nitrogen	16%	84%	-	**E-PRTR:** The majority of emissions arise from category ii activities (323 kt) mainly from WWTPs and in a lesser extent from from intensive aquaculture.. The rest of the emissions are from a wide range of category i activities (63 kt) including thermal power stations, oil/gas refineries, chemicals processes, landfills, slaughterhouses and processes for animal and vegetable raw materials. **Waterbase:** The main category ii/iii emitters are WWTPs. Emissions from agriculture are also important and account for a third of total reported emissions. Emissions from category ii/iii amount to 74 kt. Category iv emissions (11 kt) originate mainly from background emissions and atmospheric deposition.
	2%	86%	13%	
Total organic carbon	42%	58%	-	**E-PRTR:** Category i emissions (236.9 kt) are from a range of activities including thermal power stations, refineries, pulp and paper manufacture, chemicals processes, pharmaceuticals and processes for animal and vegetable raw materials. For category ii (326 kt), emissions mostly originate from waste water treatment, but some emissions arise from intensive aquaculture. **Waterbase:** Emissions are reported for several activities but noticeably not for agriculture. The majority of emissions are reported from WWTP activities in category ii/iii (60 kt).
	2%	97%	1%	
Total phosphorus	28%	72%	-	**E-PRTR:** Category i emissions (14 kt) are emitted from a wide range of activities including thermal power stations, oil/gas refineries, pulp and paper manufacture, chemicals processes and processes for animal and vegetable raw materials. For category ii (36 kt), waste water treatment is the most commonly and largest reported source. **Waterbase:** Most category ii /iii emissions (132 kt) are from WWTPs. Within category ii/iii, emissions from the agricultural sector are responsible for 9% of total emissions. Category iv inputs account for 21% of total emissions (39 kt) and, of these, diffuse sources and background inputs are the most important.
	9%	70%	21%	
Zinc	38%	62%	-	**E-PRTR:** Category i emissions (847.9 tonnes) are reported from a wide range of activities including thermal power stations, refineries, chemicals processes, fertiliser manufacture, slaughterhouses and disposal of hazardous waste. For category ii (1,393 tonnes), wastewater treatment is the most commonly and largest reported source.
	18%	62%	21%	

Pollutant Emissions to Water[1]				
Pollutants	Cat i	Cat ii / Cat ii/iii	Cat iv	Observations
				Waterbase: Emissions are reported for most activities. Category ii/iii emissions are roughly evenly split between WWTPs, agriculture and unspecified point sources and gather a total of 5,708 tonnes of zinc. Category iv (1,815 tonnes) gathers emissions from diffuse sources and background inputs.

Note 1: E-PRTR data is presented first and Waterbase data then, if one of the dataset is not available "-" is indicated

Conclusions

This study presented a considerable challenge to accurately categorise a range of different (agro-)industrial activities, to research and interrogate different and often incomparable source data on key air and water pollutants whilst seeking to ensure wide coverage of the EU-27.

Due to different scopes and geographical coverage, it was not possible to map the water emission data from Waterbase (which has greater pollutant and source coverage) onto that from E-PRTR (which generally had greater precision on emissions from IED activities). For air emissions, there were a number of activities not covered by the two key datasets (E-PRTR and LRTAP), with some residual uncertainty remaining in the results despite substantial attempts to fill missing data gaps using a range of techniques. Despite these limitations, the study outputs represent a first attempt to quantify the shares of emission from (agro-)industrial activities falling within the various regulatory and legislative regimes operating across the EU and, as such, offer a solid foundation to further refine and enhance the estimations. More complete reporting by (agro-)industrial facilities and Member States, as well as new data sets that are being developed as part of the implementation of the Water Framework Directive, will undoubtedly mean the relative splits of emissions could be calculated with increased precision in the future.

The results suggest that the EU's environmental laws are effective instruments in capturing a significant slice Europe's total pollutant emissions. Evaluation of the headline figures (which take into consideration all sources) show emissions from activities currently regulated by the IED are approximately 23% by mass of the total loading to the atmosphere and 2% by mass of the total loading to water. Regulation under other EU laws covers an additional 7% of air emissions and 90% of water emissions.

However, these headline figures hide, for example, the fact that 60% of total air emissions do not arise from (agro-)industrial sources, meaning the adjusted percentage of air emissions which are presently regulated by IED rises to well over half of all air emissions from (agro-)industrial sources. The broad conclusion is that the IED is an effective tool at capturing and ultimately reducing pollutant emissions from industry, in particular for air emissions. New proposals such as the Directive on medium combustion plant (<50 MW^{th}) is likely to further reduce emissions of key air pollutants such as NO_X and PM_{10}.

Contents

Glossary

- **(agro-)industrial activity**: a process, operation or range of processes/operations encompassing both industrial activities and agricultural activities that take place on an industrial scale. For the purposes of this study, (agro-)industrial activities are understood to be a combination of industrial and agricultural activities, which could reasonably be classified together under a common definition insofar as the activities could result in significant releases of pollutants to the environment;

- **Category**: can be either i, ii, iii or iv. For emissions to water based on data from Waterbase, it was impossible to distinguish emissions from category ii and iii and therefore emissions for this data source are presented for category ii/iii. The allocation of an activity to one specific category depends on whether the activity is directly, indirectly or un-regulated at EU level and whether it is an (agro-)industrial activity or not;

  - **Category i:** presents emissions to air and water from (agro-)industrial activities covered by the Directive on industrial emissions (IED), taking into account the thresholds defined in Annex I of the Directive;

  - **Category ii:** presents emissions to air and water (for E-PRTR data) from (agro-)industrial activities which are covered by other EU environmental legislation, such as the EU Emission Trading System (ETS), Urban Waste Water Treatment Directive and Nitrates Directive. Category ii captures emissions to water from activities with direct point or diffuse discharges which should be subject to regulation if water objectives defined under the Water Framework Directive are at risk. This would, for example, include agricultural diffuse emissions, industrial installations (including those regulated under IED) discharging indirectly (i.e. via WWTPs or off-site treatment of industrial sewage) and where industrial activities are discharging into sensitive rivers where pollution levels need careful management;

  - **Category ii/iii:** presents emissions to water for Waterbase data from those activities discharging to water and which may be subject to direct regulatory control in order that specific water objectives are met. Category ii/iii includes both point and diffuse sources which can be regulated;

  - **Category iii**: presents emissions to air from activities that are currently identified as un-regulated, that is to say not directly or indirectly affected by specific EU environmental legislation. There is no equivalent category for water emissions because water is regulated for the status of water body, not by activity. Therefore, (agro-)industrial activities contributing to emissions that may threaten an Environmental Quality Standard (EQS) in the receiving water body would infringe the legislation and should be subject to regulation (i.e. fall into category ii); and

  - **Category iv:** presents anthropogenic emissions to air and water from non (agro-)industrial activities (transport, domestic, commercial etc.) and emissions to water from other activities with highly diffuse pollutant inputs where it is difficult to provide a source-to-impact link (e.g. pollution from atmospheric deposition).

- **Group of activities**: Activities have been grouped within eight thematic groups which present emissions to air data for similar types of activities such as mineral industries or energy industries; and

- **Groups of pollutants**: Groups of pollutants have been created to present an overview of the results at a Member State and EU27 level. This has been done to simplify reporting and to aid the generation of graphics that are informative without being overly complex or lengthy.

1. Introduction

1.1 This report

AMEC Environment and Infrastructure UK Limited ('AMEC') in partnership with Bio Intelligence Service, the Institute for European Environmental Policy ("IEEP"), Milieu and the Regional Environmental Centre for Central and Eastern Europe ("REC") were contracted by the Commission to undertake the following study: "*Identification of the contribution to pollution and emissions of activities and/or pollutants not regulated under EU environmental law*" (reference ENV.C.3/FRA/2011/0030/3). This report provides a summary of the data gathered and analysis conducted between October 2012 and October 2013. To better describe its content, the title of the report was changed to read: "*Contribution of industry to pollutant emissions to air and water*".

1.2 Study context

Directive 2010/75/EU on industrial emissions (IED) was a recast of seven interrelated yet separate Directives concerned with the prevention, reduction and control of pollution from industrial sources. The IED regulates a wide range of industries in various sectors, the overall aim being to reduce and control the emissions from the most polluting activities across the EU.

In developing the proposals for the recast, the European Commission conducted a number of technical studies and an assessment of the impacts that changes to the existing seven directives would have on Member States and those industries operating within them. This assessment was focused on industries that, by virtue of their scale, range and type, made a significant contribution to the overall emissions of pollution to air, water and land and where available sources of data enabled clear comparisons (and hence conclusions) to be made. The focus was particularly, but not solely, on large combustion plants with an installed thermal capacity greater than 50 MW. This assessment also considered a range of other (agro-)industrial activities and indeed some of these were included within the scope of the recast as new Annex I activities.

However, based on reviews of the data submitted by Member State competent authorities and industrial operators under Regulation (EC) 166/2006, the European Pollutant Release and Transfer Register (E-PRTR), the water emission quality system WISE-1 and data received as a result of the implementation of Directive 2008/50/EC on ambient air quality, the initial conclusions reached by the Commission are that two particular categories of activities not covered in the review of the Integrated Pollution Prevention and Control Directive IPPCD – notably those not covered by EU environmental law and new industrial activities (developed as a result of progression and innovation) – may contribute significantly to the overall emissions to air, water and land.

Going forward, it is important that the Commission has access to up to date, comprehensive and accurate information regarding the relative contributions being made by activities currently controlled under the IED, those controlled through other EU legislation and those not currently covered by existing legislation that specifically targets emissions. To put these emissions into context, a comparison of the data against emissions from other anthropogenic sources, such as transport and the domestic sector, has been made within this report.

Development of quantifications for the above noted (agro-)industrial activities provides one additional source of information to assist the Commission in making informed decisions. It is anticipated that this report will help focus efforts in the future where the evidence points towards activities that are having – or could in the future have – a significant impact on the environment and human health because of their pollutant emissions.

1.3 Study aims and objectives

This study had three key aims as follows:

- to provide an understanding of the pollutant emission contributions to air and water from different (agro-)industrial activities and to present these within the context of overall emissions of relevant pollutants from all anthropogenic sources;
- to provide a better quantification of the contribution of IED-regulated industries to overall emissions and whether there are any 'unregulated' sectors that appear to make a significant contribution; and
- to provide descriptive measures and/or approaches that are, or in future could be, applied to prevent or reduce emissions from those activities where they are not presently regulated under the IED.

The overall objectives of the study were to provide support to the Commission in two main areas:

1. To identify and collect relevant sources of information and quantify the emissions to air and water at a sectoral level across the EU27 taking into account the following four categories:

   i. those activities currently subject to IED and included in Annex I of Directive 2010/75/EU;

   ii. (agro-)industrial activities with relevant emissions, subject to other EU legislation that affects, though not necessarily targets, emissions;

   iii. (agro-)industrial activities with relevant emissions but not subject to any EU legislation targeting emissions; and

   iv. other (anthropogenic) activities that generate relevant emissions.

2. To describe the options for controlling emissions (measures and/or approaches being taken or which possibly could be taken) from industrial activities not currently subject to control under the IED.

   These should be disaggregated as follows:

   i. measures described and differentiated as technical and non-technical;

   ii. differentiated between those current applied and those that could be applied in the future; and

   iii. a description of suitability of measures including qualitative consideration of the advantages and disadvantages for the applications being considered.

In the course of this study, Task 2 was reduced in terms of focus and priorities for the work and it is mainly delivered by Appendix G of this report.

1.4 Structure of this report

This report is structured as follows:

- Section 2 summarises the steps taken to map and define a list of activities and associate them to a category of emissions (i, ii, iii or iv);
- Section 3 describes the methodology adopted for gathering data, filling the gaps when data availability was poor and for the building of a global database of EU emissions;
- Section 4 summarises the findings of the analysis of emissions from air pollutants at EU27 level;
- Section 5 summarises the findings of the analysis of emissions from water pollutants at EU27 level; and
- Section 6 presents the conclusions from the analysis.

1.5 Limitations of the study

This study was executed as a piece of technical research to broadly establish what level of pollutant emissions are captured by current EU regulation and in particular what the relationship is between those activities currently regulated under the IED and those regulated by other EU environmental legislation. As such, the study required a far and wide-ranging review taking into account as many sources of data as possible and, considering the practicalities and limitations of the main data sets available, to create a consistent dataset where uncertainties were minimised as much as was practicable. There are several limitations to note when considering the data presented in this report:

- This report and the analysis therein is only intended to represent a snapshot in time and because of the disparities in reporting periods between available datasets, does not fully cover comparable fixed periods. Air emissions data has been drawn primarily from two sources across comparable years (as far as was practicable) and is therefore more consistent than water emissions data;
- The report relies on analysis of secondary (reported) data sources and despite all reasonable efforts made to identify and eliminate mistakes in the source data, there are anticipated to be certain inaccuracies and uncertainties inherent to even the most complete datasets which were not identified by the project team; and
- Another limitation is the presentation of pollutants and data in mass terms. The analysis of pollutant data in this way was selected because of the availability of mass emissions data and the ability to compare between pollutants, groups of pollutants and categories of activities using a common metric. The limitation to this approach is that the results do not account for the relative environmental or human health impacts caused as a result of the pollutant release. One tonne of pollutant X is therefore not comparable to one tonne of pollutant Y when assessing the actual impact on the receptor. Some

commentary on this aspect has been made within the appendix text on impacts (Appendix H) but this overall limitation should be noted when reading the results of this study.

Therefore, given these limitations and in particular the key issue of comparability, even when the gaps outlined in Section 3 of this report are taken into consideration, the results from this study should be read as being indicative rather than absolute. The study team was not able to quantify all uncertainties nor does the report acknowledge that all irregularities in the data have been picked up, despite multiple validation and cross-checking steps. Some of the more specific points around limitations are discussed within the report chapters themselves.

2. Mapping of activities and categories

2.1 Overview

This section details the elements associated with the definition of the (agro-)industrial activities that fall within each of the four categories, the legislative review process that was undertaken to help determine whether activities should sit within categories ii or iii, and the approach applied to the selection and prioritisation of specific pollutants. The objective of this study was to achieve an effective separation of emissions from a wide range of both agricultural and industrial activities. Many of these activities needed close examination, having regard to specific EU legislation, to assess if, and to what extent, the legislation affected the type and quantity of pollutants released despite the fact the legislation may not actually target them. This screening work was therefore a vital component of the overall study.

2.2 Definition of categories

Emissions from any (agro-)industrial activities considered as part of this study can be defined as belonging to one of four categories as follows:

- **Category i:** presents emissions to air and water from (agro-)industrial activities covered by the Directive on industrial emissions (IED), taking into account the thresholds defined in Annex I of the Directive;

- **Category ii:** presents emissions to air and water from (agro-)industrial activities which are covered by other EU environmental legislation, such as the EU Emission Trading System (ETS), Urban Waste Water Treatment Directive and Nitrates Directive. Category ii captures emissions to water from activities with direct point or diffuse discharges which should be subject to regulation if water objectives defined under the Water Framework Directive are at risk. This would, for example, include agricultural diffuse emissions, industrial installations (including those regulated under IED) discharging indirectly (i.e. via WWTPs or off-site treatment of industrial sewage) and where industrial activities discharge into sensitive rivers where pollution levels need careful management. For emissions data from Waterbase, emissions from category ii and iii are presented together within a category ii/iii;

- **Category iii:** presents emissions to air from activities that are currently identified as un-regulated, that is to say not directly or indirectly affected by specific environmental legislation. There is no equivalent category for water emissions because water is regulated for the status of water body, not by activity. Therefore, (agro-)industrial activities contributing to emissions that may threaten an Environmental Quality Standard (EQS) in the receiving water body would infringe the legislation and should be subject to regulation (i.e. fall into category ii); and

- **Category iv:** presents anthropogenic emissions to air and water from non (agro-)industrial activities (transport, domestic, commercial etc.) and emissions to water from other activities with highly diffuse pollutant inputs where it is difficult to provide a source-to-impact link (e.g. pollution from atmospheric deposition)

2.3 Legislative review and activity categorisation

2.3.1 Summary of legislative review

The review of EU legislation was a key part of the early work conducted by the study team to ensure a comprehensive understanding of the main (agro-)industrial activities, with relevant emissions, which could be affected by EU legislation. The conclusions from this review have been used as the basis for the categorisation of the activities and as a consequence, the presentation of the emissions data, by activity, in one of the four main categories.

Table 2.1 summarises the main EU legislation that is deemed to affect pollutant emissions without necessarily targeting emissions directly. The table lists the legislation and describes how mechanisms within the legislative act serve to affect emissions. As such, the table includes a wide range of legislation; from legislation setting environmental quality standards with feedback mechanisms that can trigger control measures for emissions from (agro-)industrial installations; to legislation that restricts the substances to be used in specific products.

While the effect of product standards on emissions is indirect, limiting or banning the use of a substance in a specific product will serve to eliminate emissions from installations producing that product, hence impacting on overall emissions. Impacts will also manifest at the end of the product life cycle, whereby waste management installations will see effects on the emissions of restricted substances in proportion to the volume of the relevant product type in the wastes (of particular relevance for facilities managing waste electronic and electrical equipment and end-of-life vehicles).

The legislation is organised according to whether the relevant emissions are to water, air or soil and also highlights whether the legislation also affects emissions in other media.

Table 2.1 Overview of relevant EU legislation affecting (but not necessarily targeting) emissions from (agro-)industrial activities

Category	Legislation	Effect on emissions	Additional media affected	
Air			**Water**	**Soil**
ii	Emissions Trading Scheme Directive 2009/29/EC	Sets a cap on overall emissions of greenhouse gases from high-emitting industry sectors, with caps reduced each year. Provides incentives for operators to reduce emissions of greenhouse gases with potential knock-on effects on air pollutants.		
ii	Waste Framework Directive 2008/98/EC	MS use a permitting system to review and authorise waste treatment installations and could choose not to give a permit where operations are considered to be harming the environment or endangering human health through emissions. This would then generate pressure on operators to reduce emissions. MS assess the national system through Waste Management Plans and may decide to target specific installations for emission reductions. To reduce greenhouse gas emissions from landfills, Member States should facilitate the separate collection and proper treatment of bio-waste.	x	x

Category	Legislation	Effect on emissions	Additional media affected	
ii	Sulphur Content of Liquid Fuels Directive (1999/32/EC)	This directive limits the sulphur content in gas oil to 0.1% by mass and in heavy fuel oil to 1% by mass. It was extended in 2005 to include marine fuels however as shipping is a category iv activity this is not relevant for the purposes of this study.		
ii	EU F gas Regulation No 842/2006	Affects the operators of stationary refrigerating equipment by setting specific controls on the recovery of F gases and the prevention/detection of leaks. Indirectly this affects emissions without setting specific limits.		
ii	Landfill Directive 1999/31/EC	Relevant to waste management activities that fall below the IED activity threshold. Industrial sites with on-site landfills require a permit to operate. The permit includes requirements for controls and monitoring, as well as closure procedures that make the site operator responsible for correcting significant adverse effects on the environment. On-site landfills must meet general requirements for landfills, which are tiered according to landfill class and include technical measures to control leachate emissions to soil, surface water and groundwater and emissions to air. Restrictions on the types of waste that can be landfilled and this will affect emissions; in particular controls on biodegradable waste will affect methane emissions.	x	x
ii	SEVESO III Directive 2012/18/EU	The requirement of SEVESO III should act to prevent accidents, and, in the case of an accident, to minimise uncontrolled emissions to all media in the case of a major accident in an installation where dangerous substances are present falling under the Directive's scope. Operators must comply with general obligations, establish an accident prevention policy and emergency plans.	x	x
ii	E-PRTR Regulation (EC) No 166/2006	The register contains information on releases of pollutants to air, water and land, as well as off-site transfers of pollutants that are present in waste-water. The register covers 91 pollutants listed in Annex II, including greenhouse gases, heavy metals, pesticides, chlorinated organic substances and other inorganic substances. Most of the activities covered are IED activities but there are some differences.	x	x
ii	Regulation 850/2004 on POPs	Prohibition on the production of Annex I substances implies there will be no emissions from chemical production facilities of these substances. MS may decide to target particular point source emitters of Annex III substances for measures to reduce or eliminate emissions. Agro-industry holders of stockpiles of Annex II substances should manage them as wastes and ensure that the persistent organic pollutant (POP) content is destroyed or irreversibly transformed so that the remaining waste and releases do not exhibit the POPs characteristics, so avoiding emissions.		x
Water			**Air**	**Soil**
ii	Water Framework Directive 2000/60/EC	Article 16 sets controls to reduce emissions, discharges and losses of the 'priority substances' and to phase out the emissions, discharges and losses of the subset of 'priority hazardous substances' may affect emissions from industrial installations (point sources) or from agriculture (point and/or diffuse sources). Upstream control measures can include stricter requirements in IED permits, as well as best environmental practice (BEP).		
ii	EQS Directive 2008/105/EC & Proposal COM(2011)876	Sets environmental quality standards (EQS) to be met by MS in implementing the water framework Directive (WFD) in order to achieve good chemical status for surface waters by 2015. In monitoring compliance, MS may make use of mixing zones to allow for the diffusion of higher concentrations by point sources.		

Category	Legislation	Effect on emissions	Additional media affected	
ii	Groundwater Directive 2006/118/EC	Measures to control point and diffuse sources of pollution under the WFD Article 11 programme of measures for river basins may be employed with the specific objectives of: meeting good groundwater status for groundwater bodies by 2015; preventing inputs of hazardous substances into groundwater; to limit inputs of non-hazardous pollutants; and to reverse upward trends in groundwater pollutants		
ii	Marine Strategy Framework Directive 2008/56/EC	Requires the achievement of Good Environmental Status for marine waters (for chemical substances this applies beyond 1 nautical mile from the coast as this zone is covered by the WFD). It should be noted, though, that most discharges are land-based and, therefore, are more likely to be driven by the need to meet the objectives of the Water Framework Directive, Priority Substances Directive and Groundwater Directive before they have the potential to impact on the objectives of the MSFD.		
ii	Nitrates Directive 91/676/EEC	Farmers operating in areas that drain into waters that are or could be affected by high nitrate levels or eutrophication must implement measures to limit the land-application of nitrogen-containing fertilisers and respect maximum limits for the application of livestock manure, as set out in action programmes. All other farmers may choose to voluntarily implement codes of good practice.	x	x
ii	Urban Waste Water Treatment Directive 91/271/EEC	Regulation or procedures for specific authorisation are required to ensure that industrial waste water entering collecting systems and discharges from certain industrial sectors of biodegradable industrial waste water not entering urban waste water treatment plants before discharge to receiving waters meet quality requirements.		
ii	Directive 2006/11/EC on pollution caused by certain dangerous substances	Industrial installations releasing discharges of substances in list I & II require prior authorisation from the competent authority. ELVs are set for list I substances and included in the authorisation. *Note: Directive 2006/11/EC was repealed by the Water Framework Directive 2000/60/EC as of 22 December 2013.*		
ii	Directive 2006/21/EC on waste from extractive industries	Facilities managing waste resulting from the extraction, treatment and storage of mineral resources and the working of quarries are obliged to meet general requirements in order to avoid environmental harm, in particular emissions of noise or odours, as well as dumping of extractive waste on land. Permits are required for operating facilities. In establishing new facilities, measures must be taken to reduce environmental impacts, in particular soil, air and water pollution by emissions. Operators must establish Waste Management Plans including measures necessary to prevent water and soil contamination; in particular by preventing leachate generation, preventing surface water or groundwater from being contaminated by the waste, and treating contaminated water and leachate in order to ensure their discharge. It includes specific measures to limit emissions of cyanide.		x
ii	WEEE Directive 2012/ 19/EU	Reduction of emissions of specific substances from waste management facilities processing waste electrical and electronic equipment (WEEE) resulting from proper treatment and storage.		x
ii	Directive 94/62/EC on Packaging and Packaging Waste	The requirement to minimise the presence of hazardous substances in packaging should serve to reduce emissions of such substances from installations manufacturing packaging, as well as from installations managing packaging waste. Sum of concentration levels of lead, cadmium mercury and hexavalent chromium present in packaging or packaging components must not exceed 100 ppm.	x	x

Category	Legislation	Effect on emissions	Additional media affected	
ii	RoHS Directive 2011/65/EU	The restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) implies that there will not be emissions of these substances from industrial installations that are manufacturing EEE (categories set out in Annex I), as well as waste management facilities that are managing EEE waste.	x	x
ii	ELV Directive 2000/53/EC	Manufacturers of vehicles are prohibited from using mercury, hexavalent chromium, cadmium and lead in vehicle components (with some exemptions). In addition, vehicle manufacturers are encouraged to limit the use of hazardous substances in new vehicles. This should serve to reduce emissions of hazardous substances, in particular prohibited substances, from installations manufacturing vehicles and vehicle components and for installations managing end-of-life vehicles.		x
ii	Regulation (EU) No 142/2011 on animal by-products	Incineration and co-incineration of waste to be undertaken according to the BAT for the control and monitoring of emissions. Disposal of animal by-products or derived products via the wastewater stream is prohibited.	x	x
ii	Regulation (EC) No 1935/2004 on food contact materials	Materials and articles must be manufactured so that they do not transfer their constituents to food in quantities which could endanger human health, or bring about an unacceptable change in the composition of the foodstuffs or deterioration in their organoleptic properties. This will in turn affect installations manufacturing the 17 groups of materials and articles included in Annex I.		
ii	Directive 98/8/EC on Biocidal Products	(agro-)industrial installations using biocides will not have emissions of CMR 1A and 1B originating from biocidal products, for example in waste waters following cleaning and maintenance. *Note: Regulation (EU) No 528/2012 of the European Parliament and of the Council concerning the making available on the market and use of biocidal products was adopted on 22 May 2012. It repealed and replaced Directive 98/8/EC from 1 September 2013.*		
Soil			**Water**	**Air**
ii	Regulation (EC) No 1102/2008 banning mercury exports and on safe storage	Specific industrial activities that produce metallic mercury as waste are obliged to abide by storage conditions that guarantee the safety of human health and the environment by minimising emissions.		x
ii	Regulation (EC) No 1907/2006 on REACH	Safety data sheets (SDS) contain risk management measures intended, *inter alia*, to ensure that emissions do not result in an exposure level above the PNEC. Downstream users of substances are required to apply the relevant risk management measures. Limited to substances that are produced or on the market at >10 tonne and display certain hazardous properties. Substances of very high concern are subject to authorisation, so limiting use with a subsequent effect on emissions of those substances from agro-industry. Certain SVHC are also subject to further restrictions, in some cases banning their use. Again, this will serve to reduce and, in the case of full bans, eliminate emissions from (agro-)industrial installations in the long term.	x	x

As a result of the extensive legislative review it became apparent that for air emissions there were some discernible activities that it was believed fell into the 'unregulated' category (iii), whilst for water emissions this was far less clear-cut. There is further discussion on this point in Section 2.2.2.

2.3.2 Categorisation of activities for air pollutants

The first step in the categorisation process was to create a list of (agro-)industrial activities that are sources of emissions to air. This list was then refined taking into account the availability of data and classifications used in reporting.

When the activity in the legislation included a threshold, data from both the activity over and under the threshold was included in the analysis to cover the totality of emissions from this specific activity. Where there were a large number of much smaller activities and/or where data was limited or not available, it was necessary to define some more aggregated groups of activities to avoid the list becoming too long. For example, for air emissions arising from the rearing of swine below the IED threshold, the corresponding activity does not distinguish between the number of sows and the number of pigs present on the farm.

The most challenging aspect of the air emission activities categorisation was to distinguish activities that fall within categories ii and iii. This was due to the interpretation of what falls in the scope of '*EU environmental legislation affecting emissions*', more specifically that the 'effect' on air emissions, whether direct or indirect, was not a simple 'yes' or 'no' answer. For example, the air quality framework and national emission ceiling directives set some broad environmental objectives (e.g. limits on ambient air quality or total emissions) but do not directly affect installation-level emissions; nor are specific sectors or activities regulated under these directives. Whilst the evidence shows that in certain cases these directives have led to conditions being set in permitted for regulated (agro-)industrial activities based on the need to maintain or meet key environmental quality standards, these are by far the minority (whilst air quality limit values from the Air Quality Directive (AQD) are considered as part of the permitting process they don't necessarily affect the eventual limits set in an operator's permit). For air emissions, the inclusion of all activities that could be indirectly affected by the AQD and NECD would have resulted in very limited delineation between category ii and iii and therefore removed some of the usefulness of the final outputs.

As might have been expected, the list of activities for air and water are therefore different. The final list for air emissions contains 104 activities, of which 6 are representative of category iv activities such as transport, domestic emissions, shipping and aviation. Appendix A presents the final list of the activities for air emissions chosen for inclusion in the study.

2.3.1 Categorisation of activities for water emissions

The determination of the activities for water emissions was considered in two parts. The first was the nature of the categorisation of activities within the general scope of the project (i.e. categories i – iv) and how these relate to the regulatory context for water emissions. The second was the way that activities are classified within the relevant data sets examined in this study and how these relate to the project categories. The second issue and its impact upon the presentation of the study results are discussed in Section 3.3.

The nature of the interaction between EU law and its influence on discharges to water presented a challenge for the project, in particular in distinguishing whether specific activities and/or specific pollutants are subject to regulation under EU law. Currently EU water law is, with one exception, based on an environmental quality approach that is driven by four main directives: Water Framework Directive, Environmental Quality Standard (Water Framework

Priority Substances) Directive, Groundwater Directive and Marine Strategy framework Directive. Further detail on these is presented in Table 2.1.

EU water law does not specify discharge limits on emission sources but any source could require control if it threatens the achievement of one or more of the legally binding quality objectives set out in the above Directives. As an exception to this, the Urban Waste Water Treatment Directive (UWWTD) sets discharge objectives on waste water treatment plants (WWTPs) according to the size and nature of the receiving waters. Such discharge objectives are prescribed in different ways. For example, for discharges to Sensitive Areas, nitrogen and/or phosphorus are to be reduced by a particular percentage (not to a specific ELV) – hence the objective is of overall load. Furthermore, Member States can take the option to reduce their overall load of discharge of these pollutants rather than apply the same controls on all WWTPs. Thus, even for the UWWTD, the influence of EU level regulation can vary. Note that the UWWTD controls may not be sufficient to meet the objectives of the WFD – if so, additional controls may be required.

Many discharges to water are regulated by IED and, therefore, are easily classified within the project. However, distinguishing between non-IED discharges regulated by EU water law and those not regulated is problematic. If any non-IED discharges threaten the achievement of EU water quality objectives, they should be subject to regulation. However:

- Whether a particular type of activity/discharge is subject to EU regulation will vary between water bodies across Member States;
- It is not clear which activities/discharges threaten compliance with EU water quality objectives. Even with reporting under the relevant Directives and submission of the first river basin management plans (RBMPs), the data are limited, both with regard to the discharges, but also in defining GES and the influence of discharges on this; and
- Where discharges are a threat to EU water objectives, the level of controls required by MS will vary, depending on the degree of threat (e.g. from requiring a small reduction to major controls).

It can be argued that any possible emission source that affects the achievement of the objectives of EU water law ought to be regulated and, conversely, regulation is not necessary if those objectives are not at risk. Therefore, there was not a clear way to categorise activities which are not subject to IED (i.e. those not in category i). However, for the purposes of this study we made the assumption that those emissions from (agro-)industrial activities are a potential risk to water protection. Furthermore, there are clear practical aspects in the regulation of emissions to water that make some sources more amenable to control than others. As a result, three categories were distinguished:

- Category i: those activities subject to IED;
- Category ii- ii/iii[1]: those activities discharging to water and which may be subject to direct regulatory control in order that specific water objectives are met; and

[1] Data from Waterbase are presented for category i, ii/iii and iv, data from E-PRTR are presented for category i and ii

- Category iv: those activities contributing pollutants to water, but for which regulatory control is problematic.

This classification does not include, as it does for air, a separate category iii, as it is not evident (nor does the data support it) that there are scenarios where emissions from (agro-)industrial activities that pose risks to EU water objectives would fall completely outside the EU legislative frameworks. In other words, if there are risks to the achievement of EU water law, then regulatory action to address these risks means that they fall into category ii. A theoretical category iii for water would include activities regulated at a national level for water outcomes not derived from EU law. It is not evident if such regulation exists or what such outcomes might be. However, for completeness and to avoid confusion, we term this category 'category ii/iii'.

Section 3.3 describes in more detail the classification of activities defined in E-PRTR and Waterbase (a source of water emissions data) and how they relate to these categories. However, in broad terms, category ii/iii includes both point and diffuse sources which can be regulated. This includes, for example, urban waste water treatment plants and E-PRTR emissions not subject to IED (i.e. activities falling below the Annex I thresholds for certain activity descriptions or not included in Annex I at all). It also includes diffuse agricultural sources as these can be regulated in various ways (as is evident by the Nitrates Directive). Category iv includes relatively undefined pollutant inputs (such as total riverine inputs, urban diffuse sources and atmospheric inputs). In some cases there may be opportunities to improve controls and management conditions to reduce inputs, but these might be less readily available to the local water/pollution control manager. The division between categories ii/iii and iv can be debated, but this division is presented as a general categorisation for the purposes of this study.

3. Data gathering and analysis

3.1 Methodology

A large part of the initial work involved the scoping of potential (agro-)industrial activities to be covered based on a review of available data and relevant legislation. It was essential to ensure that all of the major activities were represented. As expected, the availability of data for 'unregulated' activities (i.e. category iii) was overall quite limited and in some instances non-existent.

An Excel spreadsheet (dataset) was developed to store the data and to ensure that it could be presented at an activity, Member State and EU level. The spreadsheet was established based on three main data sources: external databases; sectoral reports; and data calculated from the gap-filling stage of the project. Due to the volume of data it was not been possible to verify every single data point, however the following data verification systems were implemented:

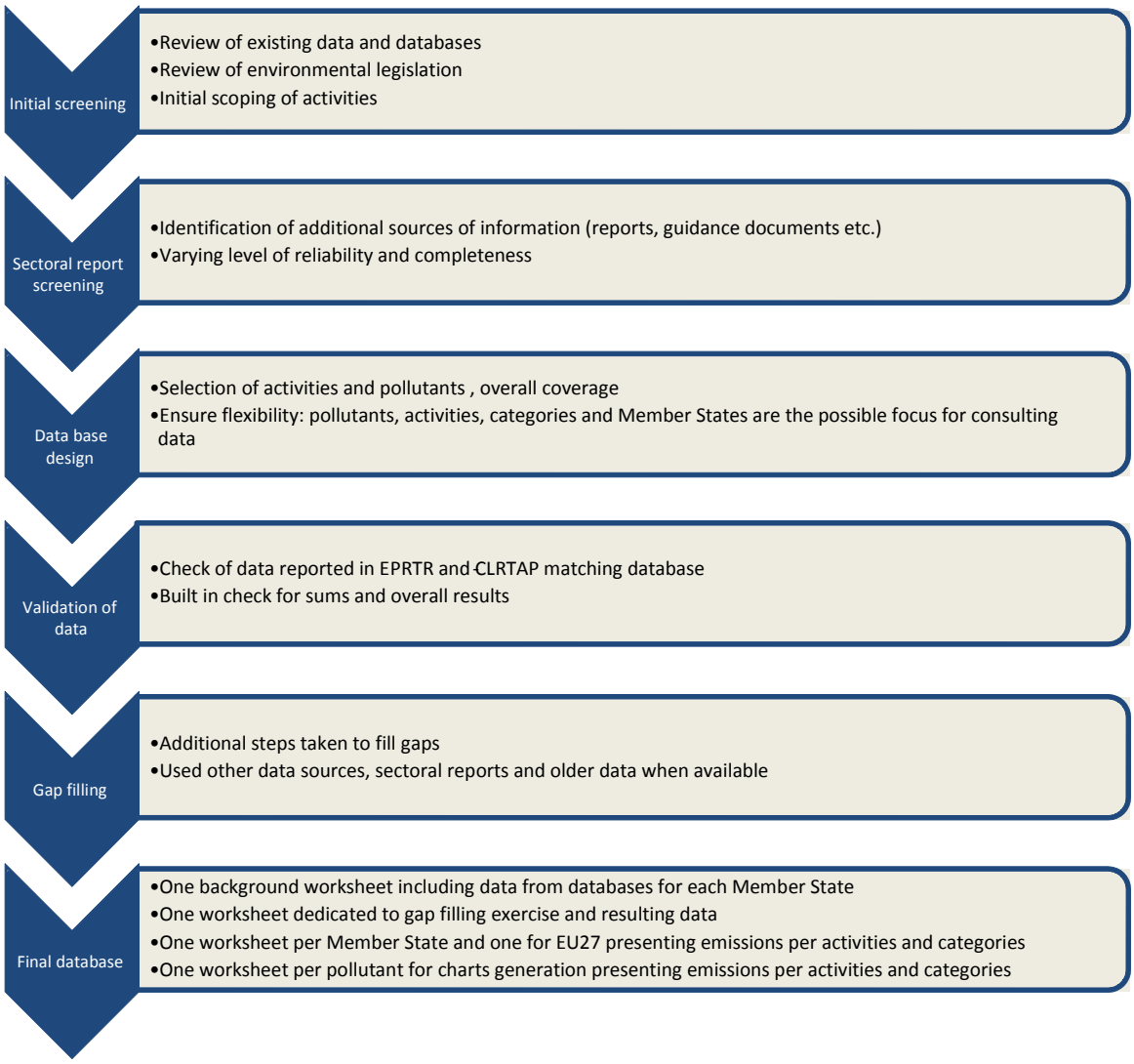
- Data extracted from reports have been, where possible, verified against other sources (e.g. Eurostat);
- Gap filling was conducted when insufficient data were available from other sources. Information used to gap-fill was sense-checked against comparative data from different databases to ensure overall quality and consistency; and
- Negative gap-filled data were zeroed at the Member State level to ensure that emissions would not be artificially reduced due to calculations between datasets[2].

The methodology for gathering and analysing data was somewhat different for air and water emissions, due to the absence of comparable data for water emissions.

Figure 3.1 presents the steps taken with regards to air emissions.

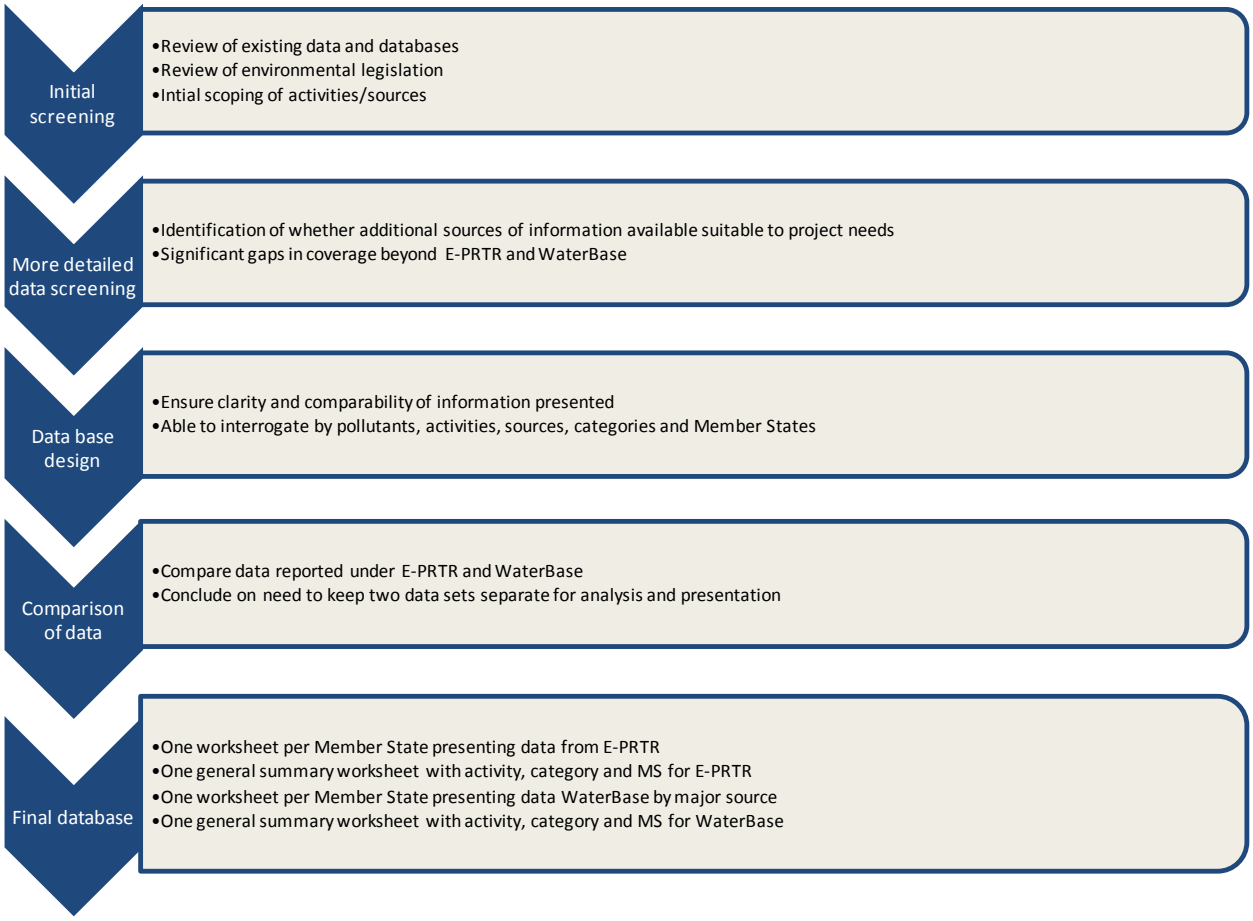
[2] The subtraction of one dataset result from another (used to apportion emissions into different categories for the purpose of this study) resulted in some cases in a negative pollutant emission due to differences within the reported data source values for particular pollutants. Whilst this highlighted possible systemic inaccuracies within the datasets themselves, a zeroing of these negative values was necessary to avoid a skewed final result.

Figure 3.1 Methodology for air



For emissions to water, the methodology followed similar initial steps but had to be adapted due to the absence of comparable datasets and the difficulties encountered in finding reliable and useable data. Figure 3.2 presents the steps taken with regards to emissions to water.

Figure 3.2 Methodology for water



3.2 Data sources for air

3.2.1 Identification and review of key data sources

Sources of data on air emissions were identified through a comprehensive review relevant national and EU-level datasets and other literature (e.g. sectoral reports, compiled industry data). An overview of the main data sources identified is provided in Table 3.1. More detailed information on data sources identified for the study is presented in Appendix B.

Table 3.1 Summary of data sources on air emissions from (agro-)industrial activities

Data source	Summary	Pollutants	Latest available data	Geographical coverage
National level databases and inventory sources				
European dataset on emissions of air pollutants submitted under Convention on Long Range Transboundary Air Pollution (CLRTAP)	The dataset contains consolidated responses for all countries as well as for each country individually.	CO, NH_3, NMVOC, NOx, PM10, PM2.5, SO_X, TSP, As, benzo(a), benzo(b), benzo(k), Cd, Cr, Cu, Hg, Indeno, Ni, Pb, Se, total PAH, Zn, HCB, HCH, PCB, dioxins and furans	2010	EU27 broken down by Member State Iceland, Liechtenstein, Norway, Switzerland, Turkey No data available for Croatia
National Emissions Ceilings (NEC) Directive Inventories	Dataset on emissions of air pollutants reported annually by MS to the European Commission under Directive 2001/81/EC.	NH_3, NMVOC, NO_X, SO_2	2010	EU27 broken down by Member State No data available for Croatia
EEA aggregated and gap-filled air emission data	Data set showing aggregated emissions of air pollutants and greenhouse gases as used in the EEA indicator factsheets and assessment reports. Data are based on the information submitted under the NEC Directive, CLRTAP and Monitoring Mechanism.	CH_4, CO, Acidifying gas, NH_3, NMVOC, NO_X, Particulate formation, PM10, PM2.5, SO_X, TOFP	2006	EU27 broken down by Member State Iceland, Liechtenstein, Switzerland, Norway No data available for Croatia
WebDab- EMEP	Emissions database of the Co-operative programme for monitoring and evaluation of long range transmission of air pollutants in Europe (EMEP), reporting data submitted under the CLRTAP. Unreported emissions are gap-filled	CO, NH_3, NMVOC, NO_X, SO_X, PM10, PM2.5, TSP, As,Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, Aldrin, benzo(a), benzo(b), benzo(k), chlordane, chlordecone, DDT, dieldrin, DIOX, endrin HCB, HCH, heptachlor, hexabnomobip, indeno, mirex, PAH, PCB, PCP, Toxaphene	2010	EU27 broken down by Member State Other parties to the Convention: Belarus, Canada, Croatia, Iceland, Monaco, Norway, Russia, Switzerland, Macedonia, Ukraine
Facility level databases and inventory sources				
European Pollutant Release and Transfer Register (E-PRTR)	Europe-wide register that provides emissions data from industrial facilities in European Union Member States and other countries. It replaced and improved upon the previous European Pollutant Emission Register (EPER). The register contains data reported annually by more than 30,000 industrial facilities covering 65 economic activities across Europe.	It covers 91 substances including greenhouse gases and key air pollutants: CH_4, CO_2, N_2O, NMVOC, NO_X,NO_2 PFCs, SO_X, SO_2, PM10, nitrogen, phosphorus	2010	EU27 broken down by Member State Iceland, Lichtenstein, Norway, Serbia and Switzerland No data available for Croatia
Large Combustion Plants (LCP) emissions inventory	Emissions data for facilities falling within the scope of the Large Combustion Plants Directive (2001/80/EC) and now Chapter III of the IED. LCPs are combustion plants with a rated thermal input ≥ 50 MW, irrespective of the type of fuel used (solid, liquid or gaseous).	SO_2, NO_X, dust	2012	EU27 broken down by Member State No data available for Croatia at the time of this study

Data source	Summary	Pollutants	Latest available data	Geographical coverage
Sectoral reports [1]				
Reports comprising collection and analysis of data from various sources, to support the European Commission on different reviews as required under the Industrial Emissions Directive	Sectors covered include: intensive rearing of cattle, rearing of different poultry species and pigs,combusion of fuels in installations with a total rated thermal input <50 MW (medium combustion plants, MCPs) and emissions from spreading of manure	Sector specific: e.g. NH_3 ,N_2O, CH_4, N, P (livestock) Dust / PM10, SO_2, NO_X (combustion)	Various: e.g. 2010 plus projections to 2030: MCPs 2013: Emissions from manure 2009 (cattle) 2008 data for NH_3, 2007 for N (poultry)	EU27 Level of information uneven across individual Member States
Reports informing revisions and review of the IPPC Directive	Sectors covered include: combustion installations with 20-50 MW rated thermal input, waste treatment facilities, aquaculture, foundries, ceramics, chemicals (incl biofuels), food manufacture, gasification, primary wood, coal fuel, wood preservation, soil, independently operated industrial wastewater treatment plants and waste incineration.	Sector specific: e.g. NO_X, SO_2 and PM (combustion) Odour,CH_4, N_2O, NH_3, NMVOC, Dust, NO_X (waste treatment facilities) SO_2, NO_X, VOC, CO,N,P (other sectors)	Various: from 2004 onwards Includes future emissions projections	EU27
Other sectoral reports from various origins	Sectors covered include: waste, agiculture, shipping, nanomaterials and ultrafine particles, households and small ciombustion sources and transport.	Sector specific: e.g. NO_X, SO_2 (shipping) PM (nanomaterials) PM, NO_X (households)	Various Includes future emissions projections	Various from EU27 to individual Member State
Emissions models				
The Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model	GAINS model provides information on economic activities (causing emissions), emisison control strategies , emission scenarios, control costs (for given scenario), impacts (environmental and human health).	NH_3, CO_2, CH_4, NO_X, N_2O, TSP, PM10, PM2.5 and PM1, SO_2, VOC Also some models contain: CO, F-gases	2010 Future emissions projections are also available	EU27 Each Member State individually Norway, Switzerland, Croatia, Russia, Turkey, Ukraine and others.

Note 1: Due to the large number of sectoral reports identified for the study, these have been grouped and summarised based on their sector focus. The full list of sectoral reports with further details is included in the Appendix B

3.2.2 Availability of emissions data

Data sources

Two main datasets have been relied upon for air emissions: E-PRTR and Member State submissions under the Convention for Long-Range Transboundary Air Pollution (LRTAP). The data reviewed is for the year 2010 as this was the latest year that complete E-PRTR data was available for at the time of the study. Whilst complementary, these two databases differ in scope, approach and pollutant coverage. Therefore, the results provide an initial indication of the size of each category, rather than a detailed quantification.

The E-PRTR database is a facility-based reporting system which only includes point source emissions and only those above the size/capacity and pollutant thresholds defined in the E-PRTR Regulation (Regulation (EC) No 166/2006). LRTAP is a national level reporting system which requires signatories to include all sources (point and areas sources) within the NFR 09 classification categories.

Furthermore, LRTAP and E-PRTR cover different pollutants. This is explained by the fact that LRTAP was developed to address transboundary air pollution and persistent organic pollutants, whereas the E-PRTR aims to monitor the emissions from (agro-)industrial facilities. Some pollutants are only covered by LRTAP and not by the E-PRTR; and vice-versa. There are also differences in scope; for example LRTAP distinguishes between $PM_{2.5}$ and PM_{10}, whereas E-PRTR only gathers data for PM_{10}.

Pollutants

Given the coverage of air pollutants within the two main datasets, and considering that data were not necessarily completely reported, even for pollutants represented in both main datasets, it was decided to focus on 17 core pollutants which are presented in bold text in Table 3.2.

Table 3.2 Air pollutant coverage in main data sources (bold text indicates final selection of pollutants)

Pollutant	E-PRTR	LRTAP
1,1,1-trichloroethane	x	
1,1,2,2-tetrachloroethane	x	
1,2-dichloroethane (EDC)	x	
Ammonia (NH_3)	x	x
Anthracene	x	
Arsenic and compounds	x	x
Benzo (a), (b), (k)		x
Cadmium and compounds	x	x
Carbon dioxide	x	
Carbon monoxide	x	x
Chlorine and inorganic compounds (HCl)	x	
Chlorofluorocarbons (CFCs)	x	
Chromium and compounds	x	x
Copper and compounds	x	x
Dichloromethane (DCM)	x	
Dieldrin, Endrin, Heptachlor	x	
Dust including fine particulate matter (PM_{10})	x (PM 10)	x (PM 2.5 and PM 10)
Ethylene Oxide	x	

Pollutant	E-PRTR	LRTAP
Halons	x	
Hexachlorobenzene (HCB)	x	x
Hexachlorocyclohexane (HCH)	x	x
Hydrochlorofluorocarbons (HCFCs)	x	
Hydro-fluorocarbons (HFCs)	x	
Hydrogen cyanide (HCN)	x	
Indeno		x
Lead and compounds	x	x
Mercury and compounds	x	x
Methane (CH_4)		x
Naphthalene	x	
Nickel and compounds	x	x
Nitrous oxide (N_2O)	x	
Non Methane Volatile Organic Compounds (NMVOC)	x	x
Oxides of nitrogen (N) and other nitrogen compounds (NO_X/NO_2)	x	x
PCDD + PCDF (dioxins + furans) (as TEQ)	x	x
Pentachlorobenzene	x	
Perfluorocarbons (PFCs)	x	
Persistent organic pollutant (Aldrin, Chlordance, Chlordecone, DDT)	x	
Polychlorinated biphenyls (PCBs)	x	x
Polycyclic aromatic hydrocarbons (PAHs)	x	x
Selenium		x
Sulphur dioxide and other sulphur compounds (SO_2/SOx)	x	x
Sulphur hexafluoride (SF_6)	x	
Tetrachloroethylene (PER)	x	
Tetrachloromethane (TCM)	x	
Total suspended particles (TSP)		x
Trichlorobenzenes (TCBs)	x	
Trichloroethylene	x	
Trichloromethane	x	
Vinyl Chloride	x	
Zinc	x	x

It is important to note that the types of pollutants emitted are activity specific and therefore full coverage of all selected pollutants was not available across all activities. For example, data on combustion activities will generally include emissions of NO_X, SO_2 and PM, whereas agricultural emissions are generally focussed on ammonia, nitrogen and phosphorus compounds. An initial assessment was undertaken of the overall quality, completeness and reliability of emissions data within the different categories and for specific pollutants; this is presented in Table 3.3 below.

Activity Coverage

Despite the range of sources available, for some activities it was impossible to identify reliable sources of data. For these activities, it was decided to either not include the activity in the database (e.g. nanotechnology) or to create a specific grouping as part of the rationalisation process to ensure meaningful data could be presented (e.g. waste management category).

3.3 Data sources for water

3.3.1 Identification and review of key data sources

For water emissions, the two principle data sets identified were the E-PRTR and Waterbase (within the WISE system). However, for many pollutants, and for a number of reasons, these datasets are not directly comparable. An overview of these two data sources is provided in Table 3.4 and more details on all the sources reviewed for the purpose of this project are included in Appendix C.

Table 3.3 Summary of data sources on water emissions

Dataset	Summary	Pollutants	Latest available data	Geographical coverage
National level databases and inventory sources				
Waterbase	Detailed data sets of emissions to water. Emissions defined based on several categories of point and diffuse sources. Available for 15 MS	Haz subs include: As, Cd, Cu, Cr, Pb, Hg, Ni, Zn and to some extent a range of organic compounds. Eutrophic substances: including: total N, total P, COD and BOD	Vary between MS – from late 1990s-2010.	The data are presented for each river basin district and can be totaled for each MS
Facility level databases and inventory sources				
European Pollutant Release and Transfer Register (E-PRTR)	E-PRTR database - The emissions data for individual facilities based on datasets officially reported by MSs	Wide range including many of the water pollutants of listed in Annex I of COM (2011) 876	2010	EU27 broken down by MS, region or river basin

3.3.2 Availability of emissions data

Data sources

Table 3.4 presents those activities within E-PRTR which are not regulated by the IED or for which the difference of threshold between the E-PRTR and the IED has made it impossible to distinguish category i from ii. As a result, the E-PRTR emissions reported for the following activities have been classified as category ii.

Table 3.4 Activities reported in the E-PRTR which are classified as category ii for this study

Reporting code	Detail of the activity	Reason for classifying in category ii
3(a)	Underground mining and related operations	Not regulated by IED
3(b)	Opencast mining and quarrying	Not regulated by IED
5(f)	Urban waste-water treatment plants	Not regulated by IED
6(c)	Industrial plants for the preservation of wood and wood products with chemicals with a production capacity of 50m3 per day	IED 6.10 regulates preservation of wood and wood products with chemicals with a production capacity of 75m3 per day other than exclusively treating against sapstain. (Bigger threshold)
7(b)	Intensive aquaculture	Not regulated by IED
9(e)	Installations for the building of and painting or removal of paint from ships	Not regulated by IED

The number of reports for these different activities varies significantly. For E-PRTR in 2010, Table 3.5 shows the number of pollutant emissions reported against each type of activity, for each Member State. There are a number of records for urban waste water treatment (UWWT) plants (activity 5(f)) and for industrial plants for the production of paper and board and other primary wood products (activity 6(b)). For underground mining (3(a)), some Member States report on a number of pollutant emissions, but for others data are absent or very limited. For other activities, the reports on emissions data are very limited.

Table 3.5 Number of pollutant sources recorded for each of the category ii activities reported in the E-PRTR for each MS (2010)

MS	3(a)	3(b)	5(f)	5(g)	6(c)	7(b)	9(e)
Austria	-	-	19	2	-	-	-
Belgium	-	2	15	1	-	-	-
Bulgaria	3	1	12	-	1	-	-
Cyprus	-	-	1	-	-	1	-
Czech Republic	3	2	13	-	-	-	-
Denmark	-	-	15	-	-	-	-
Estonia	-	-	4	-	-	-	-
Finland	2	1	17	1	1	-	-
France	-	-	80	3	-	-	-
Germany	14	1	158	2	-	-	-
Greece	-	-	3	-	-	-	-
Hungary	-	-	13	-	-	-	-
Ireland	3	-	7	-	-	-	-
Italy	3	-	77	-	-	-	-
Latvia	-	-	1	2	-	-	-
Lithuania	-	-	7	-	-	-	-
Luxembourg	-	-	2	-	-	-	-
Malta	-	-	-	-	-	2	-
The Netherlands	-	-	44	-	-	-	-
Poland	26	8	57	4	-	-	-
Portugal	-	-	27	-	-	-	-
Romania	1	1	13	1	-	-	-
Slovakia	-	-	8	-	-	-	-
Slovenia	-	-	3	-	-	-	-
Spain	1	1	58	-	-	2	-
Sweden	1	-	15	-	-	-	1
UK	1	-	130	1	-	94	-
Total	**58**	**17**	**799**	**17**	**2**	**99**	**1**

A study[3] on implementing the first three years of the E-PRTR provides some further analysis of the completeness of E-PRTR water data. The study noted that for 27 pollutants included in Annex II of the E-PRTR Regulation, the number of releases reported is below ten installations for at least one reporting year. Almost all of these pollutants are regulated (including bans), but while this might mean that releases could be limited, the authors concluded that:

> "*reporting has to be considered to be incomplete due to the fact that more facilities (other than the reporting facilities) are expected to release these pollutants. However, since these pollutants are usually not monitored in urban wastewater treatment plants, operators do not have the necessary information to quantify these releases*".

For the other 44 pollutants listed in Annex II of the E-PRTR Regulation, release reports vary and, for several pollutants, emissions are linked to one specific type of activity. Furthermore, reporting from the UK accounts for a significant proportion of all emissions.

The study undertook cross-pollutant analysis (comparing proportions of pollutants from the same type of activity for different MS, etc.) and concluded that there were potentially missing emission reports for "*total nitrogen, total phosphorus and TOC, whereas for cyanides, fluorides and phenols reporting seems to be more complete*". In overall conclusion, the study did not suggest any changes to the E-PRTR reporting thresholds for water emissions, but it did highlight issues and possible options to improve the quality of reporting in the future. It also commented on the importance of future reporting under the Water Framework Directive in providing additional data.

Waterbase allows Member States to report water emissions according to a range of different activities. For some of these activities there are defined sub-activities under which Member States may report. As Member States can report at an activity level, sub-activity level, total level or on all of them this can lead to some potential double counting. Furthermore, it should be noted that data in Waterbase is only available for 15 MSs and excludes some of the potentially more significant emitting MSs such as Germany, Italy, Spain and the UK.

The division of activities within Waterbase reflects specific regulatory concerns, such as the division of WWTPs according to the different capacity thresholds set out in the UWWT Directive. In contrast, industrial discharges are only divided according to whether they are treated or not.

For the purposes of this study, certain Waterbase activities have been combined to provide a clearer picture of the relative importance of discharges within each of the three categories emissions data has been apportioned to (categories i, ii/iii and iv). The allocation of emissions under the different Waterbase activities and how these have been mapped to the activity categories in this study is summarised in Table 3.6. It must be emphasised that this mapping is not a perfect alignment with the study categories as defined for emissions to air.

[3] UBA, 2012, Three years of implementation of the E-PRTR, Supporting study for the European Commission.

Table 3.6 Allocation of Waterbase emissions to project categories

Waterbase activity	Project category
Total Diffuse Emission to Inland Waters	ii/iii
Agricultural Emissions	ii/iii
Atmospheric Deposition	iv
Un-connected Dwellings Emissions	iv
Urban Diffuse Emissions	iv
Storm Overflow Emissions	iv
Other Diffuse Emissions	iv
Background Emissions	iv
Direct Discharges to Coastal and Transitional Water total	ii/iii
Point Sources to Groundwater total	ii/iii
Industry total	i
Industrial Waste Water Treated Discharges	i
Industrial Waste Water Untreated Discharges	i
Other waste water total	ii/iii
Other Waste Water treated Discharges	ii/iii
Other Waste Water Untreated Discharges	ii/iii
Point Sources to Inland Surface Water total	ii/iii
Urban waste water total	ii/iii
Urban Waste Water Untreated Discharges total	ii/iii
Urban Waste Water Untreated Discharges < 2 000 p.e.	ii/iii
Urban Waste Water Untreated Discharges 2 000 >= p.e. <= 10 000	ii/iii
Urban Waste Water Untreated Discharges 10 000 > p.e.<= 100 000	ii/iii
Urban Waste Water Untreated Discharges > 100 000 p.e.	ii/iii
Urban Waste Water Treated Discharges total	ii/iii
Urban Waste Water Treated Discharges < 2 000 p.e.	ii/iii
Urban Waste Water Treated Discharges 2 000 >= p.e. <= 10 000	ii/iii
Urban Waste Water Treated Discharges 10 000 > p.e.<= 100 000	ii/iii
Urban Waste Water Treated Discharges > 100 000 p.e.	ii/iii

A comparison of E-PRTR and Waterbase highlighted a number of differences in terms of geographical coverage and reporting years. Table 3.7 summarises the years for which data is available via Waterbase for each of the reporting Member States.

Table 3.7 Years for which reported data are available in Waterbase for each Member State

Member State	Years for which relevant data are available in Waterbase	Comment
AT	2001-10	2010 data are limited to a few individual WWTPs, so cannot compare to E-PRTR totals
BE	2007-9	-
BG	2007-9	-
CZ	2006-10	2010 data limited to few individual sources so cannot compare to E-PRTR totals
DK	2008-10	Only reported for N and P and for category totals, but can compare to E-PRTR
EE	2009	-
FI	2007-8	-
FR	2004-9	-
LT	2008-10	Some comparison with E-PRTR possible
LV	2006-10	Some comparison with E-PRTR possible
NL	2008-9	-
RO	2008-10	Some comparison with E-PRTR possible as data for WWTPs are provided for 2010 – other results are earlier
SE	2003-10	Some comparison with E-PRTR possible
SI	2006-10	Very few data for 2010, so comparison not possible
SK	2008-9	-

In being able to use the Waterbase data, the study approach was to combine data from different years to build up a profile for each of the three categories. It is acknowledged that this approach is imperfect and means interpretation of the results must be made having regard to the fact that are not a perfect representation of emissions at a single point in time. It is anticipated that in the near future, more directly comparable data will be generated as a result of full implementation of the Water Framework Directive and associated studies led by the Commission and European Environment Agency.

The manner in which emissions have been recorded in the Waterbase dataset could lead to double counting if emissions were simply aggregated. This is most evident in the way in which data for WWTPs (with different categories of discharges as well as sub-totals and totals) and industrial discharges are treated. However, this is not always the case and depends on the approach taken by individual Member States (as recording was not consistent). It was therefore necessary to identify the Member States for which there was a risk of double counting. Table 3.8

presents the hierarchy of emission sources as recorded in Waterbase, the Member States for which double counting was an issue and the actions taken to remedy this so as to provide summary data at an EU level.

Table 3.8 Actions taken to avoid double counting when aggregating emissions from Waterbase

Source			Member State with possible double counting and action taken
Activities – High Level	**Activities – Sub-Level I**	**Activities – Sub-Level II**	
Total Industrial Waste Water Discharges	Industrial Waste Water Treated Discharges		BE, CZ, EE, FR, LT, RO, SE - Removed Level II
	Industrial Waste Water Untreated Discharges		
Total Other Waste Water Discharges	Other Waste Water Treated Discharges		EE, LT, RO - Removed Level II
	Other Waste Water Untreated Discharges		
Total Urban Waste Water Discharges	Urban Waste Water Treated Discharges total	Urban Waste Water Treated Discharges < 2 000 p.e.	AT, FR - Removed Level III. BE - Removed Level II CZ, EE, LT, LV, RO - Removed both Level II and III
		Urban Waste Water Treated Discharges 2 000 >= p.e. <= 10 000	
		Urban Waste Water Treated Discharges 10 000 > p.e.<= 100 000	
		Urban Waste Water Treated Discharges > 100 000 p.e.	
	Urban Waste Water Untreated Discharges total	Urban Waste Water Untreated Discharges < 2 000 p.e.	
		Urban Waste Water Untreated Discharges 2 000 >= p.e. <= 10 000	
		Urban Waste Water Untreated Discharges 10 000 > p.e.<= 100 000	
		Urban Waste Water Untreated Discharges > 100 000 p.e.	

Source			Member State with possible double counting and action taken
Activities – High Level	**Activities – Sub-Level I**	**Activities – Sub-Level II**	
Total Diffuse Emissions to Inland Waters	Agricultural Emissions		BE, SE - Level I removed. - Note: For this group of emission sources, Level II sources span two categories (agricultural emissions = category ii/iii; all others = category iv). DK was the only MS which reported at Level I only – it was therefore assumed that the majority of these emissions were agricultural in origin, and therefore were recorded in category ii/iii.
	Atmospheric Deposition		
	Un-Connected Dwellings Emissions		
	Urban Diffuse Emissions		
	Storm Overflow Emissions		
	Abandoned Industrial Site Emissions		
	Other Diffuse Emissions		
	Background Emissions		

A further complication is the comparison of categories for industry and WWT (waste water treatment) between Waterbase and E-PRTR. Waterbase has two industry categories, those activities with or without their own WWT facilities. It does not specify the nature of the regulatory regime (e.g. IPPC/IED). E-PRTR includes industrial activities covered by IED, as well as a small number that are not.

Where the two databases are potentially comparable, it is evident that the data reported are different – in some cases Waterbase reports lower values than E-PRTR and in other cases higher values. Furthermore, where MSs have been compared, it has been principally on WWTPs and for limited pollutants. As a result (and also given the different reporting years), direct comparison between the two datasets is not possible and it was not considered appropriate to combine the data as it would not provide a reliable picture of emissions to water.

Whilst the E-PRTR data coverage is more complete and encompasses a wider range of pollutants and Member States than Waterbase, data from Waterbase can, however, be used to provide a guide for the relative importance of industrial and agricultural emissions compared to other sources.

In conclusion, the three categories of activity for water emissions are examined separately using both E-PRTR (for category i and some of category ii) and Waterbase (for categories i, ii/iii and iv). However, the results described in Section 5 are presented separately for each database due to the limitations described earlier. It has been assumed that industrial emissions recorded in Waterbase are category i.

Beyond the two major European-level datasets (E-PRTR and Waterbase), the most important potential sources of comparative data were considered to be international commissions responsible for protection of major seas or river basins in Europe, which have an interest in understanding pressures on those water bodies. These include the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), the Helsinki

Commission (HELCOM) and the river commissions for the Danube and Rhine. Although the data included in these sources has not been used to derive results, for completeness, information about each of these data sources is included in Appendix C.

Pollutants

E-PRTR includes data on 67 different water pollutants (or pollutant groups) and Waterbase covers 56 pollutants (it also includes some 'total' categories which are not separate pollutants). However, with both databases the level of data available varies significantly between the individual pollutants. In some cases only one reported value may be available, while for others the data are extensive for a number of activities and/or MS.

An overview of the pollutant coverage for each database is included in Appendix C. Data coverage is usually similar where both databases report on the same pollutants (although there are exceptions). In general, there are good data reports for heavy metals, nutrients and several organic compounds. However, while a number of pesticides are included in both reporting systems, in most cases reported data are poor.

This report focuses on 22 pollutants that were identified as being core sources of water emissions. Table 3.9 presents the coverage of these pollutants in E-PRTR and Waterbase.

Table 3.9 Coverage by E-PRTR and Waterbase of pollutants selected for water emissions

Pollutant	E-PRTR	Waterbase
1,2-dichloroethane (DCE)	x	x
Ammonium		x
Anthracene	x	x
Arsenic and compounds (as As)	x	x
Benzene	x	x
BOD		x
Cadmium and compounds (as Cd)	x	x
Chlorides (as total Cl)	x	
Chromium and compounds (as Cr)	x	x
Copper and compounds (as Cu)	x	x
Cyanides (as total CN)	x	x
Di-(2-ethyl hexyl) phthalate (DEHP)	x	x
Fluorides (as total F)	x	
Halogenated organic compounds (as AOX)	x	x
Lead and compounds (as Pb)	x	x
Mercury and compounds (as Hg)	x	x

Pollutant	E-PRTR	Waterbase
Nickel and compounds (as Ni)	x	x
Phenols (as total C)	x	
Total nitrogen	x	x
Total organic carbon (TOC) (as total C or COD/3)	x	x
Total phosphorus	x	x
Zinc and compounds (as Zn)	x	x

Appendix C includes further information on the coverage of other pollutants reported in E-PRTR and Waterbase that were not identified as core pollutants for the purpose of this report.

Activity Coverage

The activities reported in E-PRTR and Waterbase are not comparable. Whilst E-PRTR reports emissions for a range of activities (primarily those that would fall under category i, i.e. IED), the division of activities within Waterbase reflects specific regulatory concerns, such as WWTPs according to the different capacity thresholds set out in the UWWT Directive. Furthermore, industrial discharges are only divided according to whether they are treated or not. As a result, a comprehensive list of activities could not be established for emissions to water, in the same way that it has been done for emissions to air.

3.4 Data gaps

A range of emissions data was identified from a number of sources such as sectoral reports, national and EU level databases and modelling. However not all of these data/sources were found to be useful and a number of challenges were identified, including:

- E-PRTR data was not available for some of the activities;
- Waterbase data was incomparable with E-PRTR in most cases and was inconsistent in years reported;
- For many activities, particularly those in categories ii and iii, no single or combined source of emissions data was identified that covered air and water emissions;
- Not all datasets are comprehensive in their coverage and compiled or presented in a consistent manner (e.g. the NEC Directive reporting is at national level, whilst the E-PRTR reports at installation level and Waterbase only covers limited Member States);
- Wording and structure of the reported categories across data sources is different from the adopted list of activities (e.g. NFR Code in used in national inventories and NACE Code or activity listing in E-PRTR; neither directly match the list of activities selected for the study);

- Some reports contain data for select Member States only or cover only part of the sector (e.g. installations close to or above IED threshold); and
- Some reports contain data for only certain types of pollutants.

For category i activities, there was generally sufficient data for both water and air emissions to allow population of the Excel database developed as part of the study. For the other categories (ii, iii and iv), the completeness and compatibility of the data from different sources was more restrictive, and completion of the database required some adjustments and transformation to be made. These are discussed in more detail in the following sections.

3.4.1 Air pollutant emissions

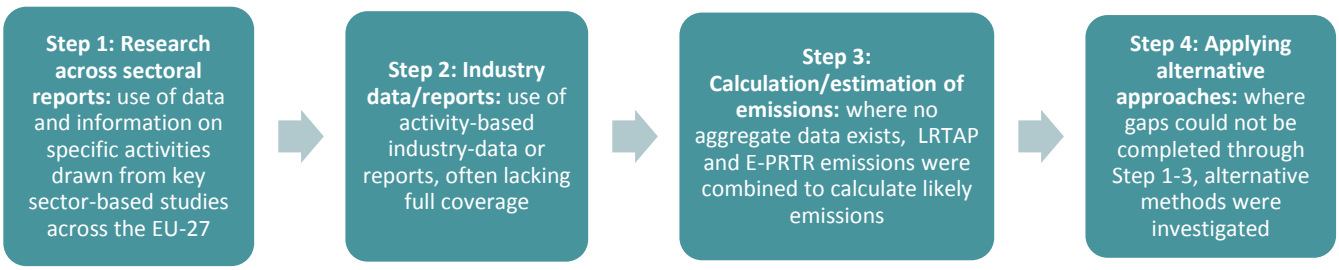
Gaps identified

For air emissions, the main data gaps were identified for industrial activities which:

- **Were not covered by LRTAP or E-PRTR**, for example emissions from production of magnesium oxide;
- **Fall below the IED thresholds**, for example, no data has been identified for ferrous metals, tanning of hides and skins, treatment and processing of milk activities when below IED thresholds.

Gap filling methodology

To fill gaps in air emissions data, the following approach has been applied:



Activities for which emissions data could not be filled based on sectoral reports (steps 1 and 2), or for which emissions could not be filled by manipulating LRTAP and E-PRTR data (step 3) were investigated further to establish if an alternative approach could be applied to derive pollutant releases (step 4).

The first element to the gap filling was a review of each activity to understand what data is available for each Member State, the size of the sector, level of production, how polluting the activity is, what are the key pollutants produced by the activity and whether the emissions factors for these activities exist. A review of the data available in the E-PRTR and reported under LRTAP was also undertaken. This assessment determined whether gap filling was possible and if so, which method would be most suitable for the specific activity.

Splitting emissions reported in the E-PRTR was used in cases where IED and E-PRTR had a different threshold or differently defined the activities.

Specifically, this approach has been used to fill emissions data for the following paper and board and wood panel activities:

- 036 - Production in industrial installations of: (b) paper or card board with a production capacity exceeding 20 tonnes per day;
- 037 - Production in industrial installations of: (c) one or more of the following wood-based panels: oriented strand board, particleboard or fibreboard with a production capacity exceeding 600 m3 per day;
- 074 - Production in industrial installations of paper or card board with a production capacity below 20 tonnes per day; and
- 094 - Production in industrial installations of one or more of the following wood-based panels: oriented strand board, particleboard or fibreboard with a production capacity below 600 m3 per day.

The following issues with emissions data for these categories were identified:

- Data in E-PRTR category 6(b) covered production of paper and board and wood-panels above 20 tonnes per day. IED separates production of paper and board above 20 tonnes as one activity; and production of panels above 600m3 per day as the second activity
- Threshold between E-PRTR and IED activities was different. E-PRTR used threshold of 20 tonnes per day, while IED used threshold of 600m3.

The following steps were undertaken to split existing E-PRTR data into these 4 activities:

- **Bottom-up emission calculations**: This involved use of emission factors for each pollutant relevant to the activity and multiplying it by production values in each Member State. Application of this method was limited to activities and pollutants for which reliable emission factors and production data were available;
- **Using ratios of calculated emissions**: Emissions calculated using a bottom up approach described above, for each pollutant (for which emission factors and activity data have been available) and for each Member State, have been used to calculate a ratio between the two activities (in the example above between emissions from paper and board production and wood panels production). This ratio has been applied to split the existing E-PRTR data (2010) into two separate categories. In cases where emissions were not reported in the 2010 E-PRTR data (but production figures suggested that the processes were running) the emissions data were filled with figures from the 2009 E-PRTR;
- **Estimating the significance in the difference between thresholds**: Literature review was undertaken to help determine how significant the difference was between the IED and E-PRTR threshold described above. Based on the information available on the percentage of companies in the EU producing panels in excess of 850m3/day and 500m3/day, it has been estimated that 89% of EU companies producing wood panels have capacity greater than 600m3/day. This percentage was used to estimate emissions from wood panel production below and above the threshold; and

- **Subtracting the emissions above IED threshold from LRTAP data**: In order to obtain emissions from the activities falling below the IED threshold, the E-PRTR emissions were subtracted from the relevant categories of data in LRTAP (in the example above, LRTAP data from both process and combustion in pulp and paper were used).

Limitations of methods applied to gap filling

Due to inconsistencies between data reported under the E-PRTR and LRTAP, where the emissions reported in E-PRTR were subtracted from respective emissions in LRTAP to derive category ii or iii emissions (i.e. below IED thresholds), the result was found to be uncertain. For example, some Member States reported data for certain activities in the E-PRTR but reported no or limited respective emissions in LRTAP. A subtraction in this case would result in negative emissions, in which case the result was zeroed to avoid distortion (see Section 3.2.2).

Information about the activities for which gap filling was applied based on sectoral or industry report is included in Appendix D.

Activities for which data gaps were not filled

Issues associated with collation of emissions data were recognised for the following sectors:

- Gasification and liquefaction: below IED threshold;
- Food and milk processing;
- Surface treatment of metals and plastics;
- Textiles and tanning below IED threshold;
- Preservation and treatment of wood and wood-based products: both above and below IED threshold;
- Production of magnesium oxide: both above and below the IED threshold;
- Non-hazardous waste disposal and recovery: both above and below the IED threshold; and
- Ferrous metal processing.

These activities primarily fell into categories ii and iii; in most cases being below IED threshold activities, although gaps were also identified for some category i activities where E-PRTR did not cover this activity and/or LRTAP emissions were not appropriate for use.

In all cases, sectoral research undertaken on each of these activities attempted to identify the number of plants operating at relevant capacities, pollutants likely to be emitted, emission factors and production data for each Member State. This was intended to inform a decision as to whether a bottom-up approach to gap filling would be possible. Unfortunately, this revealed that there was insufficient information available to address the gaps.

3.4.2 Water Emissions

Possible additional data sources

The main challenge with regard to water emission data was a lack of comparable data. Two studies have analysed the completeness of reporting in the E-PRTR and were assessed as possible sources to address the gaps identified in relation to water emission data.

The first study was conducted by UBA et al (2012)[4] which undertook a comparison of data reported for water emissions in E-PRTR with those reported by MS under the UWWT Directive and the 'State of Environment' reporting. The purpose was to determine if such comparisons provided information on the completeness of the E-PRTR data. The study concluded that some of the data reported is voluntary and cannot be used to assess completeness or representativeness of E-PRTR reporting. Based on the findings of the study, it was concluded that the data in the report was not suitable for addressing data gaps for this study.

The second study was conducted by Deltares (2013)[5], which examined diffuse water emissions reported in E-PRTR by comparing the reported emissions to other means of calculating or estimating emissions, such as models or use of emission factors. It found that for all sectors there is a lack of transparent, consistent, comparable and actual data concerning emissions of diffuse sources, emission factors and statistical data covering all EU27 Member States. Furthermore emissions data contained in the E-PRTR on diffuse sources are of limited use when scaling up to a European level. The report indicated that reporting under E-PRTR is likely to be more complete for point source emissions than diffuse emissions. The study provides a valuable critique of the potential accuracy or completeness of E-PRTR data. However, it does not provide any new data as such. In that sense it does not fill data gaps, but rather provides a guide to issues that need to be considered in addressing data gaps in the future (at least for diffuse emissions).

More details on the assessment of these two studies are available in the Appendix E.

Future filling of gaps

The Priority Substances Directive (2008/105/EC) requires Member States to establish an inventory of emissions, discharges and losses of the substances in Annex I (33 substances in total). The reference period shall be one year between 2008 and 2010 (or for some substances, an average of those years). Member States shall publish the updated inventories in their updated River Basin Management Plans under the Water Framework Directive. These need to be published by December 2015.

It is expected, therefore, that far more detailed data will become available on the specific sources of these substances across all relevant activities. Furthermore, analysis is required to determine whether the quality

[4] UBA, 2012, Three years of implementation of the E-PRTR Supporting study for the European Commission

[5] Deltares (2013). Diffuse Water Emissions in E-PRTR.

standards are at risk of being exceeded and therefore a link can be made between the emission inventory and the objectives of EU water law.

The importance of the future reporting under Directive 2008/105/EC has also been stressed by UBA et al. (2012)[6] in the review of the E-PRTR. The study highlights the need for harmonisation of methodological approaches under each process (e.g. on use of emission factors), but also stresses the importance of the future reporting to provide a more complete picture for those pollutants included under the Directive.

3.5 Overview of the resulting emissions datasets

Having taken different approaches to the categorisation of activities for air and water emissions and relying on different sources of data (with the exclusion of EPRTR), the development of two Excel spreadsheet datasets was required as part of this study. Whilst ultimately more desirable, the creation of a single consolidated set of data for air and water pollutants was not practicable given the different coverage, pollutants and activities.

The datasets are not designed to be interrogated or used as open data sources in their present state and have been prepared specifically for the purpose of compiling a range of data points into a suitable structure such that analysis can be conducted and results created from them. As described in earlier sections, there are significant gaps within both datasets (although for air these are more activity based) and it is possible in the future that more gaps could be filled by additional work and/or other reporting mechanisms (e.g. under the Water Framework Directive).

The water dataset is a simple collation of data points and requires no further specific description. The dataset for air is more complex and further descriptive text on its structure and operation is provided in Appendix F.

[6] UBA, 2012, Three years of implementation of the E-PRTR Supporting study for the European Commission

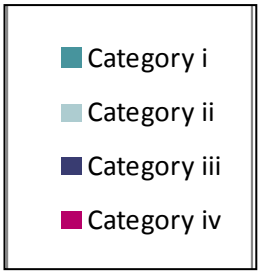
4. Results: Air emissions

4.1 Overview

This section presents the results of the study for air emissions and should be read in conjunction with the limitations highlighted in Sections 1.5 and 3.4. These results reflect a snapshot of emissions for a single year (2010). The analysis conducted on these results has focused on the mass quantity of pollutant emissions. This is slightly misleading as it does not take into account the level of hazard of the pollutants. A review of some of the possible impacts of these air emissions is presented in Appendix H.

The results are presented firstly at the aggregate level, summarising the allocation of emissions in each category, across the 27 Member States and by defined groups of pollutants. Analysis for selected individual pollutants is then presented to provide greater levels of detail. Throughout the report the following colours are used to distinguish the four defined categories:

Figure 4.1 Overview of the colour-coding per category



The first three figures present the overall findings of the study and the amount (quantity or percentage) of pollutant emissions in each of the predefined categories. Figure 4.1 presents a headline summary of the percentage of air emissions by category for all pollutants across all Member States and all (agro-)industrial activities.

There are three key points visible in Figure 4.2:

- That the IED ensures that a large proportion (the 23% in category i) of the total mass of air emissions from all sources are currently regulated and controlled (with the associated emission reductions that will come from the implementation of Best Available Techniques (BAT));
- That the overwhelming majority of air emissions come from sources that fall outside of (agro-)industrial activities, as based on the definition used for this study (i.e. category iv); and
- The emissions from those activities deemed to be 'unregulated' under current EU legislation (category iii) are relatively small when taken as a percentage (10%) of total mass emissions.

Figure 4.2 Overall partition of emissions of air pollutants per category in EU27

Note: This figure aggregates the total emissions by mass of all pollutants for EU27 in order to provide an illustrative indicator of the scale of emissions from each category, with no weighting given to the relative impacts of the different pollutants.

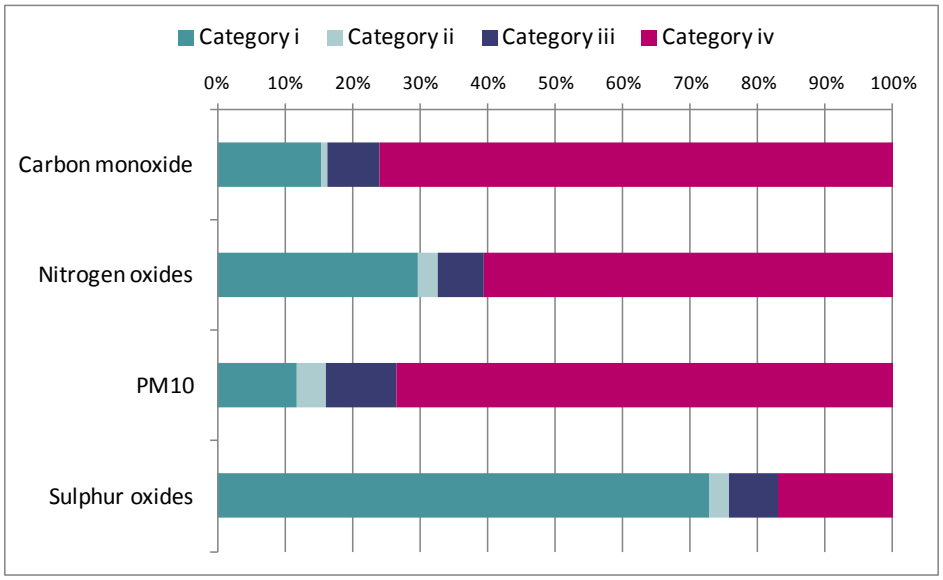
In order to facilitate the presentation of resulting data in this overview, pollutants have been placed in three groups. The split has been informed by the nature of the pollutants (e.g. heavy metals) or the types of activities they mainly arise from (e.g. combustion pollutants). A third category provides a catch-all of 'other pollutants'. The groups are:

- **Combustion pollutants**[7]: carbon monoxide, nitrogen oxides, sulphur oxides and dust (PM_{10});
- **Heavy metals**: arsenic, chromium, cadmium, copper, lead, mercury, nickel and zinc; and
- **Other**: ammonia, dioxins and furans, PAH, PCB and non-methane volatile organic compounds.

[7] Note that some of these pollutants are not exclusively emitted by combustion activities and can be also emitted during industrial processes

4.1.1 Combustion pollutants

Figure 4.3 Overview of categorisation of air emissions of combustion pollutants at EU27 level



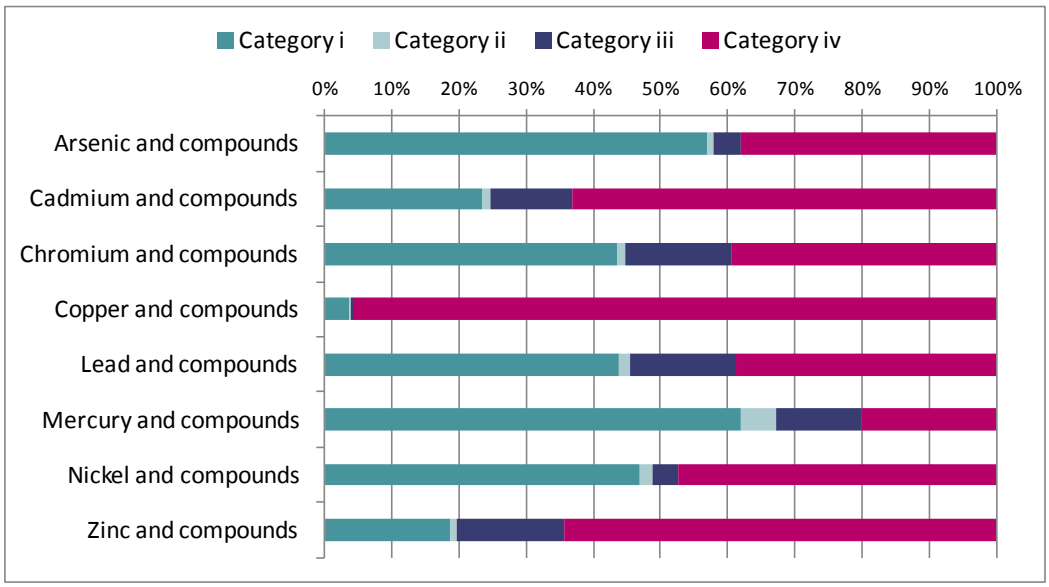
The following observations can be made on the results presented in Figure 4.3:

- The activities within category iv (i.e. non-(agro-)industrial) are a major source of carbon monoxide and PM_{10} (more than 70% in both cases) and to a lesser extent nitrogen oxides. However, emissions from sulphur oxides are largely regulated (category i and ii);
- For all pollutants, a share of the emissions is 'unregulated' at an EU level (category iii); around 5-10% of total emissions. For carbon monoxide and $PM_{10,}$ category iii emission are around half that of regulated emissions (category i). For NO_X and SOx, these emissions represent less than 10% of the total emissions and for NOx this represents a quarter of the regulated emissions. For SOx, the 'unregulated' emissions amount to nearly 10% of the regulated emissions;
- Emissions from combustion plants below 50 MWth form most of category ii and iii emissions of NO_X, PM_{10} and SO_X[8]; and
- The small size of category ii emissions compared to category iii emissions is not surprising; it is expected that most of the EU-ETS regulated installations will be accounted for in category i.

[8] As explained in Appendix D due to the gap filling for these activities, it is likely that some emissions of SOx, NOx and PM from combustion installations below 50 MWth are double counted. Due to the high level of uncertainty it is impossible to give an estimate of the overlap between categories.

4.1.2 Heavy metals

Figure 4.4 Overview of categorisation of air emissions of heavy metals at EU27 level



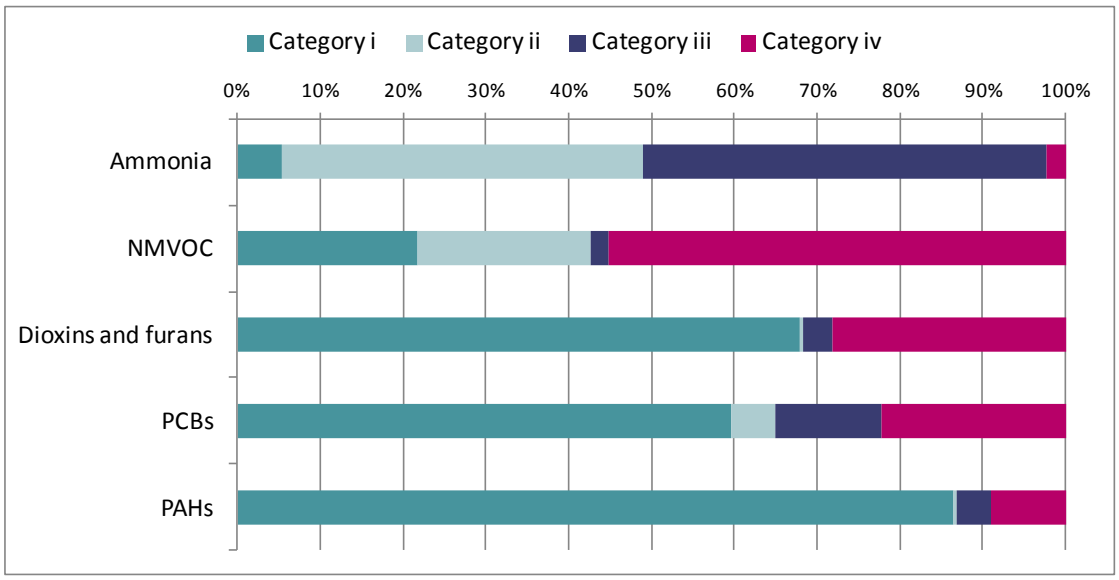
The following observations can be made:

- For the majority of these pollutants (arsenic, chromium, lead, mercury and nickel) the distribution of emissions are roughly similar with the majority (50-60%) in category i; a minimal share of emissions in category ii (0–5%); a small part in category iii (5-15%) and the rest in category iv (30-40%); and

- However, for cadmium, copper and zinc, the split of emissions between categories is quite different. More than half of cadmium emissions are from category iv (transport and other sectoral emissions). The vast majority (more than 80%) of copper emissions are also from category iv. As described later in section 4.2.9, this is due to Germany reporting high emissions from automobile tyre and brake wear in normal use. Finally, most of the zinc emissions appear to be from non- industrial activities (category iv). Around 15% of zinc emissions are from category iii and are from the production of iron and steel and surface treatment below the IED thresholds.

4.1.3 Other pollutants

Figure 4.5 Overview of categorisation of air emissions of other pollutants at EU27 level



Whilst the pollutants in Figure 4.5 show no common pattern, they highlight the following:

- Emissions from ammonia are for the majority (80%), either under category ii or category iii. A small proportion of the emissions are reported in E-PRTR from agricultural activities directly regulated by IED (category i). It is expected that a potentially substantial proportion of emissions reported in category iii are in fact from IED regulated activities but fall below the E-PRTR emissions reporting threshold, and that there is under-reporting at the Member State level for various reasons. It is not possible to determine how much of these emissions presented in category iii should be presented in category i, however a possible value is included in the IED Impact Assessment[9] which indicated that: " about 38% of ammonia emissions are emitted by agricultural installations covered by the IPPC Directive".;

- For dioxin/furan, PAH and PCB emissions, the results show some similarities, with most of the emissions originating from category i activities (more so for PAHs), and the second most important source of emissions being non (agro-)industrial category iv; and

- The majority of emissions from NMVOC (50-60%) fall within category iv.

4.1.4 Overall emissions per Member State

Figure 4.6 and Figure 4.7show the percentage of pollutant emissions in categories i, ii, iii and iv by Member State.

[9] Industrial Emissions Directive Impact Assessment (SEC(2007)1679) of 21 December 2007

Figure 4.6 Overview of categorisation of air emissions per pollutant group at MS level (in %) – Part 1 AT to FI

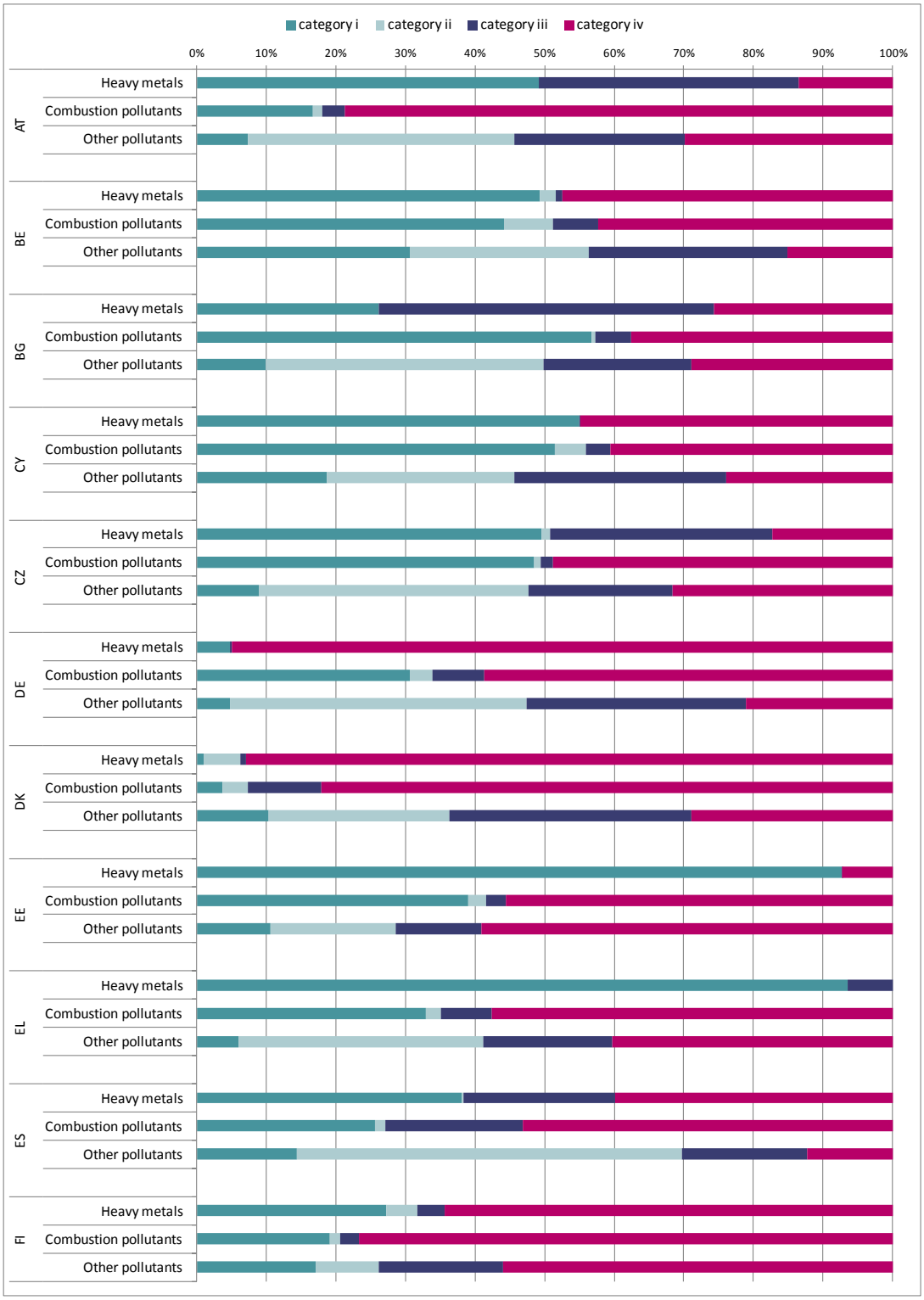
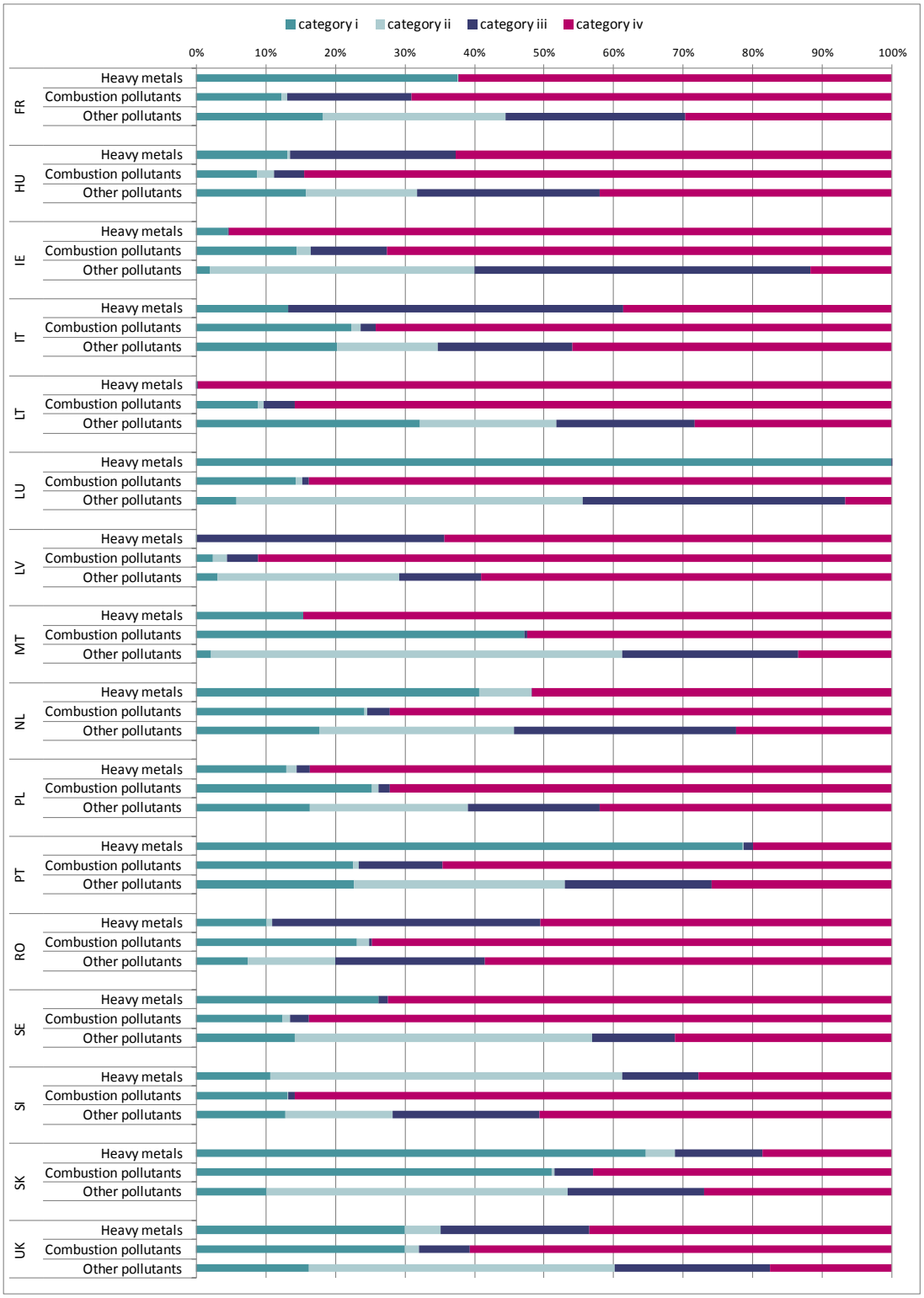


Figure 4.7 Overview of categorisation of air emissions per pollutant group at MS level (in %) – Part 2 FR to UK



What can be observed through these results is the significant variance between Member States within comparable categories. To a certain extent this should be expected given the diversity and density of specific (agro-)industrial activities within particular Member States, however the following observations can be made:

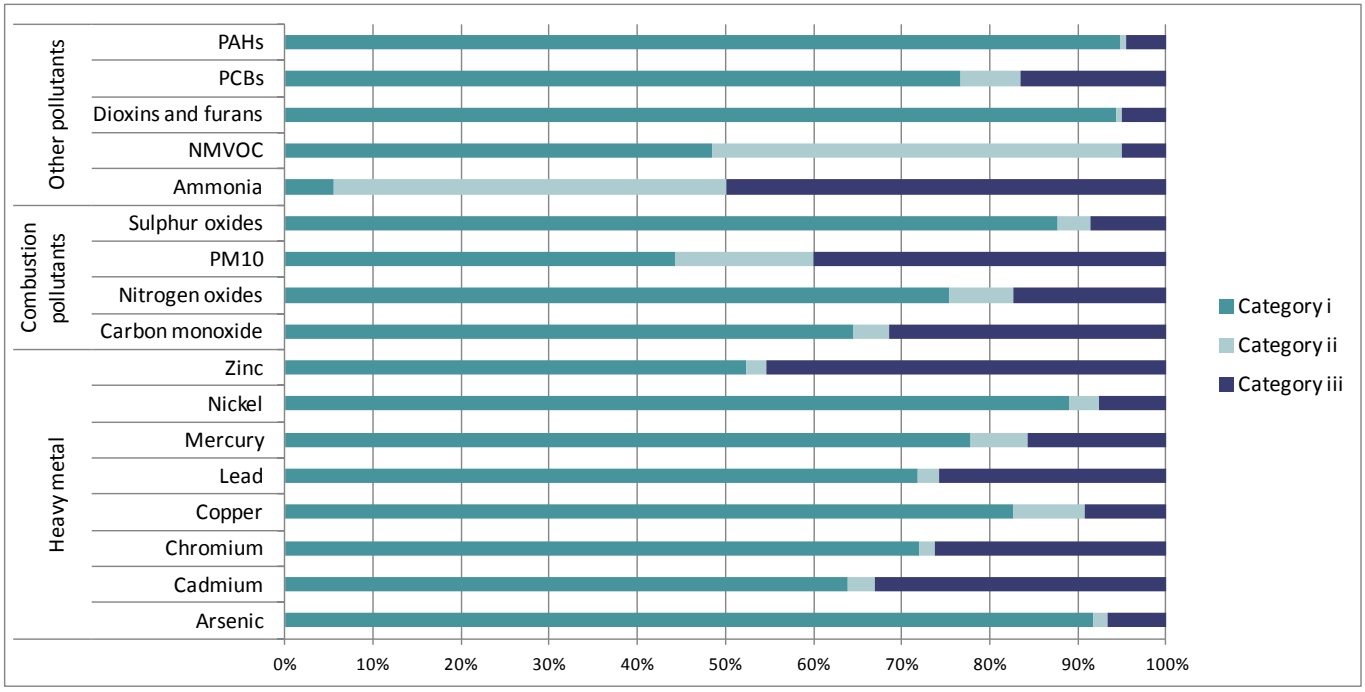
- The split between categories of heavy metal emissions shows significant variance between Member States. Some, such as Estonia, Greece and Luxembourg, show almost all emissions of heavy metals from IED activities. Others such as Germany, Denmark, Ireland and Lithuania appear to have the majority of heavy metal emissions from category iv (non (agro-)industrial activities). For Germany, further investigation has shown that most of these heavy metal emissions are copper reported under transport activity. Bulgaria, Italy, Latvia, and Romania are the few Member States with a substantial emission of heavy metals from category iii. For these reasons, it is not possible to draw any conclusions at an EU level on the categorisation of heavy metals and whether or not the majority are regulated or 'unregulated';

- For combustion pollutants, conclusions are more easily reached. The majority of emissions of these pollutants (NO_x, SO_2, CO, PM_{10}) are from domestic and transport sources (category iv). This is a pattern consistent across most Member States. Most Member States report small volumes (typically around 10% of the total) of emissions from categories ii and iii. Some Member States, such as Denmark, Ireland and Spain, have a larger share than the EU27 average of emissions in categories ii and iii. When compared with the amount of IED regulated emissions, these emissions represent a share of emissions which is not insignificant; and

- The 'other pollutants' category spans a wide range of pollutant types and as a result the splits between the four categories are even more variable across most Member States. Due to the scale of ammonia emissions (very significant when compared to most other pollutants which distort the results in this group of pollutants, other emissions reported in category i are typically <20% with much higher allocations to category ii (typically in the range 20-50%) and category iii (typically 15-30%). Discounting emissions from category iv, the conclusion is that the majority of emissions are regulated by other EU environmental legislation.

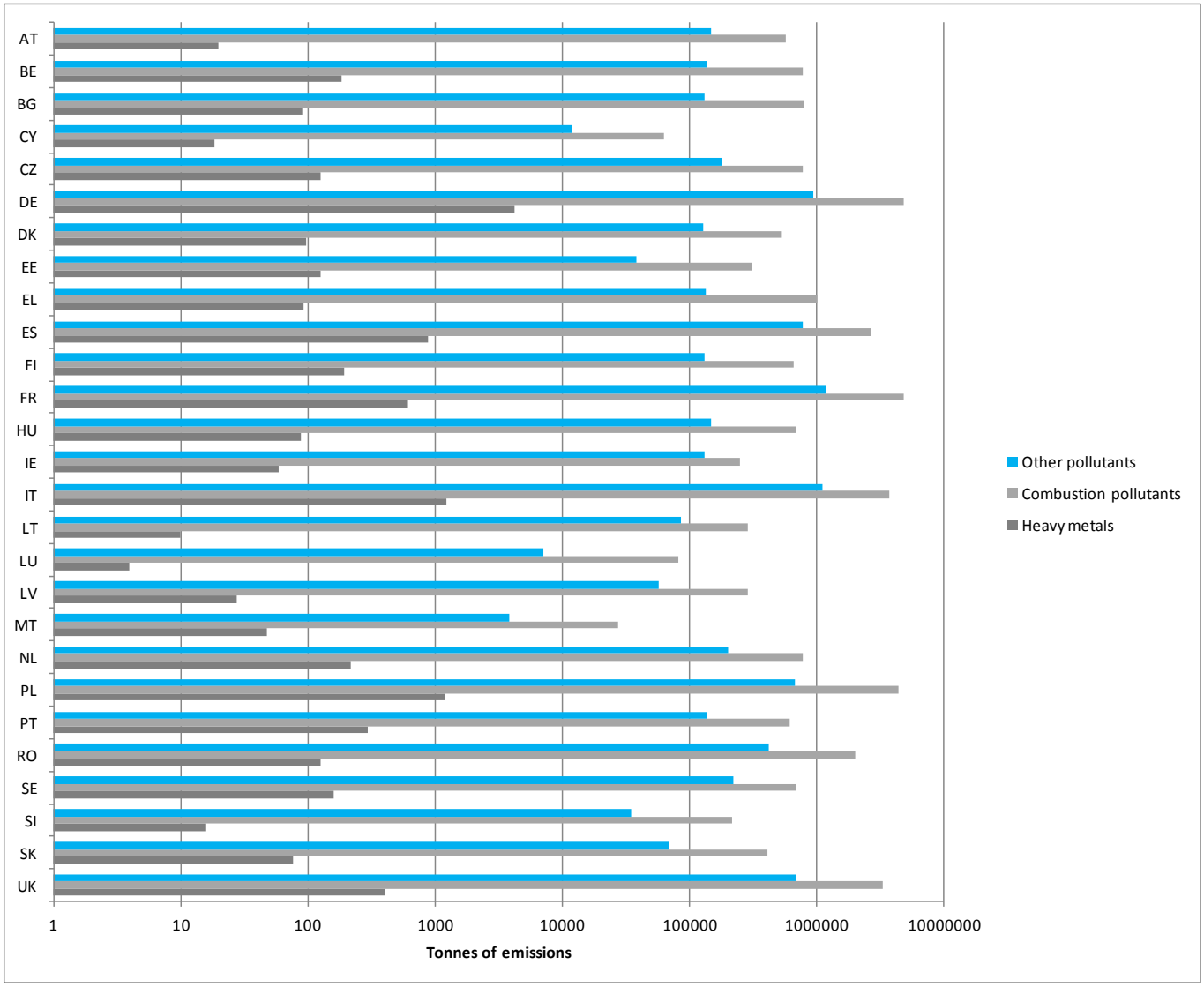
Category iii is particularly significant in the context of this project as it shows the percentage of pollutant emissions of in each group that are currently 'unregulated' at an EU level. It shows that there is considerable variation between Member States. Whilst 'unregulated' emissions do not generally comprise the majority of the emissions by pollutant groups or by category (there are some exceptions, notably Ireland and Bulgaria), if the category iv emissions are removed from the analysis the significance of the 'unregulated' emissions becomes more prominent, particularly in the 'other pollutant' group. Figure 4.8 presents the share of emissions regulated by the IED compared to emissions indirectly regulated and 'unregulated' (categories ii and iii). With the notable exceptions of ammonia, and to a lesser extent PM_{10} and NMVOC, the IED covers more than 60% of the total (agro-)industrial emissions

Figure 4.8 Overview of categorisation of air emissions without category iv at EU27 level



As opposed to Figure 4.6 and Figure 4.7 which are percentage-based, Figure 4.9 shows the same information and groups of pollutants but in mass emission terms. This shows the absolute emissions relative to specific Member States and is a useful comparator when considering the trends outlined earlier in this section. Note that for presentation purposes, the figures are presented with a logarithmic scale.

Figure 4.9 Total emissions (tonnes per annum) of air pollutants groups by Member State



Note: This chart contains a logarithmic scale for presentation purposes

4.2 Emissions by pollutant and activities

4.2.1 Interpretation of the results

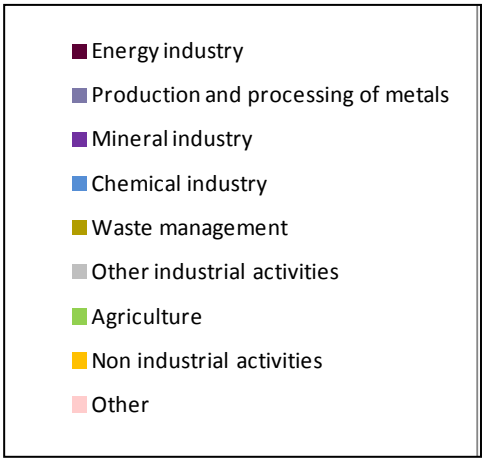
This section presents the results by pollutant and activities using a standard structure designed to provide information, in line with the terms of reference for the study, across a number of different areas including:

- The initial (summary) analysis presents the split of pollutant emissions amongst the four categories (bubble diagram). This shows how much of each pollutant is regulated (categories i & ii), 'unregulated' (category iii) and from other anthropogenic sources (category iv);

- This is followed by a more detailed analysis per group of activities (see Figure 4.10) with:
  - **a summary diagram** (pie chart) depicting the split of pollutant emissions from those activities that are judged to be the main emitters of the pollutant (by mass) based on the analysis;
  - **activity level results** for the main emitting activities which includes analysis of the splits of categories by activity (doughnut diagram), where relevant, showing for a particular group of activities how much of the pollutant emission falls into categories i, ii or iii – a useful counterpoint to the overall summary presented in the bubble diagrams;
  - **a brief summary of those 'other' activities** that are not considered the major emitters of the pollutant, which includes some commentary on emission tonnages, where relevant; and
  - **a summary of the category breakdowns by Member State** with commentary picking out key patterns or potential anomalies.

For presentation purposes, we have grouped activities in thematic groups. These groupings follow the structure of the activity groups for IED (with additions) and are rationalised from the original list of 104 (agro-)industrial activities set out in Appendix A. The grouping and colour-coding of activities is described in Figure 4.10. Non-industrial activities represent those grouped into category iv.

Figure 4.10 Overview of the colour-coding per group of activity



Colours for the groupings are standardised throughout the results section although it should be noted that the presentation focuses on those groups where there are significant emissions. **This means that not all groups are represented for all pollutants.** A detailed list of which activities are included in each group of activities is provided in Appendix A.

4.2.2 Sulphur oxides (SO_x)

Description

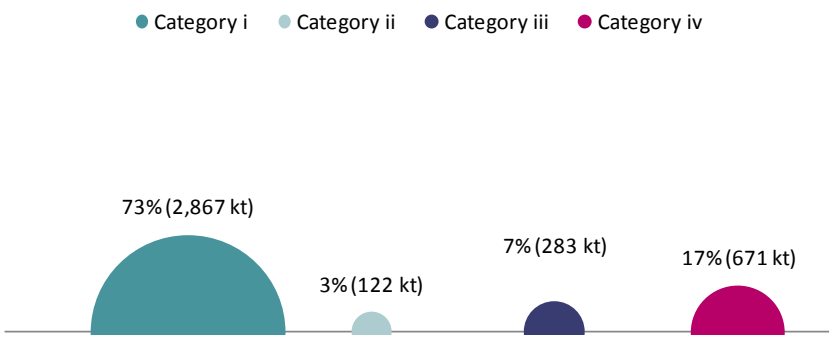
Sulphur oxides (SO_x) consist mainly of sulphur dioxide (SO_2) and sulphur trioxide (SO_3). Sulphur dioxide is a colourless gas with a pungent odour. Sulphur trioxide is a fuming colourless liquid. Since fossil fuels (coal and petroleum) often contain sulphur compounds, their combustion generates sulphur dioxide. Other anthropogenic sources of SO_2 are industrial processes involved with smelting, paper manufacture and the production of sulphuric acid (sulphur trioxide). The main source of release of SO_x is from the burning of fossil fuels. It is estimated that large industrial plants and sites are responsible for approximately 90% of the emissions of SO_2[10].

SO_2 is a major air pollutant with significant impacts on human health and the environment. It is a precursor to acid rain and atmospheric particulates. Once released in the atmosphere, it mixes with water vapour to create sulphuric acid (H_2SO_4). It contributes to acid deposition, the impacts of which can be significant, including adverse effects on aquatic ecosystems in rivers and lakes, and damage to forests. There are also increasing concerns relating to the impact of SO_2 on human health as it can trigger asthma in certain individuals.

Summary

A total of 3.9 million tonnes of SO_x was emitted to air during 2010 across the EU27. Figure 4.11 shows that the majority of emissions of SO_x (73%, 2.8 million tonnes) are already covered by the IED (category i). A smaller proportion of emissions belongs to category ii and are covered by other environmental legislation (3%, 122 kt). Finally, more than 17% (671 kt) of the SO_x emissions are reported under category iv; mainly from emissions reported under the domestic (418 kt) and shipping (151 kt) sectors. Emissions under category iii (7%, 283 kt) are due primarily to the operation of combustion plants below 20 MWth (232 kt).

Figure 4.11 Air emissions of SO_x per category (in %) (total EU27 emissions = 3.9 million tonnes)



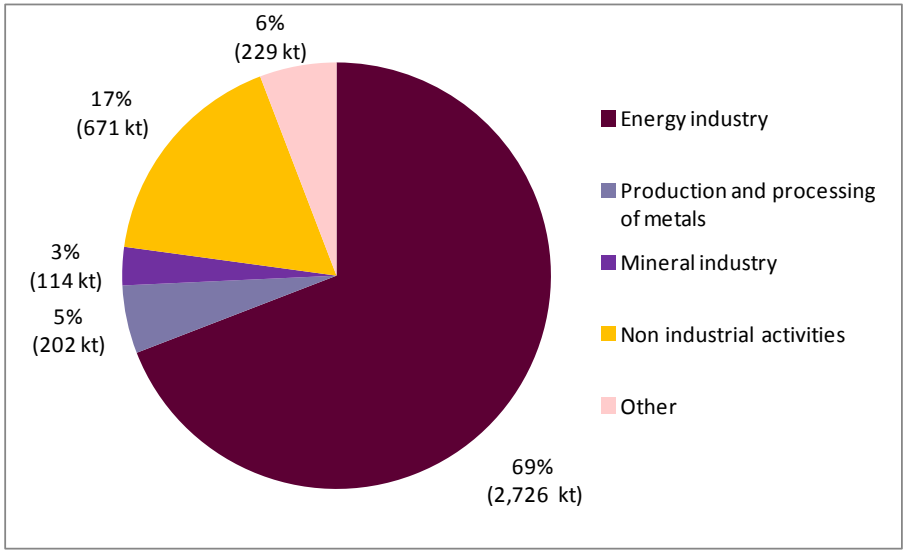
[10] E-PRTR, Sulphur oxides, Accessed 2013 http://prtr.ec.europa.eu/pgLibraryPollutants.aspx

Detailed analysis by group of activities

Overview

Figure 4.12 presents the split of SO_x emissions within the main groups of activities. Most of the emissions (2,700 kt) are from the energy industry group. Other significant groups are the non-industrial activities (670 kt), the group of 'other industrial activities' (229 kt), the production and processing of metals (202.5 kt) and the mineral industry (114 kt).

Figure 4.12 Split of SO_x emissions to air by major group of activities (total EU27 emissions = 3.9 million tonnes)



Note: Emissions from smaller groups of activities (chemical industry, waste management, other industrial activities and agriculture) have been clustered in the 'other' category due to their limited emissions.

Energy industry

Figure 4.13 Split of SO_x emissions to air– energy industry (total =2,726 kt)

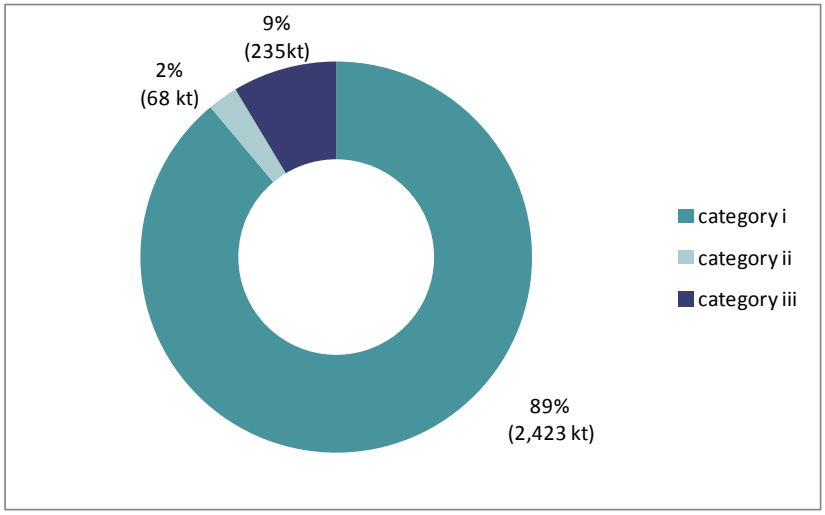


Figure 4.13 presents the detail of the emissions of SO_x by the energy industries. It shows that most emissions are in category i (2.4 million tonnes) and originate mainly from the combustion of fuels in combustion plant above 50 MWth (2 million tonnes) and from the refining of mineral oil and gas (372 kt). Category iii is not insignificant representing 9% (235 kt) of the emissions of this group; mostly from combustion installations below 20MWth (232 kt).

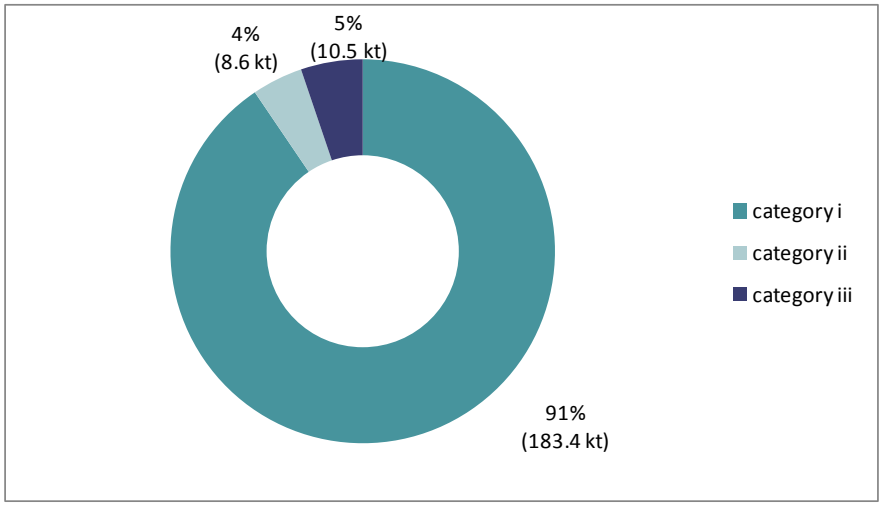
Non-industrial activities

Non-industrial activities emitted 670 kt of SO_x. The most significant sectors responsible for emissions are the domestic (418 kt) and shipping (151 kt) sectors.

Production and processing of metals

Figure 4.14 presents the emissions of SO_x by the metals production industries. Most SO_x emissions under this group are in category i (i.e. from activities regulated by the IED). The production of pig iron and steel (91kt) and non ferrous metals (42 kt) are the category i activities with the highest SO_x emissions. A small share of 'unregulated' (category iii) emissions (10.5kt) is from the production of pig iron and steel below 2.5 tonnes per hour. Finally, around 9kt of SO_x were emitted by the processing of non-ferrous metals under the IED threshold.

Figure 4.14 Split of SO_x emissions to air– production and processing of metals (total = 202.5 kt)



Mineral industry

Most of the emissions (97 out of 114 kt) in the mineral industry group are emitted by category i activities, mainly from the manufacture of glass (39 kt) and the production of cement (29 kt). The remaining emissions arise from category ii activities such as the production of cement (12.5 kt), the melting of mineral substances (2.2 kt) and the production of lime (1.5 kt) in facilities operating below the IED thresholds.

Activities not described above

- **Chemical industry**: All of the emissions of SO_x under the chemical industry group (110 kt) are associated to category i activities. The production of organic and inorganic chemicals are the two activities with the most emissions, each with around 50 kt of SO_x emissions;

- **Other industrial activities**: Emissions from other industrial activities represent 3% of the total SO_x emissions (104 kt). More than half are emitted by category i activities and from activities such as the treatment and processing of food (13 kt). The remaining emissions are split between category ii activities such as underground mining (28 kt) and from the category iii activity for the manufacture of paper and cardboard below 20 tonnes (34 kt);

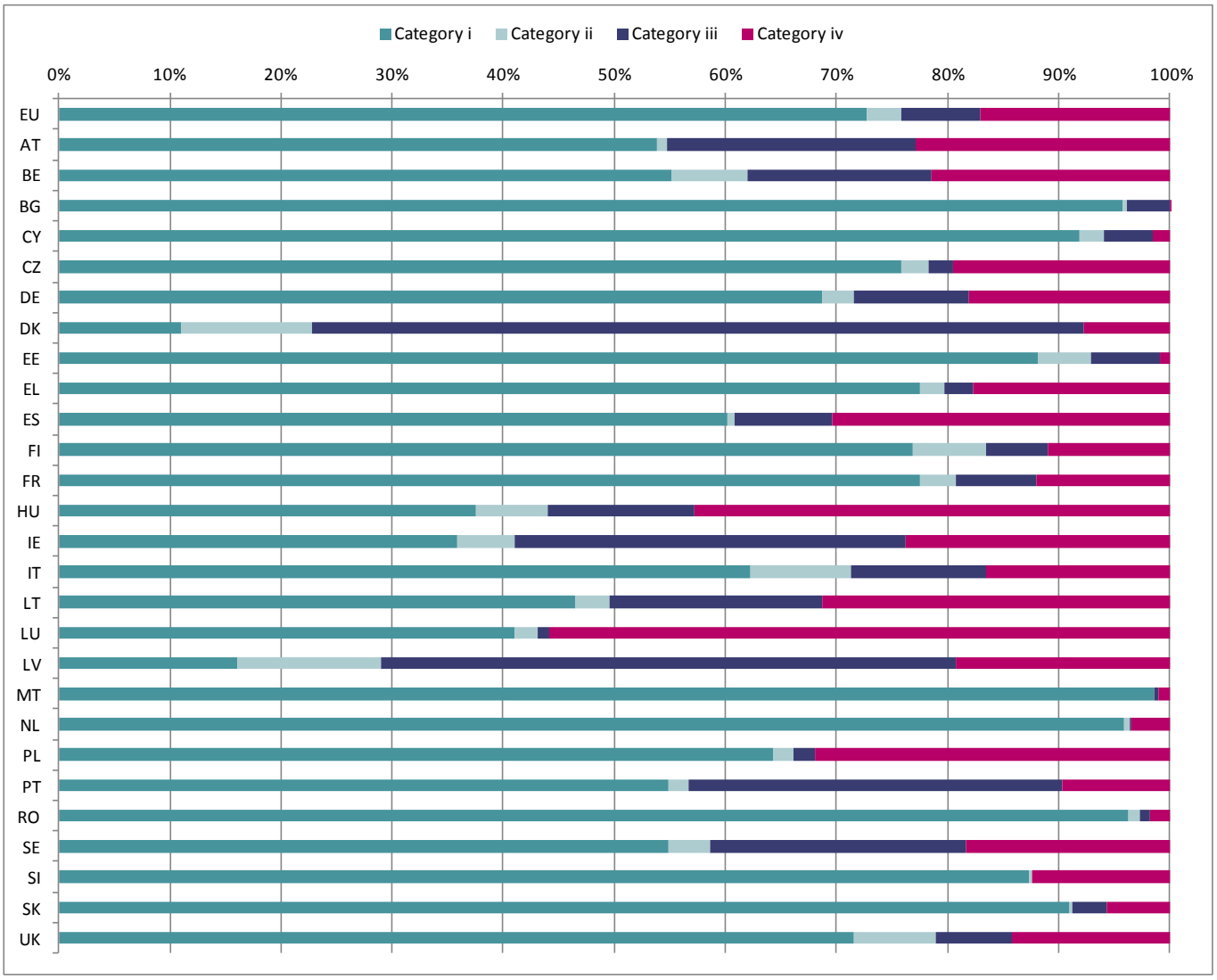
- **Waste management**: Almost all emissions (10 kt out of 11 kt) in the waste management category are included in category i and originate mainly from the disposal of non hazardous waste (6 kt) and waste incineration (2 kt). A small share of emissions (660 tonnes) is emitted by the category ii activity for the recovery, or mix of recovery and disposal, of non-hazardous waste below the IED threshold; and

- **Agriculture**: All emissions of SO_x (4 kt) are from field burning waste activities.

Additional comments at Member State level

While the general distribution described above can be observed in most Member States Figure 4.15 presents some notable variances in the split of emissions per category at Member State level.

Figure 4.15 Overall split of emissions of SO_x to air per category in each Member State and EU27 as a whole (%)



For some Member States, the share of emissions reported in category i is higher than the EU27 average (73%). This includes Malta (99%), Bulgaria (96%), the Netherlands (96%), Romania (96%), Cyprus (92%), Slovakia (91%), Estonia (88%), Slovenia (87%), Greece (78%), Finland (77%), France (77%) and Czech Republic (76%). For these Member States the share of emissions already regulated by the IED is more significant than the EU average.

For a few Member States, category iii emissions are larger than the EU average (7%). This includes Denmark (70%), Portugal (34%), and Ireland (35%). For all Member States, these emissions are primarily from combustion plants below 20 MWth and for Portugal, in addition to combustion plant, from the production of paper or cardboard below the IED threshold (20 tonnes per day production capacity).

Finally, non-industrial activities are a significant source of SO_x emissions. At an EU27 level, 17% of emissions are from category iv activities. However, for some Member States, this category is larger than average. This includes

Luxembourg (56%), Hungary (43%), Poland (32%), Spain (30%) and Austria (23%). For Austria, Luxembourg, Hungary and Poland, the domestic sector is the main source of SO_x emissions. For Spain, the shipping sector dominates.

Emissions of SO_x are spread amongst Member States; the highest emitters are Bulgaria, France, Germany, Spain Poland and the UK, which together emitted more than 50% of the total EU27 SO_x emissions.

4.2.3 Nitrogen oxides (NO_x)

Description

Nitrogen oxides (NO_x) consist of nitric oxide (NO) and nitrogen dioxide (NO_2) and are formed when nitrogen (N_2) combines with oxygen (O_2). The lifespan of these compounds in the atmosphere ranges from one to seven days (Clean Air Strategic Alliance, 2013).

NOx arises from industrial activities involving combustion and from transport. The quantity of NO_x generated depends on the temperature and the time nitrogen contained in the combustion air remains at that temperature. NO_x arises from the combustion of fuels, such as coal, that have a significant nitrogen content, which is released and oxidised during combustion. NO_2 is mainly emitted by internal combustion engines and thermal power stations. Finally, NO_x is also generated by the reaction of atmospheric nitrogen with other pollutants emitted from fuel. NO_2 is used in various chemical processes as an oxidising agent, including the production of nitric acid.

NO by itself is non-toxic, but it is converted in the air to NO_2. At low concentrations, nitrogen-containing species deposited on plants can act as nutrients. However at higher concentrations, they may contribute to acid deposition and acid rain but also to eutrophication. At high concentration levels, NO_2 is potentially toxic to plants, can injure leaves and reduce growth and yield of crops. In combination with either ozone (O_3) or sulphur dioxide (SO_2), NO_2 may cause damage at even lower concentration levels.

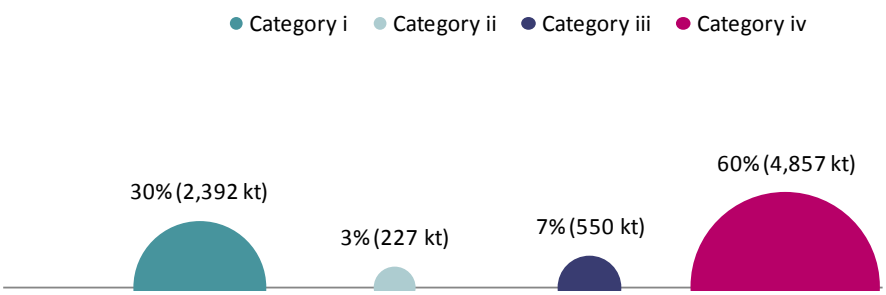
NO_x contributes to the formation of harmful particulate matter and ground level ozone in the atmosphere when combined with VOCs and sunlight. Ozone is a source of adverse effects on lung tissue in vulnerable individuals. It is easily dispersed by wind currents and can affect populations far from the original emission source. NO_x also reacts with ammonia, moisture, and other compounds to form nitric acid vapour and related particles. Inhalation of such particles is detrimental to respiratory and cardiac systems.

Summary

A total of 8 million tonnes of NO_x has been emitted to air in the EU27 in 2010. Figure 4.16 shows that most of these emissions come from activities included in category iv (4.8 million tonnes) such as the road transport sector (3.7 million tonnes). Emissions by activities regulated under the IED (category i) are the second largest category with 30% of emissions, which represents nearly 2.4 million tonnes of NO_x. Combustion activities in installations above 50 MWth represent more than half of these emissions (1.5 million tonnes). Category ii emissions are mostly due to combustion plants between 20-50 MWth (116 kt) and the use of N fertilisers other than manure (88 kt). Finally, ‘unregulated’ (agro-)industrial emissions (category iii) are mostly due to emissions from combustion plants

below 20 MWth (430 kt) and some industrial activities below relevant IED thresholds (such as manufacturing of pig irons which generated around 10 kt of NO_x).

Figure 4.16 Air emissions of NO_x per category (in %) (total EU27 emissions = 8 million tonnes)

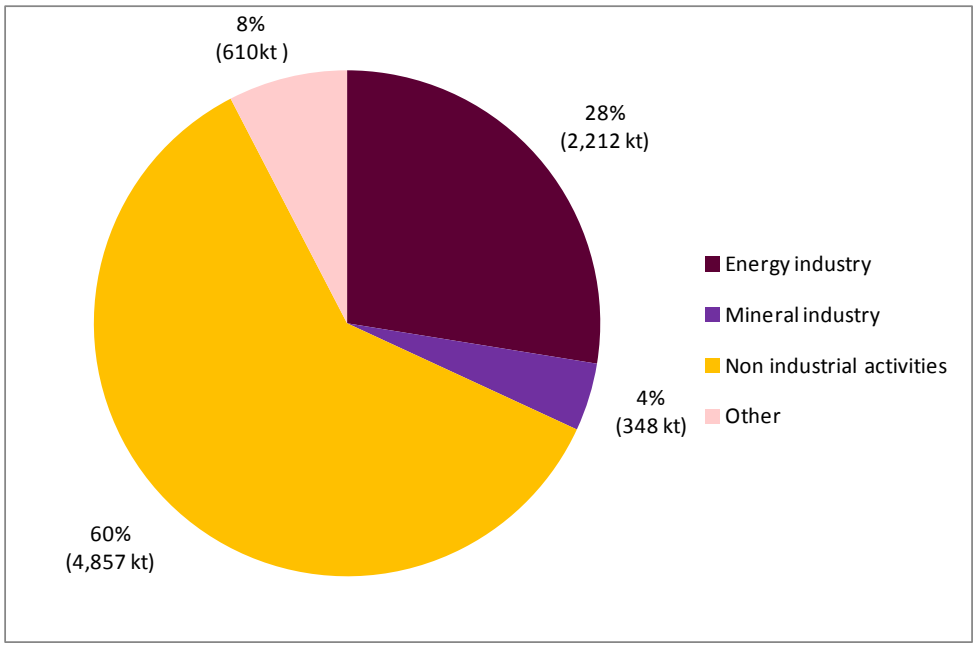


Detailed analysis by group of activities

Overview

Figure 4.17 presents the split of emissions of NO_x by main group of activities. Most of the emissions (60%, 4.8 million tonnes) are located within the activities contained in the non-industrial activities group, primarily road transport. The energy industry activities in category i are also a considerable source of emissions with 2.2 million tonnes of NO_x. Also in category i, the mineral industry emitted almost 350 kt of NO_x.

Figure 4.17 Split of NO_x emissions to air by major group of activities (total EU27 emissions = 8 million tonnes)



Note: Emissions from smaller groups of activities (production and processing of metals, chemical industry, waste management, other industrial activities and agriculture) have been clustered in the 'other' category due to their limited emissions.

Non-industrial activities

More than 75% of emissions are from road transport (3.7 million tonnes). Another 9% of emissions (440 kt) are emitted by the domestic sector whilst the shipping sector is responsible for 7% (325 kt) of the emissions in this group of activities.

Energy industry

Figure 4.18 Split of NO_x emissions to air– energy (total = 2,212 kt)

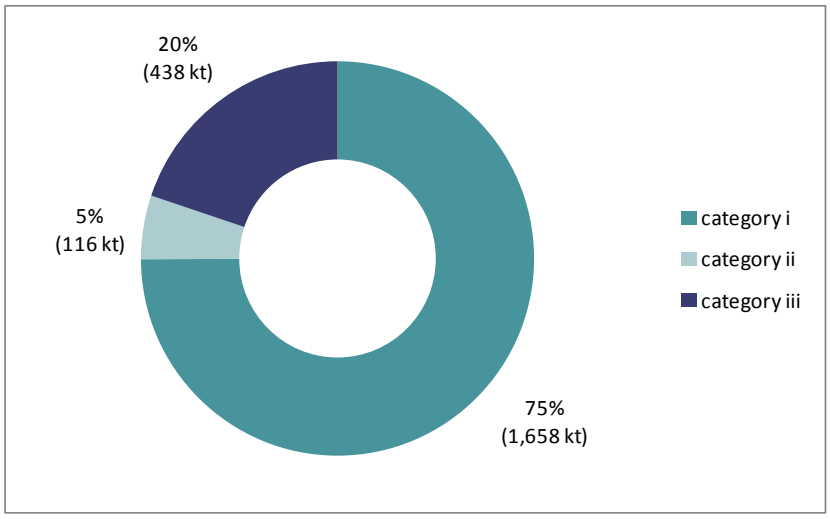


Figure 4.18 presents the split of emissions of NO_x from the energy industries. It shows that most of the emissions (75%, 1.6 million tonnes) are directly regulated by the IED (category i). The main activity responsible for these emissions is combustion installation above 50 MWth which emitted 1.5 million tonnes of NO_x. A small part of the emissions (116 kt) are indirectly regulated (category ii) and are due almost entirely to combustion installations 20-50 MWth. The remaining emissions (438 kt) in category iii are mostly emitted by the activity of combustion plants below 20MWth (436 kt).

Mineral industry

Almost all emissions (97%) in the mineral industry group are regulated by the IED. The remaining emissions (12 kt) are due to mineral industry activities under the IED thresholds as follows: manufacture of glass (4.6 kt), the production of lime (4.8 kt) and the production of cement (2.5 kt).

Activities not described above

- **Other industrial activities**: Other industrial activities are responsible for 2% (155 kt) of the overall emissions of NO_x in the EU27. More than half of the emissions of this group (101 kt) are emitted by activities in category i, however 45 kt of NO_x are emitted by the production of paper and cardboard under the IED thresholds and are not captured by any other EU legislation so are 'unregulated'(category iii);

- **Agriculture**: Agriculture is responsible for 2% (146 kt) of the overall emissions of NO_x in the EU27. Almost 60% of the emissions from agriculture are due to the use of fertilisers other than manure (88 kt, category ii). The remaining 40% of emissions (57 kt) are due to a mix of category iii activities, mainly the storage, transport and handling of agricultural products in and off farm (37 kt) and the field burning of agricultural waste (16 kt);

- **Production and processing of metals**: Most of the emissions of NO_x in this group were emitted by category i activities (134 kt out of 145 kt) such as the production of pig iron (88 kt), and metal ore roasting and splinting (19 kt). Production of pig iron and steel below 2.5 tonnes per hour (category iii) is responsible for almost 10 kt of NO_x. Finally, a small quantity of NO_x is emitted by activities under category ii (1.3 kt) and is due to the processing of non ferrous metals below IED thresholds;

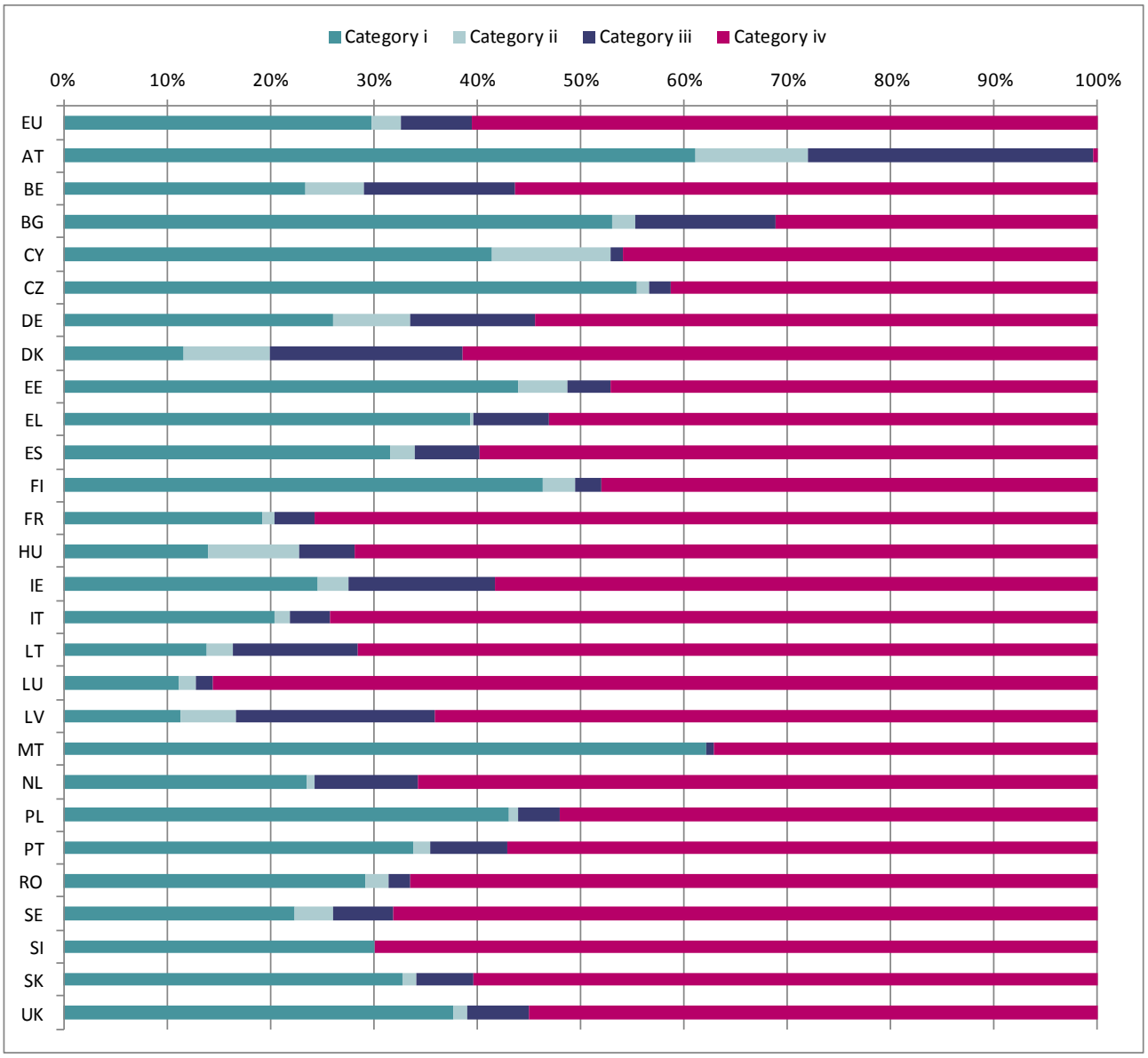
- **Chemical industry**: The chemical industry is responsible for 2% (126 kt) of the overall emissions of NO_x at an EU27 level. All of the emissions are from category i activities, in particular the production of organic (72 kt) and inorganic (34 kt) chemicals. Other emissions are due to the production of fertilisers (19 kt); and

- **Waste management**: A small quantity of NO_x is emitted by waste management related activities (38 kt). Most of these emissions are from category i (36 kt) where the main emitting activity is waste incineration (22 kt). The remaining emissions (2 kt) are from category ii activities.

Additional comments at Member State level

While the general distribution described in the section above can be observed in most Member States Figure 4.19 presents some notable variances.

Figure 4.19 Overall split of emissions of NO_x to air per category in each Member State and EU27 as a whole (%)



Austria is noticeable for having a larger share (28%) of emissions than the EU average (7%) under category iii. These emissions are split almost equally between emissions from combustions installations below 20 MWth and the production of paper and cardboard below 20 tonnes a day.

A few Member States have a greater share of emissions reported under category i than the EU average (30%). This is the case for Malta (62%), Austria (61%), Czech Republic (55%), Bulgaria (53%), Finland (46%), and Poland (43%). This is due to the following activities: combustion in installations above 50 MWth (a large majority of emissions for Austria, Bulgaria, Czech Republic, Finland, Malta and Poland); manufacturing of iron (Austria, Czech Republic, Finland); manufacturing of chemicals (Austria); manufacturing of cement, lime and magnesium oxides (Czech Republic); refining mineral oil and gas (Finland and Poland); production of coke (Poland) and metal

ore roasting and sintering (Poland).The share of emissions reported in category ii by Estonia (14%) and Cyprus (11%) are also considerably larger than the EU average (3%). For both Member States emissions are from combustion plants between 20-50 MWth and the use of synthetic fertilisers.

Whilst most of the emissions at EU level are located in category iv (60%) and more specifically from road transport, for Bulgaria it represents a smaller share of its total emission (31%) which is explained by the fact that most of its NO_x emissions are emitted by category i activities. Conversely, Luxembourg has a large share of its emissions located in category iv activities (86%) due mostly to emissions from the road transport sector.

Emissions of NOx are reported by all Member States, but a group of Member States is responsible for a large share of the emissions. The highest emitters are France, Germany, Italy, Spain and the UK. Together, they emitted 60% of the total NOx emissions at EU27 level.

4.2.4 Particulate matter (PM10)

Description

Particulate matter (or dust) is a term used to describe particles of carbon, metals and inorganic salts suspended in a gas or liquid. PM10 is the term used to describe particulate matter smaller than 10 microns in size. Particulate matter can consist of different pollutants such as sulphur dioxide, nitrogen oxides, carbon monoxide, mineral dust, organic matter, and elemental carbon also known as black carbon or soot.

The chemical composition of these fine particles depends on their source; when containing mineral oxides particular matter is light-absorbing. When suspended in the atmosphere, they are designated as aerosols. Anthropogenic activities (fossil fuel combustion for example) can be precursors for these aerosols. Some particles derive from the oxidation of pollutants such as sulphur and nitrogen oxides into sulphuric acid (liquid) and nitric acid (gaseous).

In general, the smaller and lighter a particle is, the longer it will stay in the air. Larger particles (greater than 10 micrometres in diameter) tend to settle to the ground by gravity in a matter of hours.

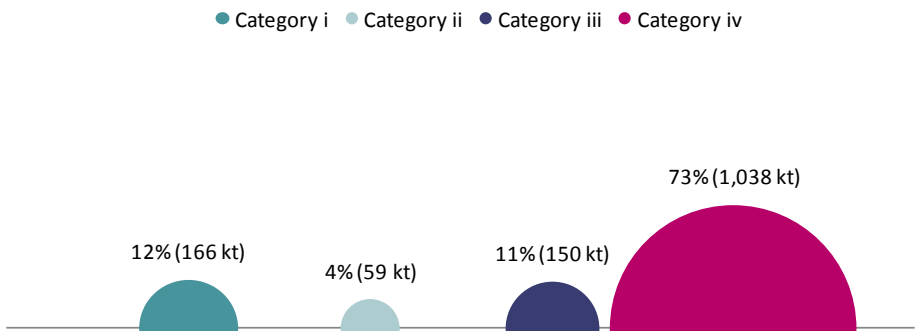
Many industrial and combustion processes use or generate substances in a particulate form. Particulate matter is mostly produced by combustion of fuels, waste incineration, building and construction, quarrying activities and other industrial processes.

In terms of potential to harm human health, particulate matter is one of the most important pollutants as it penetrates into sensitive regions of the respiratory system, exacerbating respiratory illnesses such as asthma and contributing to increased prevalence and incidence of other cardiovascular diseases and premature death. At a global scale, particulate matter contributes to climate change through its ability to alter the radiative forcing of the atmosphere (E-PRTR, 2013).

Summary

In 2010, more than 1.4 million tonnes of PM10 were emitted to air at an EU27 level. Figure 4.20 shows that most of these emissions were emitted by activities in category iv: mainly the domestic (700 kt) and road transport (280 kt) sectors. Emissions from IED regulated (category i) and 'unregulated' activities (category iii) have the second biggest shares of emissions (12% and 11% respectively). Emissions in category i (166 kt) are due to activities such as combustion installations above 50 MWth (76 kt) and waste incineration (28 kt). Emissions in category iii (150 kt) are mainly due to the transport and storage of agricultural products (63 kt) and combustion plants below 20 MWth (37 kt).

Figure 4.20 Air emissions of PM10 per category (total EU27 emissions = 1.4 million tonnes)

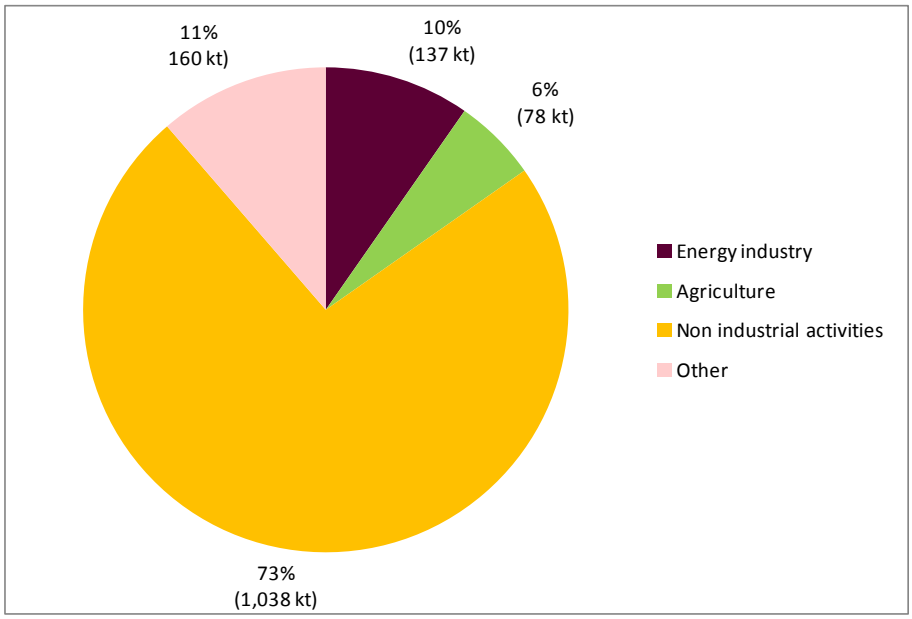


Detailed analysis by group of activities

Overview

Figure 4.21 presents the source of emissions of PM10 by main group of activities. Most of the emissions (representing more than 1 million tonnes) are located within the group of non-industrial activities. Within this group of activities, the domestic sector is the major source of PM10 emissions. The energy industry related activities are also a significant source of emissions with 137 kt of PM10 emitted. Finally, the agriculture sector emitted 78 kt of PM10.

Figure 4.21 Split of emissions of PM10 to air by major group of activities (total EU27 emissions =1.4 million tonnes)



Note: Emissions from smaller group of activities (production and processing of metals, mineral industry, chemical industry, waste management and other industrial activities) have been clustered in the 'other category' due to their limited emissions.

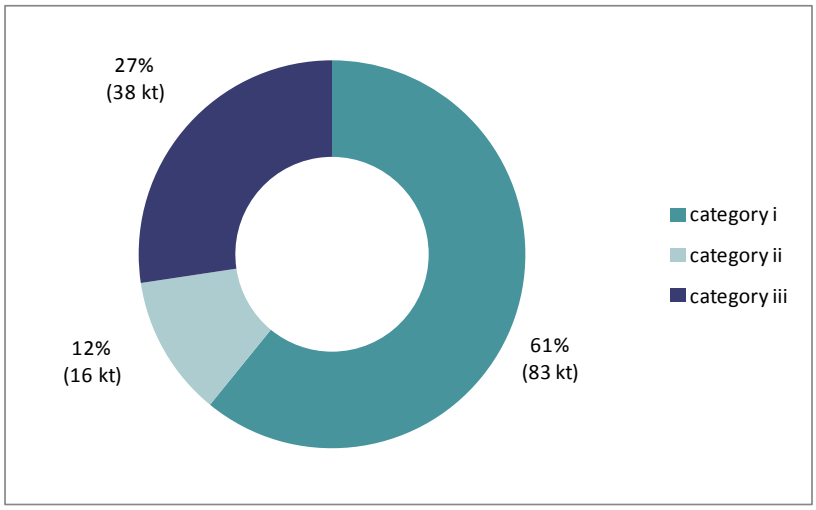
Non-industrial activities

Most of the emissions in this group of activities (67%) are from the domestic sector (700 kt) and road transport (280 kt). Other smaller sources such as the commercial (18 kt) and shipping (21 kt) sectors are each responsible for 2% of the total PM10 emissions in this group of activities.

Energy industry

Figure 4.22 presents the splits of emissions of PM10 from the energy industries. It shows that the majority of the emissions (83 kt, 61%) come from activities already regulated under the IED with a further 12% (16 kt) from those activities regulated under other EU legislation. Consequently, 73% of energy industry PM10 emissions are either directly or indirectly regulated. The activities responsible for these emissions are the combustion of fuels in installations above 50MWth (76 kt) and those between 20 to 50 MWth (16 kt). The remaining emissions (category iii) originate almost exclusively from the activity of combustion plants below 20 MWth (37 kt) which are not currently regulated at an EU level.

Figure 4.22 Split of emissions of PM10 to air– energy industry (total =137 kt)



Agriculture

Figure 4.23 Split of emissions of PM10 to air per group of activities – agriculture (total = 78 kt)

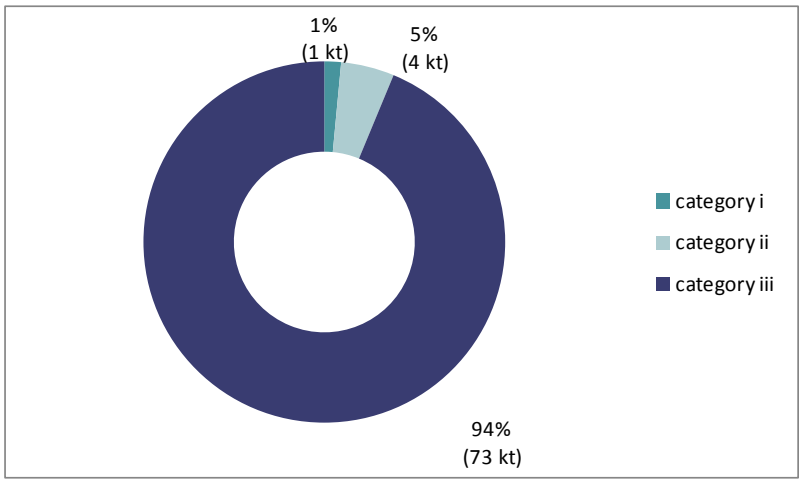


Figure 4.23 presents the split of emissions of PM10 from the agriculture sector. The overwhelming majority of emissions (73 kt) are currently 'unregulated' and located in category iii. The activity responsible for more than 86% of these emissions (63 kt) is the storage, handling and transport of agricultural products on and off-farm. The remainder of emissions in category iii comes from field burning of agricultural wastes.

Activities not described above

- **Production and processing of metals**: Overall, the production and processing of metals activities are responsible for 4% of total PM10 emissions (53.5 kt). Almost half of the emissions (26 kt) are currently regulated by the IED (category i) and only a small proportion (6%) of emissions are

indirectly affected by environmental legislation (3 kt of PM10 emitted by the processing of non-ferrous metals). The rest (23 kt) are currently 'unregulated' (category iii) and are emitted by activities such as the production of pig iron or steel in installations below 2.5 tonnes per hour;

- **Other industrial activities**: The group of other industrial activities is responsible for a small share of total emissions of PM10 (3%, 46 kt). A part of the emissions are regulated under the IED (10.7 kt) or emitted by activities in category ii (20.3 kt). Category iii emissions (15 kt) are due mainly to the production of paper and cardboard in installations with a production capacity below the IED threshold of 20 tonnes per day;

- **Waste management**: Almost all of the total 31 kt of PM10 emitted by the waste management related activities are from category i activities and as such captured by the IED;

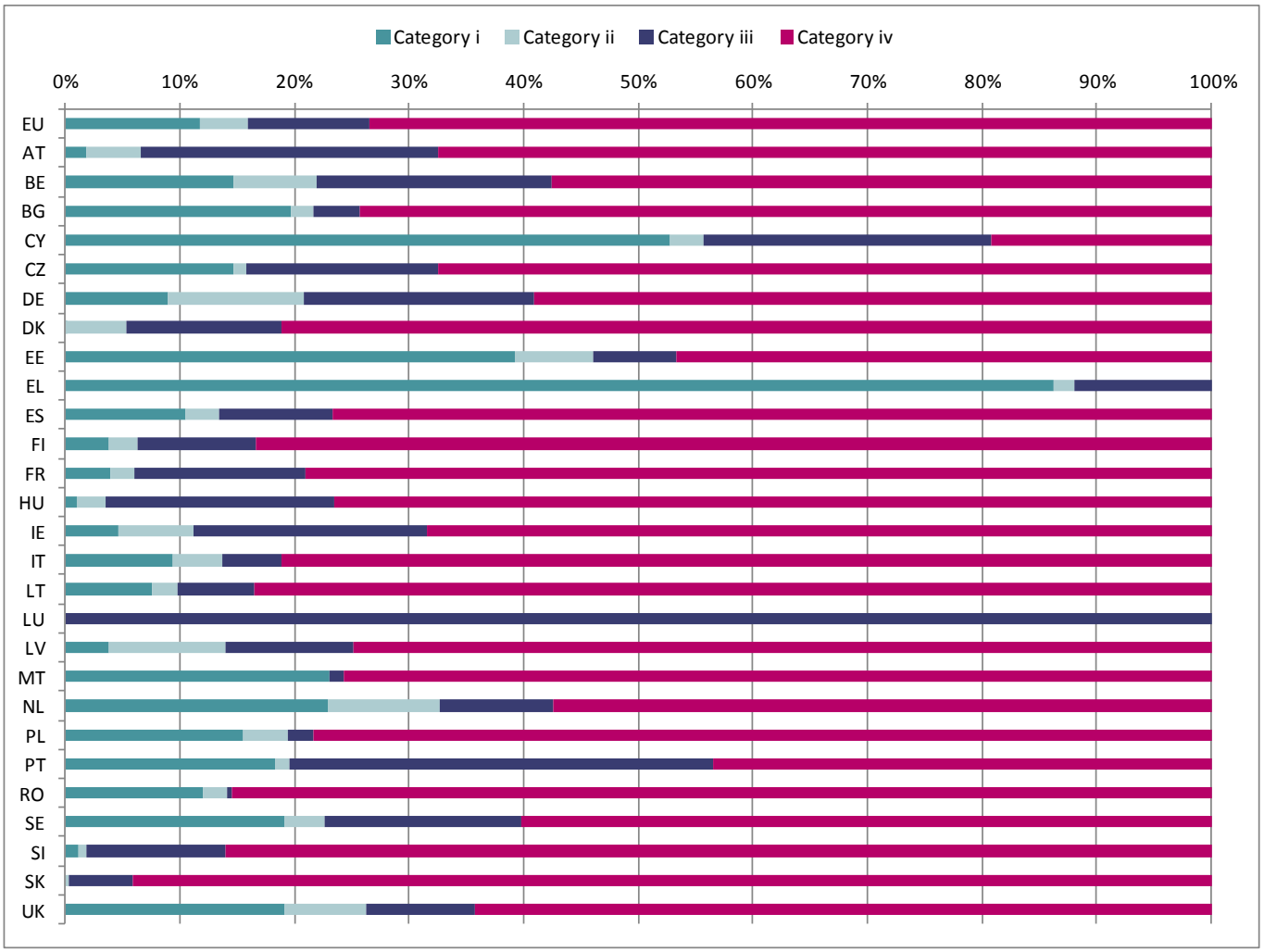
- **Mineral industry**: A total of 23 kt of PM is emitted by the mineral industry. Most of the emissions (73%, 15.6 kt) reported under this group of activities are allocated to category ii. The majority of these emissions are from the production of cement (12 kt) and the production of lime (3 kt) below IED thresholds. All of the remaining emissions (7.2 kt) arise from category i activities; and

- **Chemical industry**: The chemical industry is a limited source of PM10. Overall 7 kt of emissions are allocated to this group of activities and all of them are arising from category i activities. Almost half of the emissions (3.2 kt) are arising from the production of fertilisers.

Additional comments at Member State level

Whilst the general EU27 distribution described above can be observed in most Member States; Figure 4.24 presents some notable variances.

Figure 4.24 Split of emissions of PM10 to air by category at Member State and EU27 as a whole (%)



A few Member States have lower emissions reported under category i than the overall EU average (12%); this includes Italy (9%), Lithuania (8%), Ireland (5%), Finland (4%), France (4%), Latvia (4%), Austria (2%), Hungary (1%), Slovenia (1%), Denmark (0%), Luxembourg (0%) and Slovakia (0%). The explanations for these differences may relate to a combination of the size of the Member States (smaller Member States generally have less IED regulated installations); the choice of fuel mix (i.e. Member States using more gaseous fuels will have low PM emissions in general) and the introduction of abatement techniques at IED sites to reduce PM emissions.

Whilst most of the emissions are located in category iv at an EU level (73%), and more specifically in transport, some Member States appear to have a larger than average category iv, which contributes more than 80% of their total emissions of PM10. This is the case for Slovakia (94%), Slovenia (86%), Romania (85%), Lithuania (84%), Finland (83%), Latvia (82%), Denmark (81%) and Italy (81%). For all of these Member States, the domestic, shipping and road transport sectors are the predominant sources of emissions.

Category iii at an EU27 level contributes 11% of total PM10 emissions. However for some Member States this share of 'unregulated' PM10 emissions is more important: this includes Luxembourg (100%), Portugal (37%), Austria (26%) and Cyprus (25%). These emissions are generated by different activities between Member States although for Austria and Cyprus combustion plants below 20MWth are the main sources of emissions. Other contributing activities are the storage and handling of agriculture waste (Austria), the production of cardboard and paper below 20 tonnes a day (Portugal and Luxembourg), the field burning of agricultural waste (Portugal) and the production of pig irons below 2.5 tonnes per hour (Portugal).

Emissions of PM10 are spread across all Member States with France, Italy and Poland being the highest emitters. Together, these three Member States are responsible for 41% of the total EU27 PM10 emissions.

4.2.5 Carbon monoxide (CO)

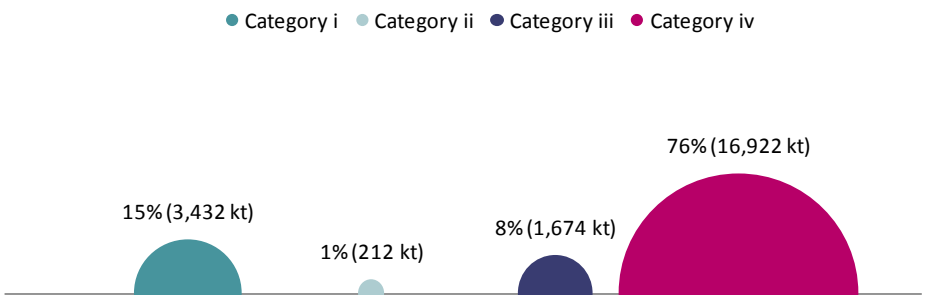
Description

Carbon monoxide (CO) is a colourless, odourless poisonous gas and can be either man-made or produced naturally. CO is mainly emitted by small combustion units used for domestic uses. CO is also released by the metal refining and chemical industry as well as from vehicles that are not fitted with a catalytic converter. Levels of carbon monoxide are believed to reflect traffic volumes in urban areas. Some natural processes produce CO but only in small amounts in comparison. Short-term exposure at high concentrations can result in death. Long-term exposure at low concentrations can result in neurological problems and harm to unborn babies. Carbon monoxide can react with other pollutants to produce ground level ozone, an important pollutant at local and global scales. Elevated levels of ozone can cause respiratory health problems and lead to premature mortality. High levels of ozone also damage plants, reducing agricultural crop yields and decreasing forest growth (E-PRTR, 2013).

Summary

More than 22 million tonnes of CO were emitted to air in the EU27 in 2010. Figure 4.25 shows that the majority of these emissions (16.9 million tonnes) was emitted by activities included in category iv and more specifically by the domestic (8.8 million tonnes) and road transport (7.2 million tonnes) sectors. Industrial activities regulated by the IED are also a significant source of emissions (15% of the total CO emissions, 3.4 million tonnes). The third most important category is from 'unregulated' activities (category iii), with 1.6 million tonnes of CO. The bulk of these emissions originate from the production of pig iron and steel below 2.5 tonnes per hour (1.1 million tonnes) and the field burning of agricultural wastes (440 kt).

Figure 4.25 Air emissions of CO per category (in %) (total EU27 emissions= 22.2 million tonnes)

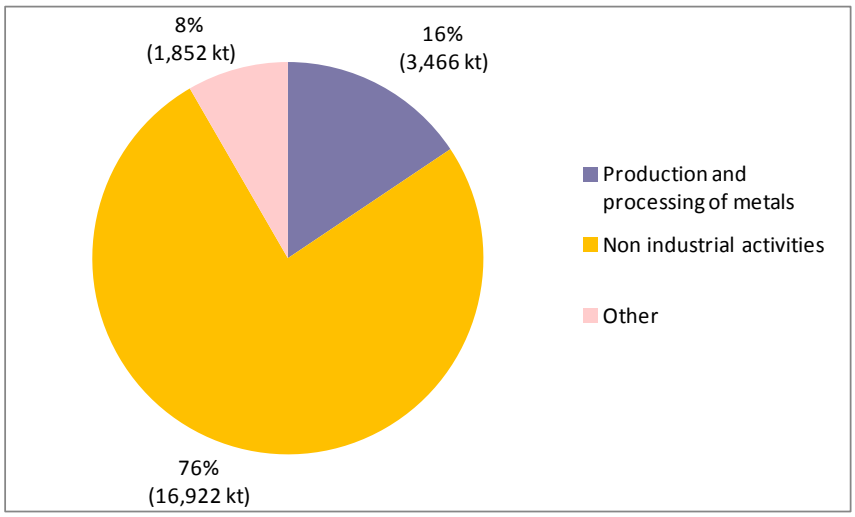


Detailed analysis by group of activities

Overview

Figure 4.26 presents the sources of emissions of CO by group of activities. Most of the emissions of CO arise from non-industrial activities (nearly 17 million tonnes) and the production and processing of metals (3.4 million tonnes).

Figure 4.26 Split of emissions of CO to air per major group of activities (total EU27 emissions = 22.2 million tonnes)



Note: emissions from smaller group of activities (energy industry, mineral industry, chemical industry, waste management, other industrial activities and agriculture) have been clustered in an 'other' category due to their limited emissions.

Non-industrial activities

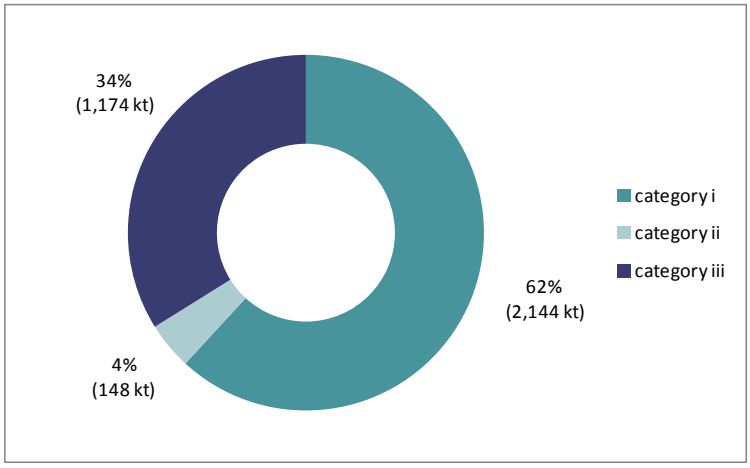
The group of non-industrial activities (category iv) generates most of the emissions from CO at an EU27 level (nearly 17 million tonnes). Within this group of activities, the emissions are split between emissions from the domestic sector (8.8 million tonnes) and from road transport (7.2 million tonnes). The remaining emissions are split between shipping (426 kt), commercial services (369 kt), aviation (101 kt) and railways (around 30 kt).

Production and processing of metals

The second most important source of emissions of CO at an EU27 level is from the production and processing of metals (3.5 million tonnes). However, whilst it is the second most important source of emissions, it is significantly smaller than emissions from non-industrial activities.

Figure 4.27 presents the split of emissions of CO by category. A large majority of emissions are regulated by the IED (more than 2 million tonnes) with 1.5 million tonnes of emissions in this category due to the production of pig iron or steel. Category ii emissions represent 148 kt of CO emissions. A third of the total emissions under this group are currently 'unregulated' (category iii) representing just over 1 million tonnes of CO. The activity responsible for these emissions is the production of pig iron or steel below 2.5 tonnes per hour.

Figure 4.27 Split of emissions of CO to air– production and processing of metals (total =3,466 kt)



Activities not described above

- **Agriculture**: Agriculture is for 443 kt of emissions of CO. All of the emissions in the agriculture group are currently 'unregulated' (category iii) and due to the field burning of agricultural wastes;
- **Mineral industry**: The mineral industry sector contributes over 431 kt of CO. The vast majority of these emissions (392 kt) are emitted by activities located in category i such as the production of cement (330 kt), the melting of mineral substances (27 kt) and the production of lime (18 kt). The remaining emissions (37 kt) are emitted from category ii activities, in particular the manufacture of lime below 50 tonnes a day (36 kt);
- **Waste management**: These activities are responsible for 351 kt of emissions of CO with the majority (343.3 kt, 98%) regulated by the IED (category i). The remaining 2% (7.5 kt) are due to the activity of landfills below the IED threshold and are captured by other legislation (category ii);
- **Energy industry**: The energy industry sector contributed 305 kt of CO in 2010. All of the emissions come from IED regulated activities including combustion installations above 50MWth (220 kt), the refining of mineral oil and gas (51kt) and the coal running mills (20 kt);

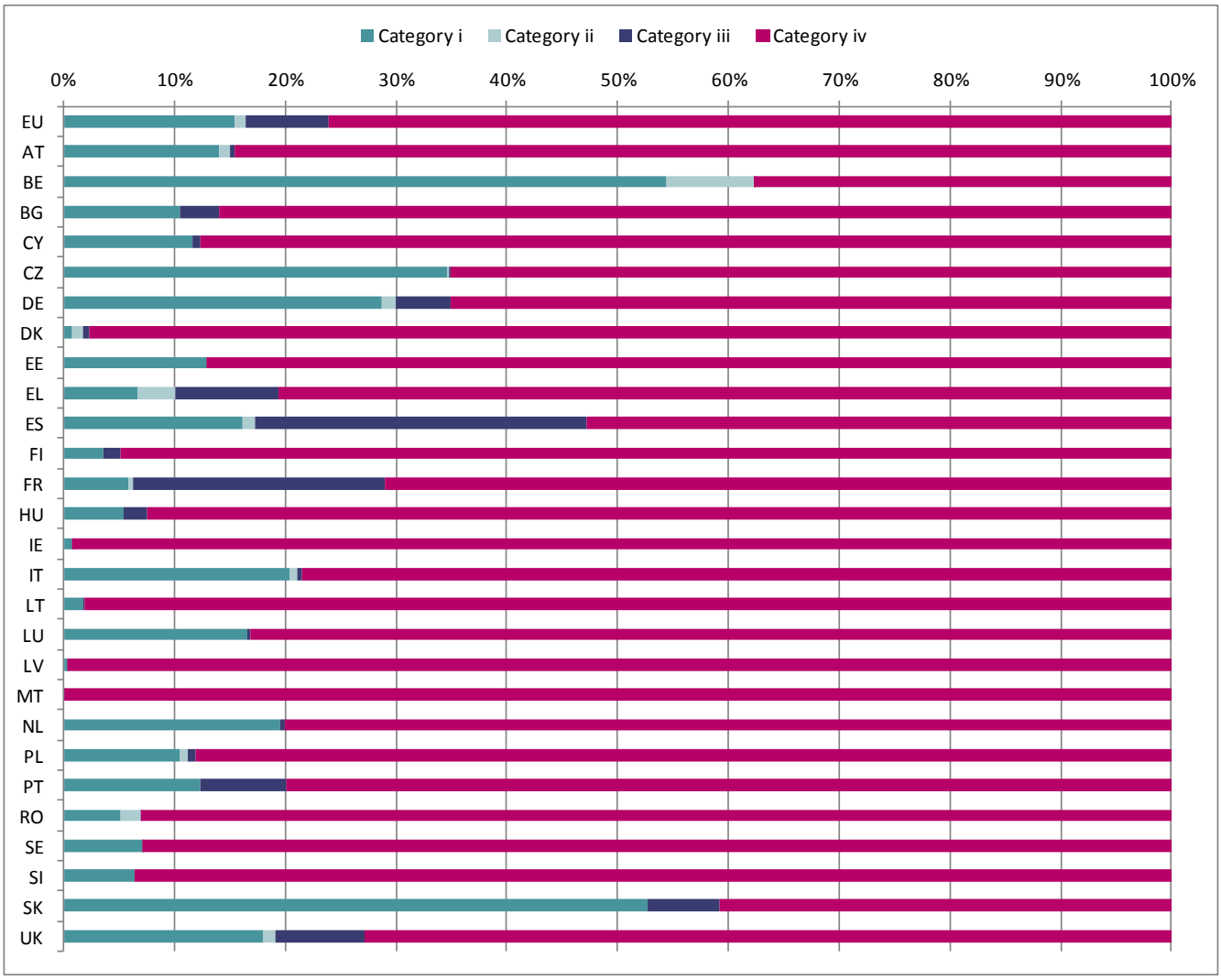
- **Chemical industry**: All of the emissions of CO reported by the chemical industry (191 kt) are emitted by category i activities, mainly the production of inorganic chemicals (140 kt) and the production of organic chemicals (46 kt); and

- **Other industrial activities**: The group formed by other industrial activities is responsible for 131 kt of CO emitted in 2010. The emissions are mostly split between category i activities (55 kt) such as the production of pulp paper and cardboard (44 kt) and the production of carbon (7kt) and category iii activities (57 kt) such as the production of paper and cardboard below 20 tonnes per day (56 kt). The remaining emissions came from category ii activities.

Additional comments at Member State level

While the general EU distribution described above can be observed in most Member States, Figure 4.28 presents some notable variances.

Figure 4.28 Split of emissions of CO to air by category at Member State and EU27 as a whole (%)



At an EU27 level, category iv presents the largest share of emissions (76%) with some Member State reporting an even higher share of their CO emissions in this category. This is the case of Latvia (100%), Malta (100%), Ireland (99%), Lithuania (98%), Denmark (98%), Finland (95%), Slovenia (94%), Romania (93%), Sweden (93%) , Hungary (92%), Cyprus (88%), Estonia (87%), Bulgaria (86%), and Austria (85%). For these Member States CO is emitted by both the domestic and road transport sectors. For the following Member States domestic emissions are the main source of CO followed by road transport: Austria, Bulgaria, Denmark, Estonia, Lithuania, Latvia, Romania, Slovenia and Sweden. For the other Member States it is the road transport sector that is the main emitter: Cyprus, Finland, Hungary, Ireland and Malta. Denmark and Finland also have some significant emissions from the commercial service sector and Sweden reports large CO emissions from its shipping sector.

Two Member States have reported smaller than average category iv emissions: Spain (53%) and Belgium (38%). However, the sources of these emissions are the same as for other Member States (domestic and road transport sectors).

A few Member States report a larger category i than the EU average (15%). This is the case for Belgium (54%), Slovakia (53%), Czech Republic (35%) and Germany (29%). The activities responsible for CO emissions include pig iron and steel production (Belgium, Czech Republic, Germany and Slovakia), production of cement (Belgium, Czech Republic and Germany), combustion installations above 50 MWth (Germany) and the production of non-ferrous metals (Slovakia).

Finally, two Member States have reported large source of emissions in category iii activities, greater than the EU average (8%). This is the case for Spain (30%) and France (23%). This is primarily due to the field burning of agricultural waste and pig iron and steel production below 2.5 tonnes per hour.

Emissions of CO are spread across all Member States with France, Germany, Italy and Poland being the highest emitters. Together, these three Member States are responsible for 53% of the total EU27 CO emissions.

4.2.6 Arsenic (As)

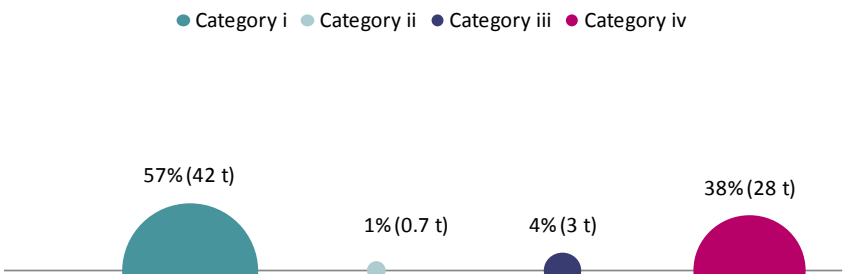
Description

Arsenic is a grey coloured solid, which shows properties that are partly metallic and partly non-metallic. Inorganic compounds of arsenic are usually colourless solids with variable solubility in water. Arsenic compounds are mainly used in agricultural pesticides and wood preservatives as well as glass, metal alloys, bronzing and in pyrotechnics. The main source of releases of arsenic compounds into the environment is from the burning of fossil fuels in power stations. They are also released through their use in pesticides and wood preservatives. Arsenic persists in the environment, accumulates in living organisms and at high concentrations is toxic to wildlife. Long term exposure to certain arsenic compounds may cause skin and lung cancer. Direct contact with skin can cause burning and irritation. However the extent of harmful effects following exposure to arsenic compounds depends upon both the form and bioavailability of arsenic (E-PRTR, 2013).

Summary

EU27 Member States emitted a total of 74 tonnes of arsenic to air in 2010. Figure 4.29 shows that most of these emissions (42 tonnes) were emitted by activities included in category i. Combustion installations above 50MWth (19.4 tonnes), waste incineration (9.9 tonnes) and the manufacture of glass (3.6 tonnes) have together contributed almost half (43%) of the total arsenic emissions. Category iv is the second largest category contributing 38% of arsenic emissions (28 tonnes), most of which are from the domestic (20.9 tonnes) sector. Category ii emissions amount to less than 1 tonne and arise mainly from the processing of non-ferrous metals (0.2 tonne) and the production of cement (0.2 tonne) below the IED thresholds with the rest split between other industrial processes and waste activities below relevant IED threshold. Category iii emissions amount to 3 tonnes and originate mainly from the production of pig iron and steel below 2.5 tonnes per day.

Figure 4.29 Air emissions of arsenic to air by category (in %) (total EU27 emissions = 73.7 tonnes)

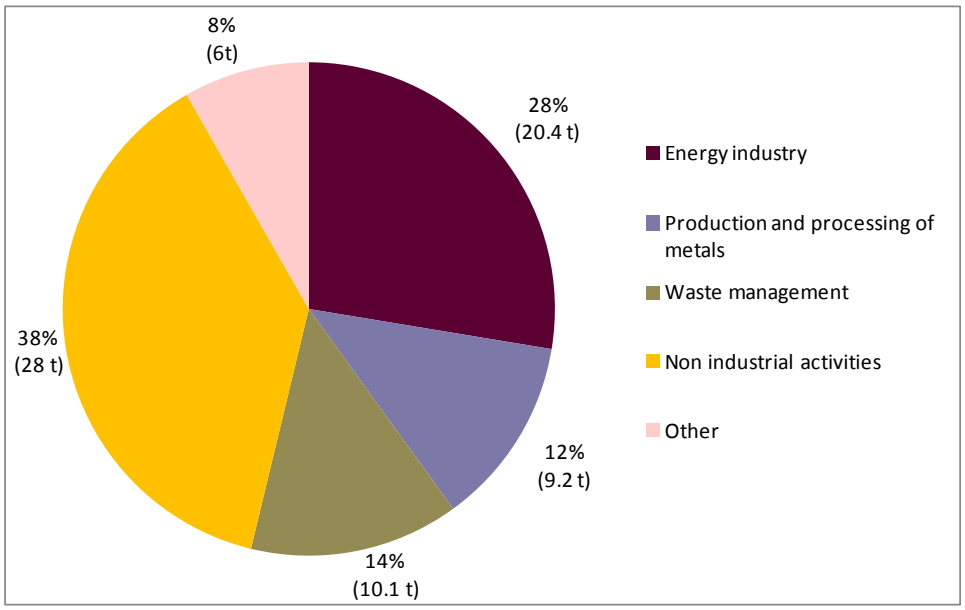


Detailed analysis by group of activities

Overview

Figure 4.30 presents the source of emissions of arsenic for the major group of emitting activities. The most important contributor to arsenic emissions is the non-industrial activities sector, with 38% of total emissions (28 tonnes), of which almost 21 tonnes are from domestic sources. The second most important group of activities are the energy industries, which is responsible for around 20 tonnes of arsenic. The data shows that waste management activities emit 10 tonnes of arsenic, of which 9 tonnes are due to waste incineration, and the production and processing of metals a further 9 tonnes.

Figure 4.30 Split of emissions of arsenic to air by major group of activities (total EU27 emissions = 73.7 tonnes)



Note: emissions from smaller group of activities (chemical industry, mineral industry, other industrial activities and agriculture) have been added to form the 'other' category due to their limited emissions.

Non-industrial activities

Non-industrial activities have generated 28 tonnes of arsenic and emissions from the domestic sector represent most of the total (20.9 tonnes) but other important sources of emissions are shipping (3.6 tonnes) and commercial services (2.7 tonnes).

Energy industry

The energy sector is responsible for 20.4 tonnes of arsenic, which are emitted from installations in category i. The most important source of arsenic emissions are combustion plants above 50 MWth (19.4 tonnes). The refining of mineral oil and gas emitted just under 1 tonne of arsenic.

Waste management

Waste management activities contribute 10.1 tonnes of arsenic per annum. Almost all of these emissions are located in category i and thus regulated by the IED. The activities that contribute the most are waste incineration (9.9 tonnes) and landfills (0.1 tonne). A very small amount of emissions are from category ii waste related activities (2 kg).

Production and processing of metals

Figure 4.31 Split of emissions of arsenic to air–production and processing of metals (total = 9.2 tonnes)

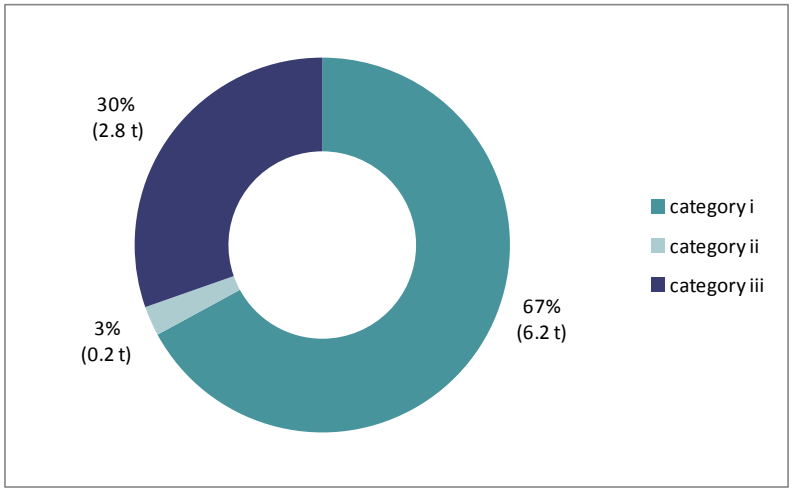


Figure 4.31 presents the distribution of emissions in the different categories. It shows that most of the emissions (6.2 tonnes) were emitted by category i activities, in particular the production of non-ferrous metals (3.2 tonnes) and the production of pig iron and steel (2.5 tonnes). The production of pig iron and steel below 2.5 tonnes per hour is responsible for the emissions of 2.8 tonnes of arsenic in category iii.

Activities not described above

- **Mineral industry**: The mineral industry emitted around 4.2 tonnes of arsenic. Most of these emissions originate from category i activities (3.7 tonnes) and primarily the manufacture of glass fibre (3.6 tonnes). The melting of mineral substances and the production of cement below IED thresholds, both activities under category ii are responsible each for 0.2 tonnes of emissions;

- **Other industrial activities**: In total, 1.5 tonnes of arsenic was emitted by other industrial activities gathered in this group. Almost all of these emissions (1.2 tonnes) are from category i activities such as the production of paper and cardboard (> 1 tonne). Emissions reported under category ii activities (80 kg) are very limited and arise mostly from underground mining and other related operations (74 kg). Finally a small proportion of the total emissions are reported from category iii activities (0.2 tonnes) from the production of paper and cardboard below 20 tonnes a day;

- **Chemical industry**: The chemical industry emitted 335 kg of arsenic in 2010. All of these emissions are from category i activities; and

- **Agriculture**: Arsenic is emitted to air by the agriculture sector in very limited quantities. The only emissions recorded are 60 kg of emissions from field burning of agricultural wastes.

Additional comments at Member State level

While the general distribution described above can be observed in most Member States, Figure 4.32 presents some notable variances. Furthermore, Austria and Luxembourg did not report any emissions of arsenic to the E-PRTR or the LRTAP.

Figure 4.32 Split of emissions of arsenic to air per category at Member State and EU27 as a whole (%)

A few Member States have a category i significantly larger than the EU average (63%). This is the case for Estonia (100 %), Slovenia (100 %), Cyprus (97 %), Greece (93 %) and Bulgaria (90%). The most frequent source of emissions is the activity of combustion installations above 50 MW.

The analysis of Member State emissions has also shown that three Member States have relatively large category iii emissions in comparison to the EU27 average (4%). This is the case for Hungary (72%), Romania (22%) and Latvia (18%). For all of these Member States, emissions arise from the production of pig iron or steel with a capacity lower than 2.5 tonnes per hour.

Whilst at an EU27 level category ii emissions are 1% of the total arsenic emissions, for one Member State (Denmark) this category represents a higher share of emissions (10%). This is due to emissions from activities involving organic solvents below IED thresholds.

Finally, for some Member States, category iv is a large source of emissions greater than the EU average of 38%. This is the case for Lithuania (99%), Poland (90%), Latvia (82%), Romania (77%), Denmark (76%) and Ireland

(62%). For Ireland, Lithuania and Poland, most of the emissions are from the domestic sector. For Romania and Denmark, emissions from the shipping sector are the most important and in Latvia, emissions from the domestic and the shipping sectors are equal.

Four Member States (Estonia, Poland, Spain and the UK) are responsible for more than half (63%) of the total EU27 emissions of arsenic.

4.2.7 Cadmium

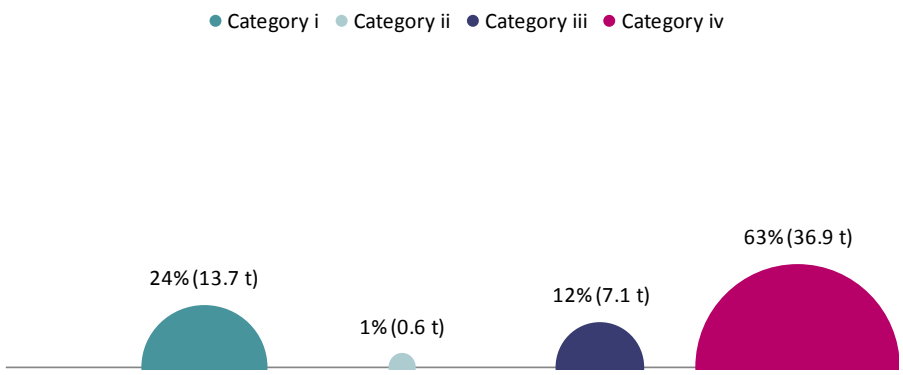
Description

Cadmium is a soft silvery metal which occurs in nature in mineral form with other elements such as oxygen, chlorine and sulphur. Cadmium is used in a variety of ways including in batteries (nickel cadmium), corrosion resistant metal plating, pigments and plastics and low melting point metal alloys. It is mostly released during metal processing (e.g. zinc, aluminium, iron and steel) and during the recycling of batteries. It is also released during the combustion of fossil fuels in power stations. Cadmium is readily accumulated by many organisms - particularly by micro-organisms and molluscs and is easily concentrated in the food chain. It can have a wide range of toxic effects on plants and animals. Mostly the effects are on growth and reproduction and occur only following moderate or high exposures during long periods (E-PRTR, 2013).

Summary

A total of 58.3 tonnes of cadmium was emitted to air in the EU27 in 2010. Under category iv, 36.9 tonnes of cadmium activities were emitted with the domestic sector being the main source of emissions (27.6 tonnes). Under category i, 13.7 tonnes of cadmium were emitted by IED regulated activities. The main activities responsible are the production of pig iron and steel (4.8 tonnes), combustion installations above 50 MWth (2.1 tonnes) and the production of chemicals (1.5 tonnes). A total of 12% of cadmium emissions is currently ‘unregulated’ (category iii), this represents 7.1 tonnes. The production of pig iron or steel below 2.5 tonnes per hour is the main source of these ‘unregulated’ emissions, responsible for 6.5 tonnes of cadmium. Under category ii, a total of 670kg of cadmium was emitted with the main source of emissions being the processing of non-ferrous metals below IED thresholds (almost 400 kg).

Figure 4.33 Air emissions of cadmium by category (in %) (total EU27 emissions = 58.3 tonnes)

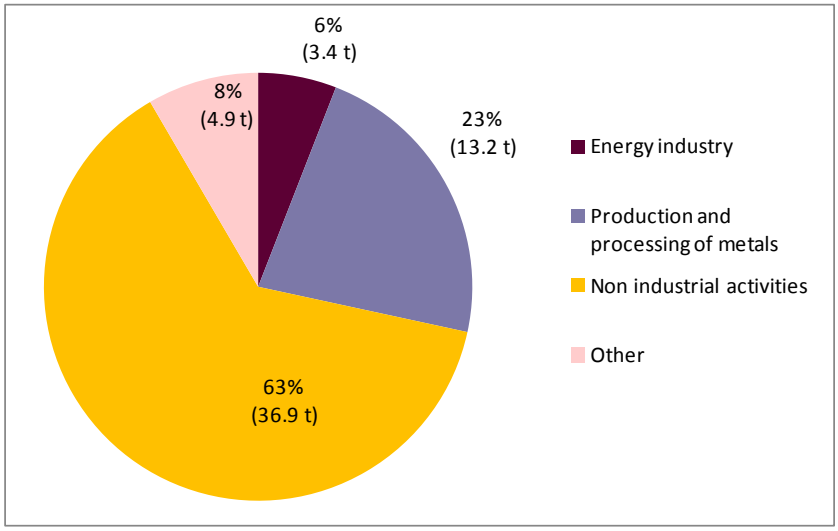


Detailed analysis by group of activities

Overview

Figure 4.34 presents the sources of emissions of cadmium by main group of activities. It shows that over 60% of cadmium emissions are from non-industrial activities (36.9 tonnes). The second most important source of cadmium is the production and processing of metals, which generated 13.1 tonnes of cadmium. Emissions from the energy industry sector were 3.4 tonnes whilst 4.9 tonnes were emitted by a group of activities that include the mineral, waste, chemical and other industrial sectors and agriculture.

Figure 4.34 Split of emissions of cadmium to air by major group of activities (total = 58.3 tonnes)



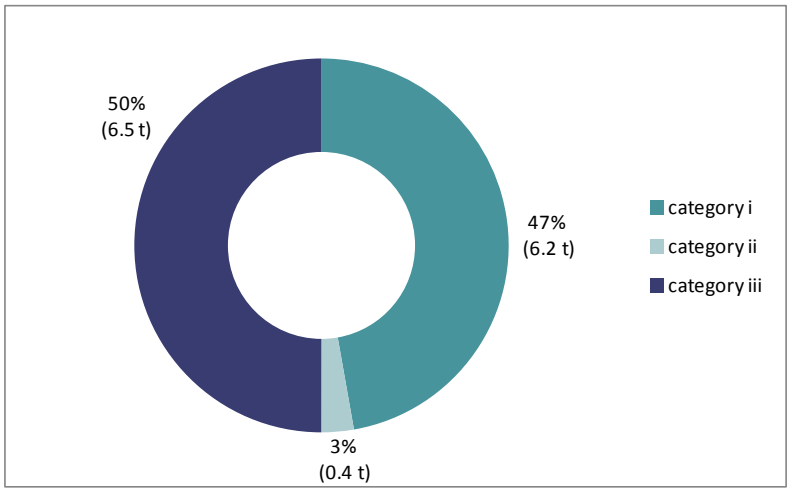
Note: emissions from smaller group of activities (mineral industry, waste management, chemical industry, other industrial activities and agriculture) have been clustered in the 'other' category due to their limited emissions.

Non-industrial activities

Almost 37 tonnes of cadmium are emitted by non-industrial activities in category iv. The majority of these emissions (27.6 tonnes) are from the domestic sector followed by the commercial services sector (5.6 tonnes) and road transport (nearly 3 tonnes).

Production and processing of metals

Figure 4.35 Split of emissions of cadmium to air– production and processing of metals (total = 13.1 tonnes)



The production and processing of metals is the second most important source of emissions of cadmium after non-industrial activities with 13.1 tonnes of cadmium emitted in 2010. Just over half of the emissions (6.6 t) are either directly (category i) or indirectly (category ii) regulated. The main activities responsible for these emissions are the production of pig iron or steel (4.8 tonnes) and the processing of non ferrous metals below IED thresholds (0.4 tonnes). The other half of the emissions (6.5 tonnes) are due to 'unregulated' activities (category iii), and more specifically from the production of pig iron or steel below 2.5 tonnes per hour.

Energy industry

All cadmium emissions in the energy industries (3.4 tonnes) are emitted by category i activities, mainly from combustion plant above 50MWth (2.1 tonnes) and the refining of mineral oil and gas (1.3 tonnes).

Activities not described above

- **Other industrial activities**: A total of 1.5 tonnes of cadmium are emitted from other industrial activities. Category i activities are responsible for 1 tonne of emissions, mainly from the production of pulp, paper and cardboard. The rest of the emissions (0.5 tonnes) are emitted by category iii activities, in particular the production of paper and cardboard below 20 tonnes per day;

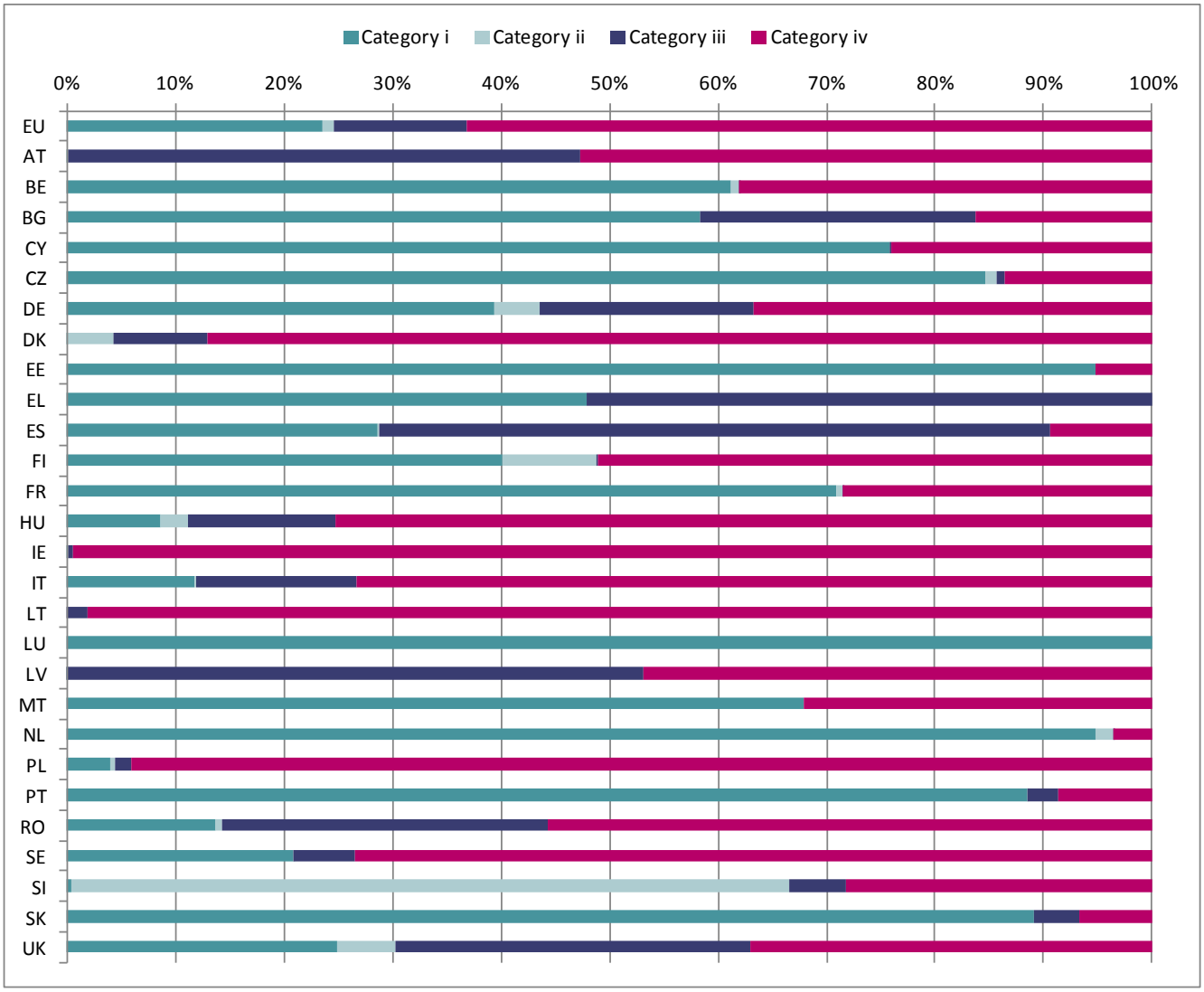
- **Chemical industry:** The chemical industry is responsible for 1.5 tonnes of cadmium emissions, all emitted by category i activities and mostly from the production of inorganic chemicals (1.3 tonnes);

- **Waste management**: Almost all the emissions from waste management (1.2 tonnes) are from waste incineration (category i);
- **Mineral industry**: In this group of activities, all of the emissions (0.7 tonnes) are either directly or indirectly regulated. Emissions arise from the production of cement, lime and magnesium (0.5 tonnes) and the manufacture of glass (0.2 tonnes); and
- **Agriculture:** A relatively small quantity of cadmium is emitted from the field burning of agricultural wastes (50 kg).

Additional comments at Member State level

While the general EU27 distribution described above can be observed in most Member States, Figure 4.36 presents some notable variances.

Figure 4.36 Split of emissions of cadmium to air by category at Member State and EU27 as a whole (%)



At an EU27 level, category i activities contributed 24% of the total cadmium emissions. However for some Member States, this category represented more than three-quarters of the total emissions. This is the case for Luxembourg (100%), Estonia (95%), the Netherlands (95%), Czech Republic (85%), Slovakia (89 %), Portugal (88%) and Cyprus (76%). This means that for these Member States, the majority of cadmium emissions are already regulated.

In Slovenia, the emissions contained in category ii were found to be significantly higher than the EU average (1%) and were emitted from activities involving the melting of non-ferrous metals below IED thresholds.

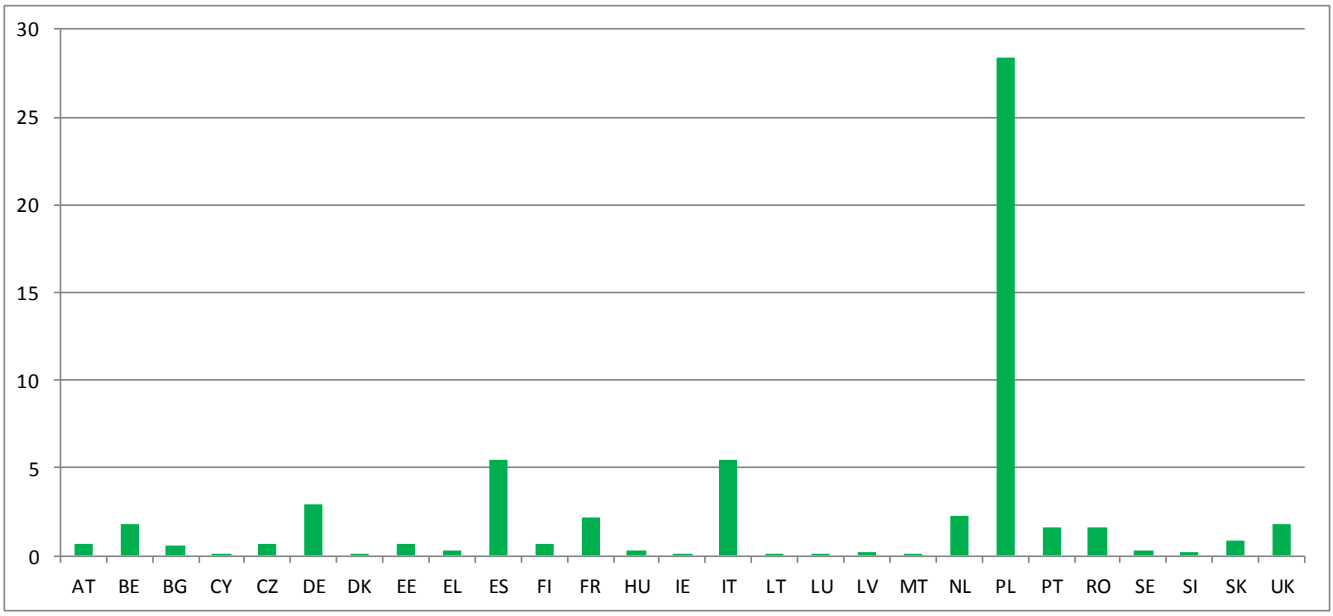
For some Member States the levels of 'unregulated' emissions (category iii) of cadmium are higher than the EU average (12%). This is the case for Spain (62%), Latvia (53%) and Greece (52%). The following activities are responsible: pig iron or steel below 2.5 tonnes per hour (Spain, Latvia) and the production of paper and cardboard under the IED threshold (Greece).

For the following Member States, emissions reported under category iv activities are higher than the EU average (63%): Ireland (99%), Lithuania (98%), Poland (94%) and Denmark (87%). The majority of these emissions are from the domestic sector (Ireland and Poland) and road transport (Denmark and Lithuania).

Whilst at an EU27 level category iv contains the largest share of cadmium emissions, for some Member States it is proportionally much lower. This is the case for Estonia (5%), the Netherlands (4%), Greece (0%), and Luxembourg (0%).

It is noteworthy that Poland appears to be responsible for nearly half of the total emissions of cadmium at an EU27 level. Figure 4.37 presents the total emissions of cadmium per Member State. As stated above, most of the emissions of cadmium from Poland are due to activities in category iv and more specifically are reported in LRTAP under the code 1A4B1, which refers to residential stationary plants.

Figure 4.37 Detail of emissions of cadmium to air per Member State (in tonnes)



4.2.8 Chromium

Description

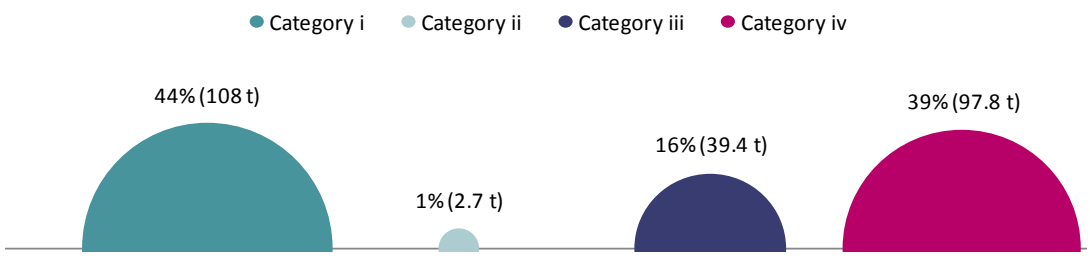
Chromium is a hard, steel-grey coloured metal which has a high melting point and can take a high polish. Compounds of chromium are usually highly coloured. This metal has a high corrosion resistance and hardness and is an important component of stainless steel and high performance alloys. It is also used in furnace bricks, dyes and pigments, chrome plating, chemical catalysts, leather tanning and wood preservatives. Most anthropogenic sources of chromium emissions to the environment are from chemical manufacturing, the combustion of fossil fuels, waste incineration and steel making; a smaller source is glass production. Pure chromium metal and alloys are not hazardous to health. Exposure to low levels of chromium compounds in the environment is not likely to affect

health. No significant effects on the global environment are expected due to chromium releases. In the environment, chromium compounds may be toxic to some species of wildlife. Some aquatic species (but not fish) accumulate chromium and therefore the metal concentrates up the food chain. The level of toxicity of chromium is very dependent of its oxidation state; chromium (VI) compounds are more readily absorbed and more highly toxic than chromium (III) compounds (E-PRTR, 2013).

Summary

Nearly 248 tonnes of chromium were emitted to air across the EU27 in 2010. Figure 4.38 shows that most of these emissions are from activities included in category i (108 tonnes) with the production of pig iron and steel and combustion plants above 50 MWth together generating nearly 30% of the total emissions of chromium. Category iv is the next most significant category, representing 39% of chromium emissions (around 98 tonnes), with the majority arising from road transport. Category iii emissions represent 39.4 tonnes of chromium, the majority arising from the production of pig iron or steel below 2.5 tonnes per hour (37.5 tonnes). Category ii is the smallest category (2.7 tonnes) of which 1.6 tonnes are from the production of cement below the IED threshold.

Figure 4.38 Air emissions of chromium per category (in %) (total EU27 emissions = 247.9 tonnes)

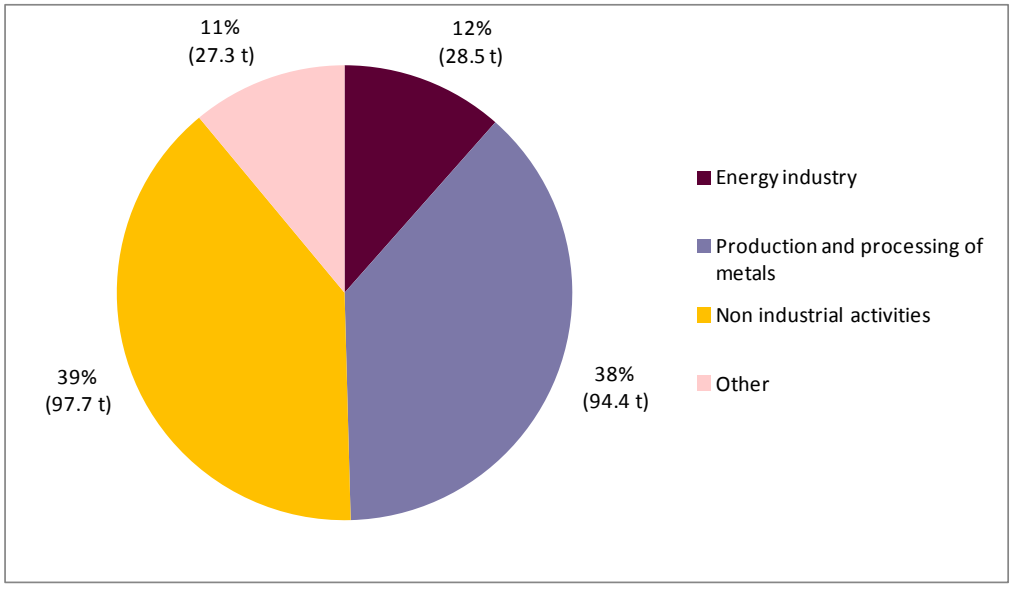


Detailed analysis by group of activities

Overview

Figure 4.39 presents the sources of emissions of chromium by main group of activity. The top two emitters are non-industrial activities (98 tonnes) and the production and processing of metals (94 tonnes). Emissions from the energy industries total around 29 tonnes of chromium and the remainder (27 tonnes) is split between waste management (12 tonnes), mineral industries (7.7 tonnes), other industrial activities (5.3 tonnes), the chemical industry (2.1 tonnes) and agriculture (0.2 tonnes).

Figure 4.39 Split of emissions of chromium to air by major group of activities (total EU27 emissions = 247.9 tonnes)



Note: emissions from smaller group of activities (waste management, mineral industry, chemical industry, other industrial activities and agriculture) have been clustered in the 'other' category due to their limited emissions.

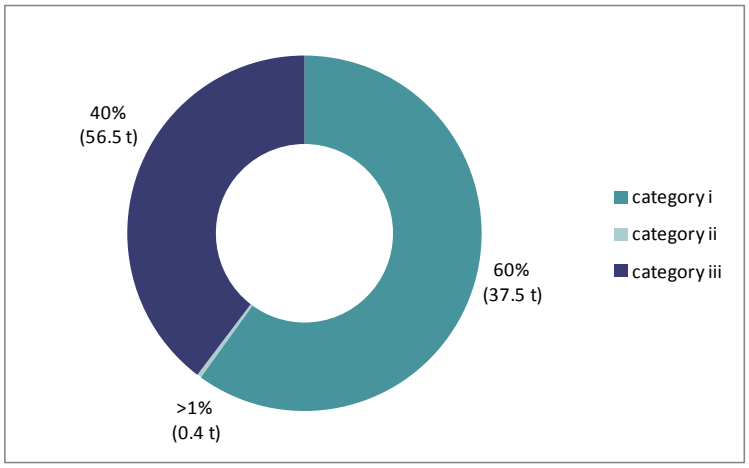
Non-industrial activities

This group of activities has generated a total of 97.7 tonnes of chromium in 2010 (all within category iv). Emissions from road transport are the most important with nearly 50 tonnes of chromium emitted, followed by the domestic (38.1 tonnes) and commercial services (9.6 tonnes) sectors.

Production and processing of metals

Overall, the production and processing of metals is responsible for 94.4 tonnes of chromium. Figure 4.40 shows that 60% of these are emitted by IED regulated activities (category i) with the dominant emitter being the production of pig iron or steel (46 tonnes) followed by emissions from processing activities involving ferrous metals (4.4 tonnes) and the surface treatment of metals and plastics (3.7 tonnes). Category iii emissions (37.5 tonnes) are emitted from the production of pig iron or steel below 2.5 tonnes per hour. Some very small emissions from category ii (0.4 tonnes) are also present.

Figure 4.40 Split of emissions of chromium to air– production and processing of metals (total = 94.4 tonnes)



Energy industry

All of the emissions (28.5 tonnes) reported under this group of activities are from category i activities namely combustion installations above 50 MWth (23.7 tonnes) and the refining of mineral gas and oil (4.8 tonnes).

Activities not described above

- **Waste management:** A total of 12 tonnes of chromium was emitted by waste management activities, the majority of which is from category i activities (11.9 tonnes). Emissions from waste incineration (11.3 tonnes) and the disposal of hazardous waste (0.5 tonnes) are the main sources of emissions in category i;

- **Mineral industry**: The mineral industry emitted around 7.7 tonnes of chromium in total, most of which is from category i activities (5.5 tonnes) such as the production of glass (3.4 tonnes). The production of cement below 500 tonnes a day is responsible for the second largest quantity of emissions (1.6 tonnes);

- **Other industrial activities:** In total 5.3 tonnes of chromium was emitted by the group of other industrial activities. The majority of these emissions (3.4 tonnes) are from processes regulated by the IED (category i); for example almost 3 tonnes of chromium were emitted by the production of pulp and paper. A further 1.6 tonnes are emitted from the production of pulp and paper below 20 tonnes per day (category iii). Finally, 0.3 tonnes of chromium were emitted by category ii activities;

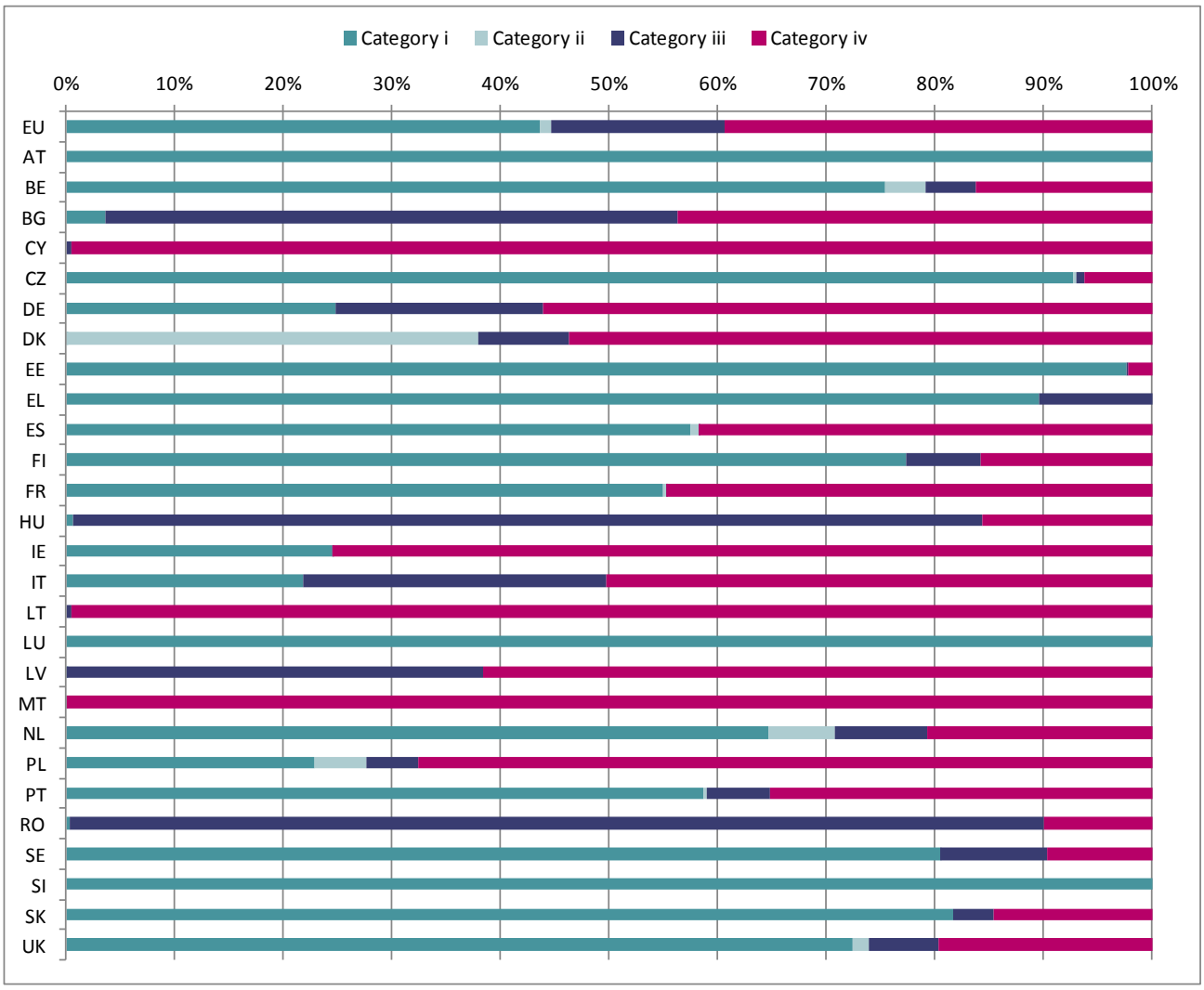
- **Chemical industry:** The chemical industry emitted 2.1 tonnes of chromium in 2010, all from activities regulated by the IED (category i). The main source of emissions is the production of organic chemicals (1.6 tonnes); and

- **Agriculture:** 0.2 tonnes of chromium are estimated to have been emitted by the field burning of agricultural waste (category iii activity).

Additional comments at Member State level

While the general EU27 distribution described above can be observed in most Member States, Figure 4.41 presents some notable variances.

Figure 4.41 Split of emissions of chromium to air by category at Member State and EU27 as a whole (%)



Some Member States have reported more emissions under category i activities than the EU average (44%). This is the case for Austria (100%), Czech Republic (93%), Estonia (98%), Greece (90%), Luxembourg (100%) and Slovenia (100%). This means that for these Member States, the overwhelming majority (and in some case the totality) of the emissions of chromium to air are regulated under the IED.

For one Member State, the size of emissions included in category ii is significantly more important than the EU average (1%). This is the case for Denmark (38%) whose emissions arise from activities involving organic solvents conducted below the IED threshold.

At an EU27 level, category iii emissions are generally small (16% of the total emissions), but for some Member States their share is more important. This is the case for Hungary (84%) and Romania (90%). For both of these Member States, these emissions primarily arise from the production of pig iron or steel below 2.5 tonnes per hour.

For some Member States, the share of emissions located in category iv is higher than the EU average (39%). This is the case for Cyprus (99%), Lithuania (100%), and Malta (100%). For all of these Member States, emissions mainly arise from road transport followed by domestic emissions.

Emissions of chromium are spread between Member States; however, the three highest emitters are responsible for 43% of the total emissions at EU27 level. This is the case of Germany, Italy and Poland.

4.2.9 Copper

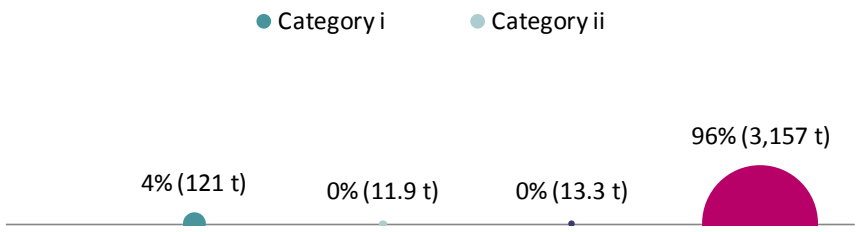
Description

Copper is a reddish brown metal that is conductor of electricity and heat. As a result, copper is widely used to make electrical wires, electrical and electronic applications, water pipes and heat exchangers. Copper compounds are used in wood preservatives, boat anti-fouling paints and agricultural chemicals. Most (agro-)industrial releases of copper are through the burning of fossil fuels in power plants, metal production, waste incinerators, sewage treatment and through the application of agricultural chemicals (e.g. copper sulphate). Exposure to small amounts of copper in drinking water and food is common in nature and thus background concentration levels are unlikely to have adverse effects on health. However, high levels of copper emissions that lead to increased concentrations in soil and surface and ground waters may have environmental and health consequences. Copper can accumulate in certain organisms and at high concentrations has toxic effects on some species of aquatic life and soil micro-organisms, potentially disrupting nutrient cycling processes (E-PRTR, 2013).

Summary

In 2010, 3.3 kt of copper was emitted to the atmosphere across the EU27. Figure 4.42 shows that most of these emissions were emitted by activities included in category iv (3.1 kt) and in particular from road transport (90% of total copper emissions representing 2.9 kt). Industrial activities regulated by the IED (category i) are a source of 4% (121 tonnes) of copper emissions, with emissions from the production of pig iron and steel (31 tonnes), production of non ferrous metals (31 tonnes) and combustion plants above 50 MWth (15 tonnes) being the largest sources in this category. Only a small amount (13.3 tonnes) was reported from activities that are currently ‘unregulated’ and within category iii. This is primarily due to emissions from the production of pig iron or steel with a capacity below 2.5 tonnes per hour (12.4 tonnes).

Figure 4.42 Air emissions of copper by category (in %) (total EU27 emissions = 3,303 tonnes)

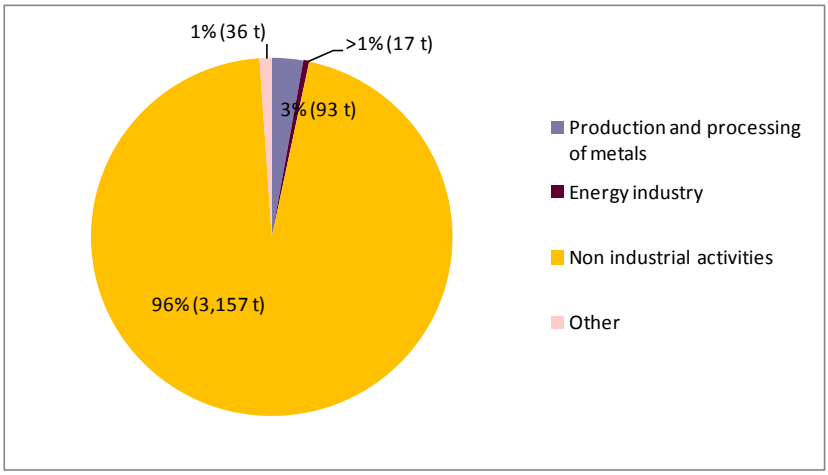


Detailed analysis by group of activities

Overview

Figure 4.43 presents the sources of emissions of copper by the main groups of activities they arise from. The vast majority of emissions arise from non-industrial activities, and more specifically from road transport. Two other important groups of activities in terms of emissions include the production and processing of metals and the energy industries.

Figure 4.43 Split of emissions of copper to air by major group of activities (total EU27 emissions= 3,303 tonnes)



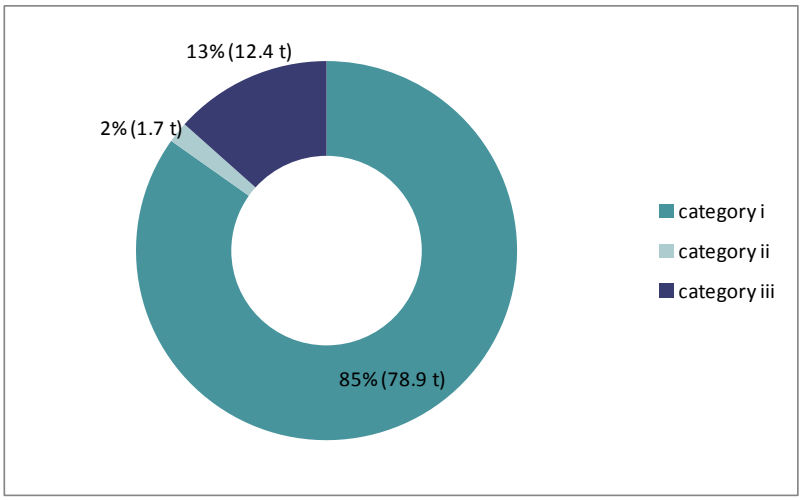
Note: emissions from smaller group of activities (mineral industry, chemical industry, other industrial activities, waste management and agriculture) have been clustered to form the 'other' category due to their limited emissions.

Non-industrial activities

This group generates the large majority of emissions from copper at an EU27 level (3,157 tonnes, category iv) with the most significant activities being road transport (2,967 kt), domestic (100 tonnes) and railways (65 tonnes).

Production and processing of metals

Figure 4.44 Split of emissions of copper to air by group of activities – production and processing of metals (total = 93 tonnes)



A total of 93 tonnes of copper is emitted by activities related to the production and processing of metals. Figure 4.44 shows that the vast majority of emissions (78.9 tonnes) in this group are from activities regulated by the IED. The main activities are the production of pig iron or steel (31 tonnes), processing of non-ferrous metals (31 tonnes) and metals ore roasting (10.6 tonnes). The installations melting non ferrous metals below IED threshold are responsible for most of the copper emissions under category ii (1.6 tonnes). Finally, all of the emissions under category iii (12.4 tonnes) are due to the production of pig iron or steel below 2.5 tonnes per hour.

Energy industry

The energy industry is estimated around 17 tonnes of copper. All of these emissions are reported by activities regulated under the IED (category i) and most (15 tonnes) originate from combustion installations above 50 MWth.

Activities not described above

- **Other industrial activities**: A total of 14.5 tonnes of copper was emitted by other industrial activities, the majority of which (8 tonnes) came from category ii activities. Underground mining activities have contributed to 6.5 tonnes of emissions under this category. The second most important source of emissions are category i activities (4.7) and more specifically the production of paper and cardboard. Less than 1 tonne of copper is 'unregulated' and is emitted during the production of paper and cardboard with a production capacity below 20 tonnes a day;

- **Waste management:** Waste management activities are responsible for 10.2 tonnes of copper emitted in 2010. All of these emissions are from category i activities, more specifically from waste incineration (8.8 tonnes), landfills (0.7 tonnes) and disposal of hazardous waste (0.6 tonnes).

- **Chemical industry:** The chemical industry is a relatively small emitter of copper, with 5.7 tonnes emitted in 2010. All of the emissions are due to category i activities, more specifically from the production of inorganic (3 tonnes) and organic (2 tonnes) chemicals;

- **Mineral industry:** The mineral industry is responsible for 5.6 tonnes of copper emissions with the majority (4.1 tonnes) from activities belonging to category i, in particular from the manufacture of glass (3.4 tonnes) and from the manufacture of cement and lime (0.7 tonnes). The remaining emissions are due to category ii activities, in particular the production of cement and lime below the IED thresholds (1.5 tonnes); and

- **Agriculture**: No emissions are reported from the agriculture sector.

Additional comments at Member State level

While the general EU27 distribution described above can be observed in most Member States, Figure 4.45 presents some notable variances. Austria has not reported any data on emissions of copper in the E-PRTR and in LRTAP.

Figure 4.45 Split of emissions of copper to air by category at Member State and EU27 as a whole (%)

Some Member States show a much larger share of emissions from category i than the EU average (4%). This is the case for Luxembourg (100%), Slovenia (100%), Greece (89%), Estonia (52%), Slovakia (51%) and Czech Republic (45%). For these Member States a larger than average share of emissions of copper is already regulated.

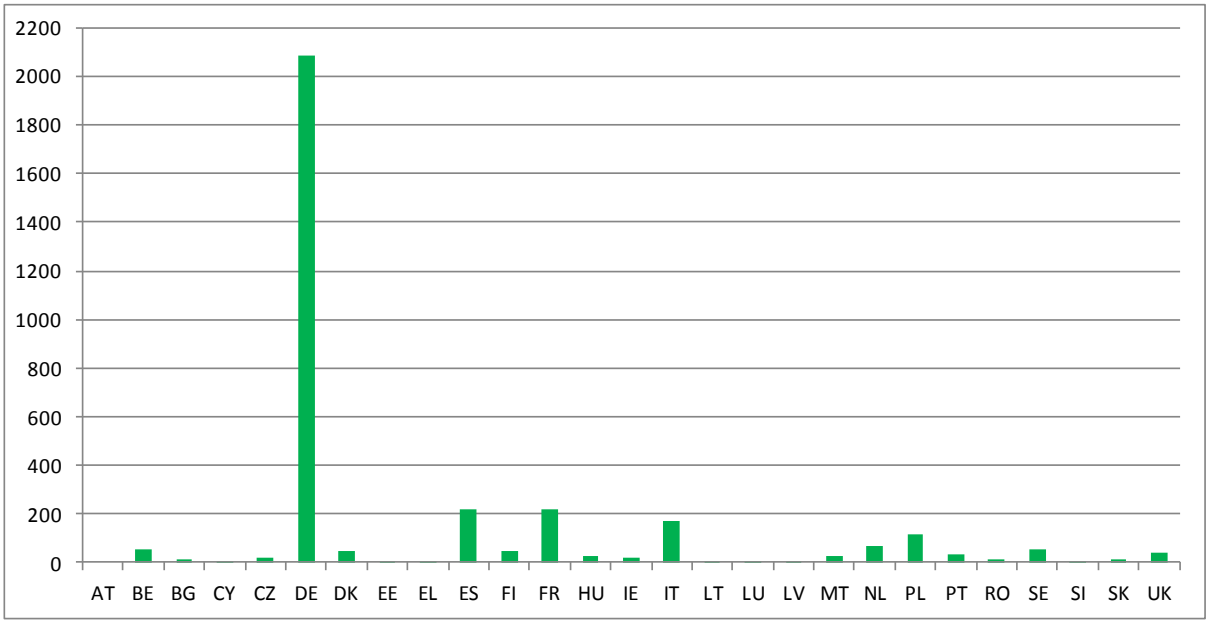
Two Member States have larger than EU average category ii emissions (>1%). This is the case for Denmark (5%) and Poland (5%). Emissions in Denmark are due to activities using organic solvents conducted below the IED thresholds and in Poland, emissions are due to underground mining activities.

Three Member States have reported larger than average (>1%) category iii emissions: Slovakia (18%), Greece (11%) and the UK (10%). Emissions are from the production of paper and/or cardboard below 20 tonnes per day and for Slovakia and the UK the production of pig iron or steel below 2.5 tonnes per hour.

Finally, whilst category iv contributed the majority of emissions at an EU level (96%); some Member States have reported relatively small emissions shares (Bulgaria (65%), the UK (62%) and Slovakia (30%)).

One point to note on emissions of copper to air is that the majority of overall emissions at an EU27 level appear to be emitted by Germany. Figure 4.46 presents the total emissions in tonnes per Member State. Germany reports 2,080 tonnes of copper which represents 63% of the total emissions of copper at EU27. In addition, Germany reports 99% of its emissions of copper to air in category iv and the road transport sector. Further investigations have shown that emissions from Germany are reported under LRTAP under 1A3Bvi code which corresponds to automobile tyre and brake wear.

Figure 4.46 Detail of emissions of copper to air by Member State (in tonnes)



4.2.10 Lead

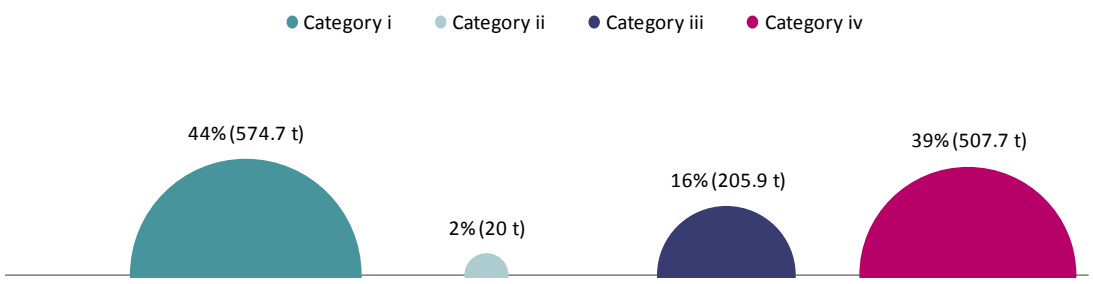
Description

Lead is used in lead-acid batteries, as a roofing material, in solders in electrical systems and as radiation shielding. Man-made releases of lead arise mostly from metal production and processing, from the burning of fossil fuels in power stations and from the chemical industry. A significant amount of lead used to be released from the use of lead in petrol, lead paints and plumbing, though this has decreased rapidly as these uses have been phased out. Lead is a cumulative poison which affects the central nervous system. Low levels of exposure to lead can also cause harm to the unborn child and to the development of the brain in children, damage the male reproductive system and is potentially carcinogenic. Lead is found in the environment in soils and sediments. Its solubility increases in soft, acidic water. It is toxic to plants and animals when they are exposed to high levels (E-PRTR, 2013).

Summary

In 2010, a total of 1,308 tonnes of lead was emitted to the atmosphere across the EU27. Figure 4.47 shows that nearly half of these emissions (574.7 tonnes) were emitted by activities included in category i. Industrial processes, such as the production of pig iron or steel, the production of inorganic chemicals and waste incineration are responsible for a large share of lead emissions. Category iv is the second largest group of emissions, most of which originate from the road transport and domestic sectors (almost 400 tonnes of lead in total). Emissions from 'unregulated' activities represent 205.9 tonnes of lead. Most of these emissions are due to the production of pig iron or steel below 2.5 tonnes per hour (196 tonnes). Finally, emissions from category ii activities are small (20 tonnes) and arise mostly from the processing of non-ferrous metals below IED thresholds (12 tonnes).

Figure 4.47 Air emissions of lead by category (in %) (total EU27 emissions= 1,308 tonnes)

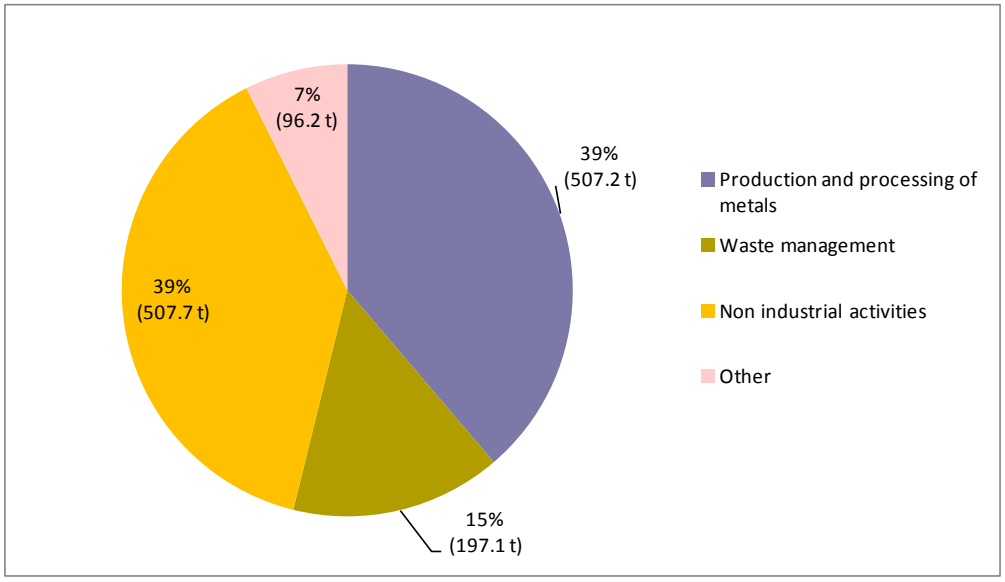


Detailed analysis by group of activities

Overview

Figure 4.48 presents the main group of activities responsible for emissions of lead at an EU27 level. The production and processing of metals (507.2 tonnes) and non-industrial activities (507.7 tonnes) are the main source of emissions contributing 80% of the total emissions. Waste management activities emit around 197 tonnes and other industrial activities total around 96 tonnes of lead emissions.

Figure 4.48 Split of emissions of lead to air by major group of activities (total EU27 emissions = 1,308 tonnes)



Note: emissions from smaller group of activities (energy industry, mineral industry, chemical industry, other industrial activities and agriculture) have been added to form the 'other' category due to their limited emissions.

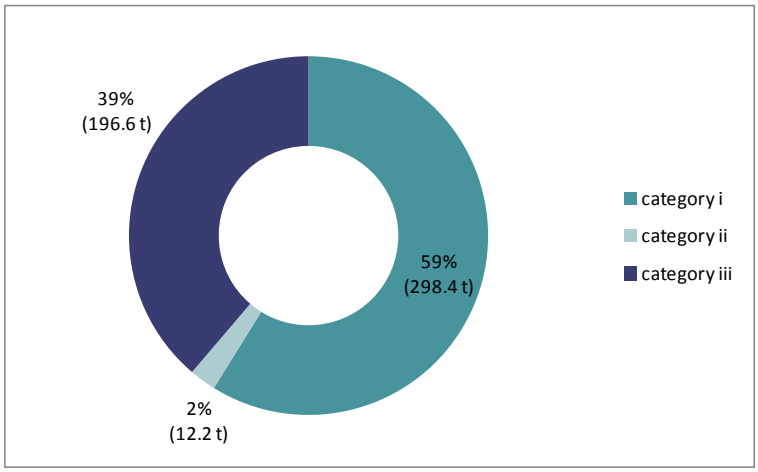
Non-industrial activities

This group of activities is the second most important source of emissions (507.7 tonnes) of lead. Two sectors are equally responsible for generating most of these emissions: road transport (200 tonnes) and the domestic sector (200 tonnes). The commercial services sector and the aviation sector are also important sources, emitting 90 and 16 tonnes of lead, respectively.

Production and processing of metals

A total of 507.2 tonnes of lead is emitted by activities related to the production and processing of metals. Figure 4.49 shows that the majority of these emissions are currently regulated by the IED (category i representing 298 tonnes) from activities such as the production of pig iron and steel (216 tonnes), metal ore roasting (37 tonnes) and the processing of non-ferrous metals (around 30 tonnes). More than a third of emissions of lead are 'unregulated' (category iii), all of which are exclusively originating from the production of pig iron or steel below 2.5 tonnes per hour (196.6 tonnes).

Figure 4.49 Split of emissions of lead to air – production and processing of metals (total = 507.2 tonnes)



Waste management

Emissions of lead from waste management are important (197.1 tonnes). Almost all are reported by category i activities with the main emitter being waste incineration (195 tonnes). The remaining emissions from category ii (0.5 tonnes) are from waste management activities carried out below the IED thresholds.

Activities not described above

- **Energy industry**: All of the emissions by the energy industries (57.2 tonnes) were emitted by category i activities, mostly from combustion installations above 50MWth (53.8 tonnes) and a much smaller amount from the refining of mineral oil and gas (3 tonnes);

- **Mineral industry**: A total of 20.5 tonnes of lead was emitted by the mineral industry. Most of these emissions (13.8 tonnes) are already regulated by the IED with the main emitter in this category the manufacture of glass (12.6 tonnes). The rest of the emissions (6.7 tonnes) are from category ii activities and in particular the manufacture of cement and lime (6 tonnes overall) below the IED thresholds;

- **Other industrial activities**: Other industrial activities contribute 14.1 tonnes of lead emissions. The majority of these emissions (8.3 tonnes) come from category iii activities, and primarily the production of paper or cardboard below IED thresholds (8.2 tonnes). Emissions from category i (5.1 tonnes) are mainly due to the production of paper or cardboard (5 tonnes);

- **Chemical industry**: The chemical industry emitted a total of 3.4 tonnes of lead in 2010, all of which were emitted by IED regulated activities (category i). The overwhelming majority of emissions are due to the production of inorganic chemicals (3.2 tonnes of lead); and

- **Agriculture**: Almost one tonne of lead was emitted from the field burning of agricultural waste. This is an activity which is classified in category iii and as such is considered ‘unregulated’.

Additional comments at Member State level

While the general EU27 distribution described above can be observed in most Member States Figure 4.50 presents some notable variances. Furthermore, no emissions were reported from Luxembourg.

Figure 4.50 Split of emissions of lead to air by category at Member State and EU27 as a whole (%)

Slovenia stands out in that its share of emissions in category ii (more than 50%) is larger than the EU27 average (2%). These emissions are primarily from the processing of non-ferrous metals activities operating below the IED thresholds.

For some Member States, category iii represents a significant proportion of the total emissions and more than the EU average of 16%. This is the case for Austria (71%), Romania (61%), Hungary (59%), Latvia (52%), Bulgaria (47%) and Spain (47%). For these Member States these emissions are due to the production of pig iron or steel below 2.5 tonnes per hour.

For the following Member States, category iv represents the largest share of emissions: Cyprus (100%), Ireland (100%), Lithuania (100%), Malta (100%) and Denmark (95%). For all these Member States road transport is the main source of lead emissions.

It is interesting to note that Germany, Poland and Portugal are the biggest emitters of lead in Europe. Together, they emit 34% of the total EU27 lead emissions.

4.2.11 Mercury (Hg)

Description

Mercury is a silver coloured metal which is liquid at room temperature and is odourless and non-flammable. Mercury combines with other elements such as chlorine, sulphur and oxygen to form inorganic salts which are usually white powders or crystals. Mercury also combines with carbon to form organo-mercury compounds, which are much more hazardous and toxic than elemental mercury. Metallic mercury is used in thermometers, dental fillings and batteries and is used to manufacture chlorine gas and caustic soda. Mercury vapour is used in the manufacture of fluorescent lamps.

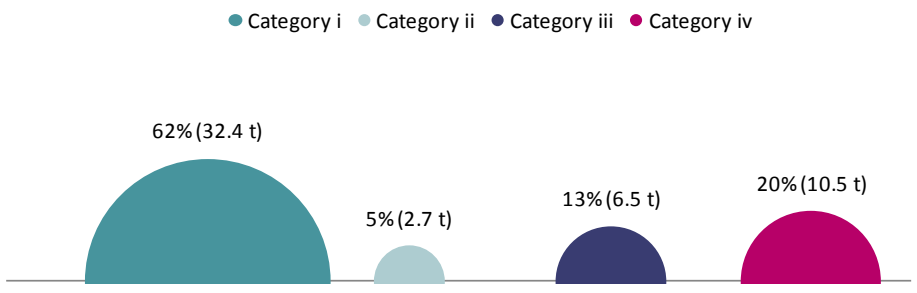
Mercury is released into the environment from a number of sources including waste incineration, manufacturing, from batteries manufacturing and disposal, metal production and coal combustion. It is also released from its use in dental surgeries, from crematoria and from hospitals. As a consequence of the persistent nature of mercury, its ability to undergo long-range transport and the bioaccumulation potential in the environment, mercury is regarded as a globally important pollutant. Exposure in humans usually occurs through consumption of contaminated fish or grain and ingestion may be carcinogenic even in small quantities; the human nervous system is very sensitive to mercury in all forms. Some forms, such as methyl mercury, are more toxic because more mercury can reach the brain, although generally mercury and mercury compounds are considered toxic to wildlife, plants and micro-organisms. Organo-mercury compounds are accumulated by some species in the aquatic environment and low levels of mercury can build up to high levels in insects, birds and fish (E-PRTR, 2013).

Summary

In 2010, a total of 52.1 tonnes of mercury was emitted to air. The figure below shows that most of these emissions (32.4 tonnes) were emitted by activities regulated by the IED (category i), mainly from the combustion of fuels in installations above 50 MWth (16.2 tonnes); the production of pig iron and steel (3.7 tonnes) and waste incineration (3.4 tonnes). The second most important source of emissions (10.5 tonnes) are category iv activities and in particular emissions from the domestic, commercial and shipping sectors (approximately 3 tonnes emitted by each). Category iii activities contribute 6.5 tonnes, most of which originates from the production of pig iron and steel below 2.5 tonnes per hour. A total of 2.7 tonnes of emissions are affected by other environmental legislation (category ii) with the production of cement below the IED threshold the highest emitter in this category (1.7 tonnes).

By comparison, UNEP[11]estimated, for 2010, that the EU27 emitted 87.5 tonnes of mercury to air (within a range of 44.5 to 226 tonnes). About half of the emissions were attributed to industrial and household coal combustion.

Figure 4.51 Air emissions of mercury by category (%) (total EU27 emissions = 52.1 tonnes)



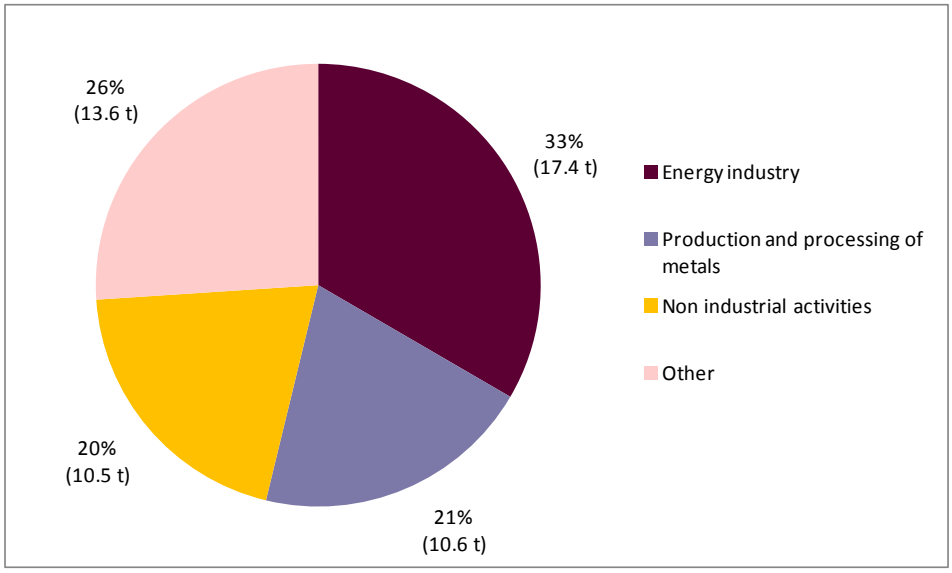
Detailed analysis by group of activities

Overview

Figure 4.58 presents the source of emissions of mercury by main group of activity. The main emitters are the energy industry (17.4 tonnes), the production and processing of metals (10.6 tonnes) and non-industrial activities (10.5 tonnes). The remaining emissions are split between the mineral industry (4.7 tonnes), waste management (4.5 tonnes), the chemical industry (3.2 tonnes), other industrial activities (1.1 tonnes) and agriculture (0.1 tonnes).

[11] UNEP, Global mercury assessment 2013. Background report (http://www.amap.no/documents/doc/technical-background-report-for-the-global-mercury-assessment-2013/848) and Summary (http://www.unep.org/PDF/PressReleases/GlobalMercuryAssessment2013.pdf)

Figure 4.52 Emissions of mercury to air by major group of activities (total EU27 emissions = 52.1 tonnes)



Note: emissions from smaller group of activities (chemical industry, mineral industry, waste management, other industrial activities and agriculture) have been added to form the 'other' category due to their limited emissions.

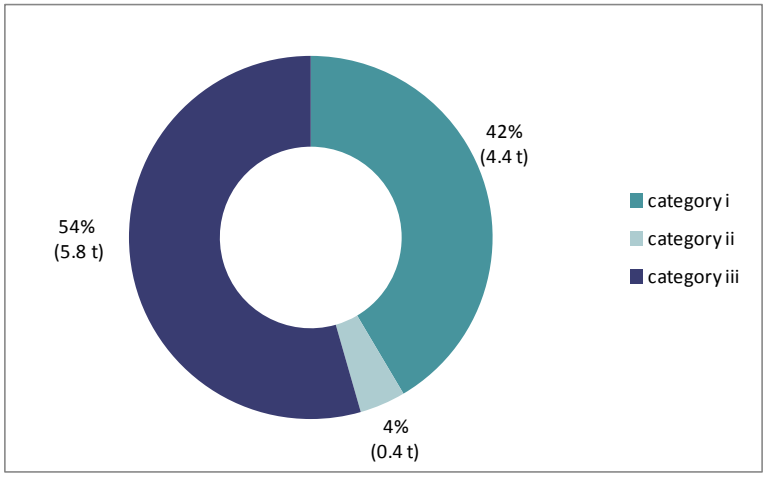
Energy industry

All emissions (17.4 tonnes) under this activity group are attributed to IED activities (category i) and are primarily from the combustion of fuels in installations above 50 MWth (16.2 tonnes) and the refining of mineral oil and gas (1.2 tonnes).

Production and processing of metals

Figure 4.59 shows that the highest share of emissions of mercury (5.8 tonnes) in this group of activities are emitted by 'unregulated' activities (category iii). These emissions appear to be exclusively due to the production of pig iron or steel with a capacity lower than 2.5 tonnes per hour. Emissions under category i (4.4 tonnes) are mainly due to the production of pig iron or steel above the IED threshold (3.7 tonnes). A small share of emissions (0.4 tonnes) is emitted from the processing of non-ferrous metals under the IED threshold.

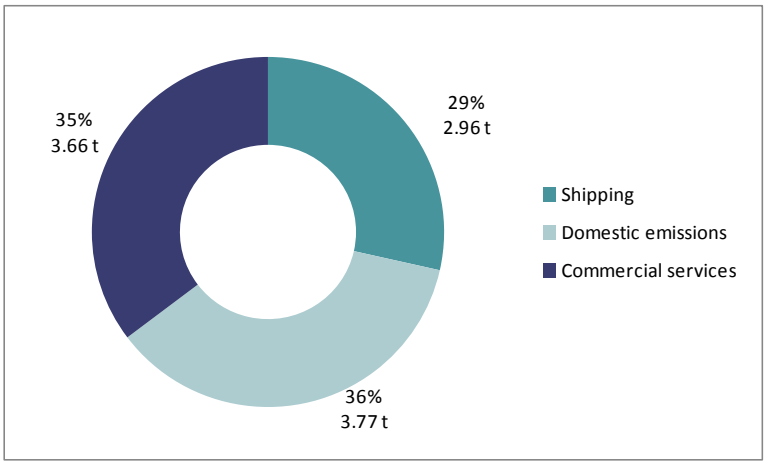
Figure 4.53 Emissions of mercury to air– production and processing of metals (total = 10.6 tonnes)



Non-industrial activities

Figure 4.60 presents the main sectors responsible for mercury emissions from non-industrial activities. The domestic and commercial sectors have similar emissions; closely followed by the shipping sector.

Figure 4.54 Emissions of mercury to air– non-industrial activities (total = 10.5 tonnes)



Note: 0.2 tonnes of mercury were emitted by other sources included in the non-industrial activity group.

Activities not described above

The remaining emissions are split between the mineral industry (4.7 tonnes), waste management (4.5 tonnes), the chemical industry (3.2 tonnes), other industrial activities (1.1 tonnes) and agriculture (0.1 tonnes).

- **Mineral industry**: A total of 4.7 tonnes of mercury was emitted by activities in this group. The majority of the emissions (2.9 tonnes) came from category i activities and more specifically from the production of lime and cement (2.8 tonnes). Other emissions (1.8 tonnes) are due almost exclusively to the production of cement below the IED threshold (category ii);

- **Waste management**: Out of the total 4.5 tonnes of mercury emitted by this group of activities, 4 tonnes is emitted by IED activities (category i), primarily from waste incineration (3.4 tonnes). The remaining emissions are from activities indirectly regulated by environmental legislation (category ii); more specifically by landfills under the IED threshold;

- **Chemical industry**: A total of 3.2 tonnes of mercury was emitted by activities in this group, all from activities in category i. The majority of emissions are due to the production of organic (1.9 tonnes) and inorganic (1.3 tonnes) chemicals;

- **Other industrial activities**: Overall 1.1 tonnes are reported under this group; of which 0.7 tonnes is from the production of paper or cardboard below 20 tonnes per day (category iii) and 0.4 tonnes from the production of pulp and paper above the IED thresholds (category i); and

- **Agriculture**: A total of 0.06 tonnes of mercury have been reported in this group of activity, most of which are from category i activities.

Additional comments at Member State level

While the general EU27 trend described above can be observed in most Member States, Figure 4.53 presents some notable variances.

Figure 4.55 Split of emissions of mercury to air by category at Member State and EU27 as a whole (%)

For three Member States, emissions under category ii are significantly higher than the EU27 average of 5%: Slovenia (75%), Poland (24%) and Ireland (14%). For Ireland, emissions are due to landfill activities, for Poland the production of cement under the IED threshold is responsible whilst for Slovenia it is the processing of non-ferrous metals under the IED threshold.

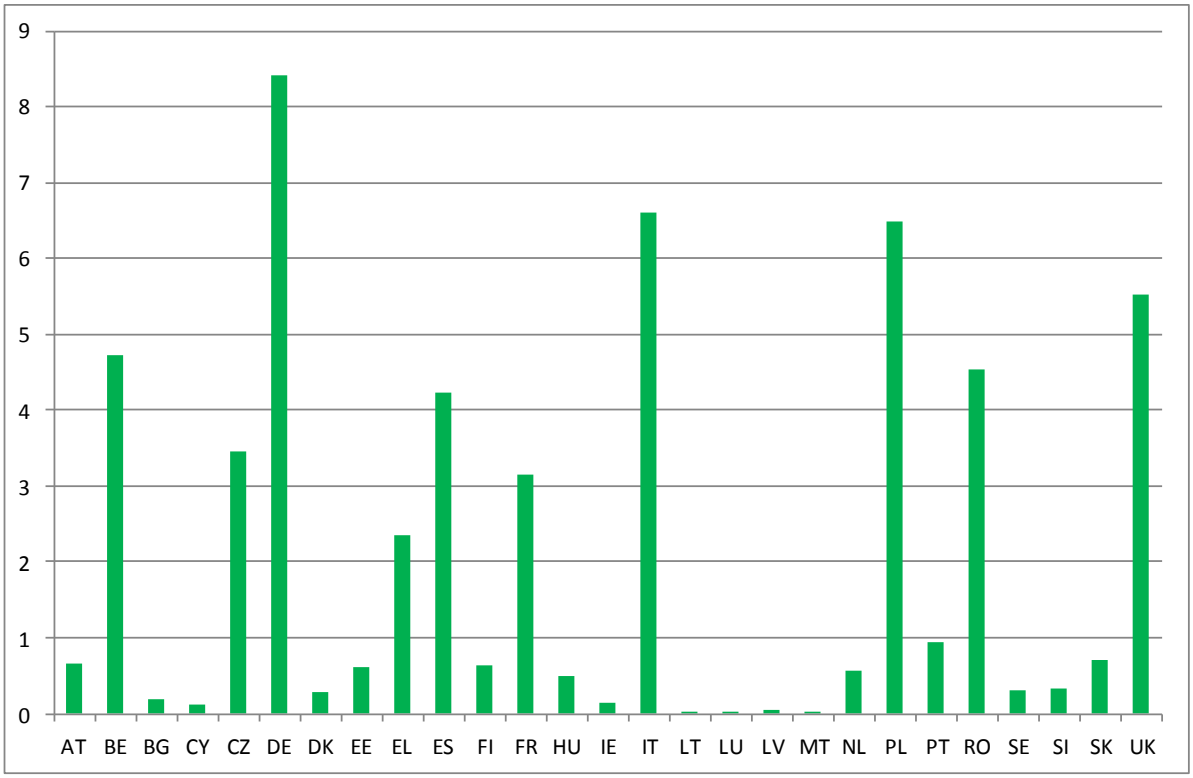
For a few Member States, the share of emissions under category iii is significantly higher than the EU27 average (13%): Bulgaria (58%) and Spain (43%). For all Member States the production of pig iron or steel below the IED threshold is the source of these emissions.

For the following Member States, the share of emissions presented under category iv is significantly higher than the EU27 average (20%) notably Lithuania (99%), Latvia (74%), Ireland (73%), and Malta (73%). For Ireland, Latvia and Lithuania most of the emissions are due to the domestic sector and the commercial sector for Lithuania. For Malta the shipping sector is the main source of mercury emissions in category iv.

Figure 4.54 presents the total quantity of mercury emissions by Member State. Germany, Italy, Poland and the UK are the highest emitters of mercury in EU27. Their combined emissions represent 52% of the total EU27 mercury

emissions. The highest emitting activity in Germany, Poland and the UK is the combustion of fuels in installations above 50 MWth, whilst for Italy it is emissions from the commercial sector.

Figure 4.56 Total emissions of mercury per Member State (in tonnes)



4.2.12 Nickel

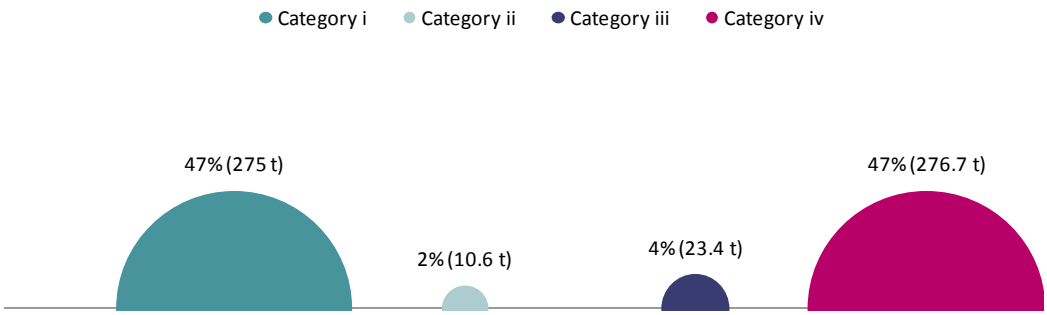
Description

Nickel is a white, silvery hard metal with magnetic properties. Nickel compounds are often green in colour. Nickel is used in the manufacture of steel and other alloys. It is used extensively in batteries, in chemical, petroleum and electrical industries as well as in ceramics and electroplating. Releases of nickel into the environment mostly come from the burning of fossil fuels, mining and refining processes and from waste incineration. Nickel occurs naturally in the environment in small amounts. Releases of nickel are unlikely to have an immediate effect on the local and global environment. Very small amounts have been shown to be essential for normal growth and reproduction in some species of animals and plants. The most common health effect of nickel is an allergic reaction following prolonged contact with the metal (e.g. with jewellery or coins) with some people (about 10-20%) becoming sensitive to it and developing skin rashes and, more rarely, asthma. Once a person has become sensitive further contact with the metal will produce a reaction. Chronic inhalation exposure to nickel fumes may cause cancer. Nickel can accumulate in soils and sediments and may ultimately affect water quality. It does not appear to accumulate in fish, plants or animals used for food (E-PRTR, 2013).

Summary

In 2010, nearly 586 tonnes of nickel were emitted to the atmosphere across the EU27. Figure 4.57 shows that these emissions were emitted equally by activities included in category i and by non-industrial activities. Combustion plants above 50 MWth (113 tonnes), the refining of mineral oil and gas (106 tonnes) and the manufacture of organic chemicals (11 tonnes) are the main sources of emissions. Category iv is the second largest category contributing 276.7 tonnes of nickel. Most of these arise from the domestic (117 tonnes) and commercial (94 tonnes) sectors. Emissions from category iii amount to 23 tonnes and are mainly due to the production of pig iron or steel below 2.5 tonnes per hour (14 tonnes) and the manufacture of paper or cardboard under the IED threshold (9 tonnes). Emissions from category ii are also limited (10 tonnes) and are mainly due to industrial processes such as processing of non-ferrous metals (8.6 tonnes).

Figure 4.57 Air emissions of nickel to air by category (in %) (total EU27 emissions = 585.7 tonnes)

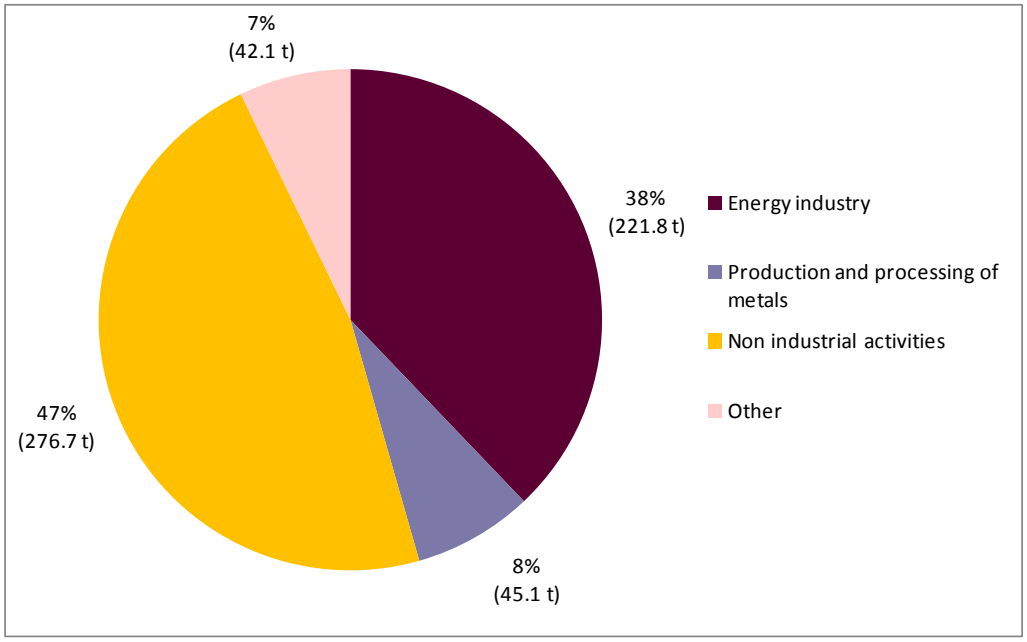


Detailed analysis by group of activities

Overview

Figure 4.58 presents the sources of emissions of nickel by major emitting groups of activities. Overall, the main sources of emissions are non-industrial activities which are responsible for 276.7 tonnes of emissions followed by the energy industries which contribute 221 tonnes. The third most important source of emissions is the production and processing of metals which emitted a total of 45 tonnes of nickel in 2010.

Figure 4.58 Emissions of nickel to air by major group of activities (total EU27 emissions = 585.7 tonnes)



Note: emissions from smaller group of activities (mineral industry, chemical industry, waste management, other industrial activities and agriculture) have been added to form the 'other' category due to their limited emissions.

Non-industrial activities

Non-industrial activities have generated 276.7 tonnes of nickel. The main sources of these emissions are the domestic (117 tonnes) and commercial services (94 tonnes) sectors. The shipping sector is responsible for 40 tonnes of emissions of nickel.

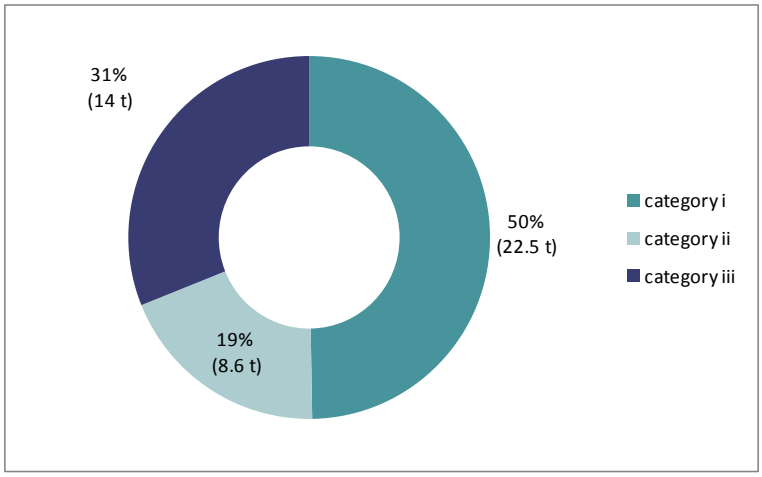
Energy industry

A total of 221.8 tonnes of emissions are emitted by energy related activities. All of the emitting activities are regulated by the IED (category i). The main sources of emissions are the combustion of fuel in combustion installations above 50 MWth (113 tonnes) and the refining of mineral oil and gas (106 tonnes).

Production and processing of metals

A total of 45.1 tonnes of nickel were emitted by activities included in this group. Figure 4.59 presents the split of the emissions of nickel per category.

Figure 4.59 Split of emissions of nickel to air per group of activities – production and processing of metals (total = 45.1 tonnes)



Half of the emissions of nickel (22.5 tonnes) are emitted by IED regulated activities (category i) with the main contributors being the production of pig iron or steel (14 tonnes) and the surface treatment of metals or plastics (nearly 4 tonnes). The processing of non-ferrous metals below the IED threshold (category ii) contribute 8.6 tonnes of nickel. Finally, 14 tonnes of nickel are emitted under category iii by the production of pig iron and steel below 2.5 tonnes per hour.

Activities not described above

- **Other industrial activities**: This group of activity is responsible for 20.9 tonnes of nickel with the majority (11.5 tonnes) emitted by category i activities. The main emitters are the production of pulp (3 tonnes) and paper (6 tonnes). Emissions under category iii amount to 9 tonnes of nickel due to the production of paper and cardboard below 20 tonnes per day;

- **Chemical industry**: A total of 13.2 tonnes of nickel were emitted by the chemical industry, all part of category i. The main emitting activities are the production of organic (11 tonnes) and inorganic (1.6 tonnes) chemicals;

- **Mineral industry:** A total of 5.8 tonnes of nickel were emitted by the mineral industry from category i (4 tonnes) and ii (1.8 tonnes) activities. The biggest emitters under category i are the manufacture of glass (1.3 tonnes) and the production of ceramics (1.7 tonnes). Most of the emissions under category ii are due to the production of cement below 500 tonnes per day (1.6 tonnes);

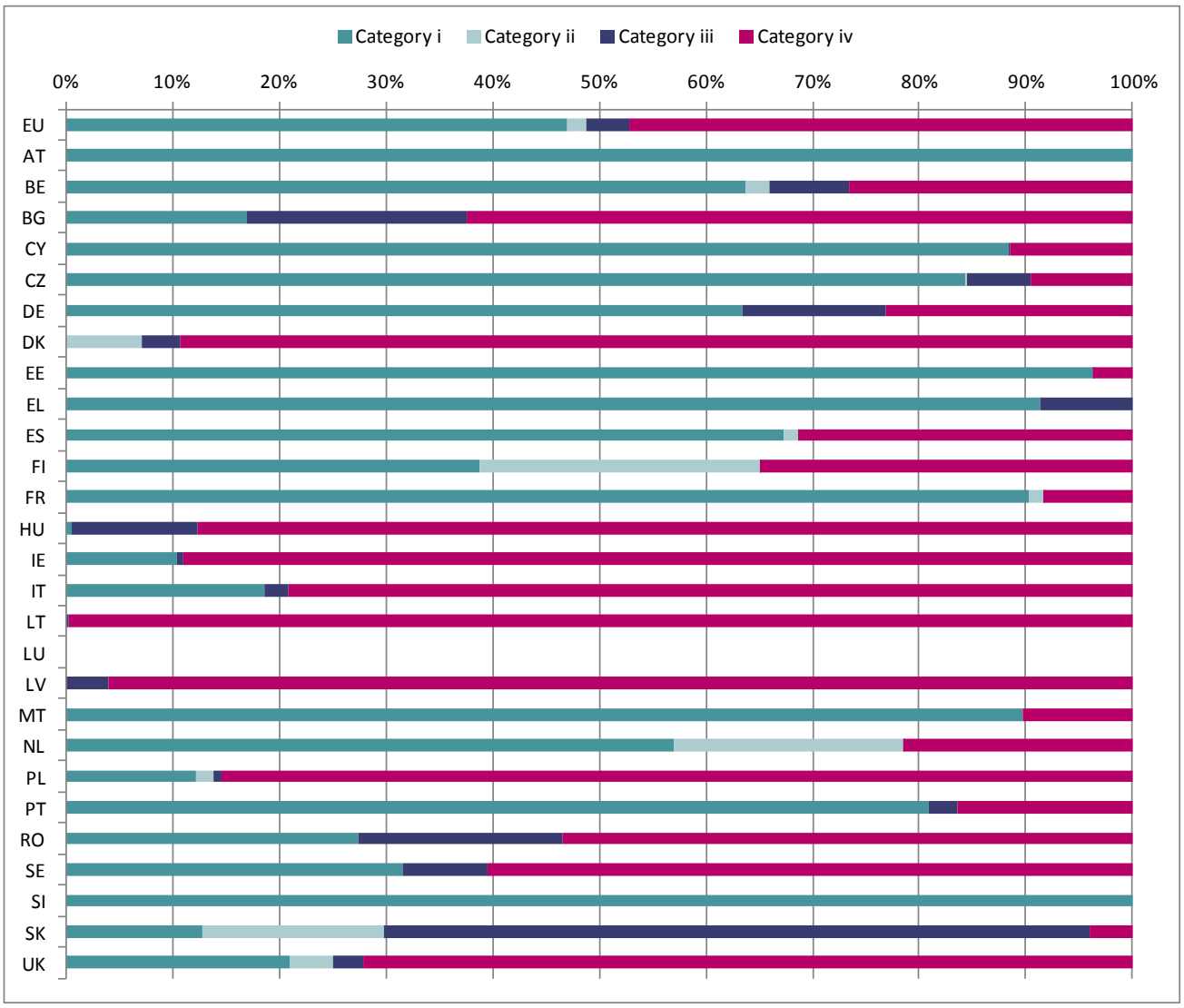
- **Waste management**: A total of 2 tonnes of emissions of nickel are due to waste management activities and mostly from category i waste incineration (1.3 tonnes); and

- **Agriculture**: There are almost no emissions reported under this group, the only emission is 0.2 tonnes of nickel from field burning of agricultural waste.

Additional comments at Member State level

While general EU27 distribution described above can be observed in most Member States, Figure 4.60 presents some notable variances. Furthermore, no emissions of nickel were reported by Luxembourg.

Figure 4.60 Split of emissions of nickel to air by category at Member State and EU27 as a whole (%)



A few Member States have a share of emissions in category ii significantly larger than the EU average (2%): Finland (26%), the Netherlands (22%) and Slovakia (17%). For Finland, this is due to waste management activities below the IED thresholds whereas for the Netherlands and Slovakia the emissions are from the processing of non ferrous metals below IED threshold.

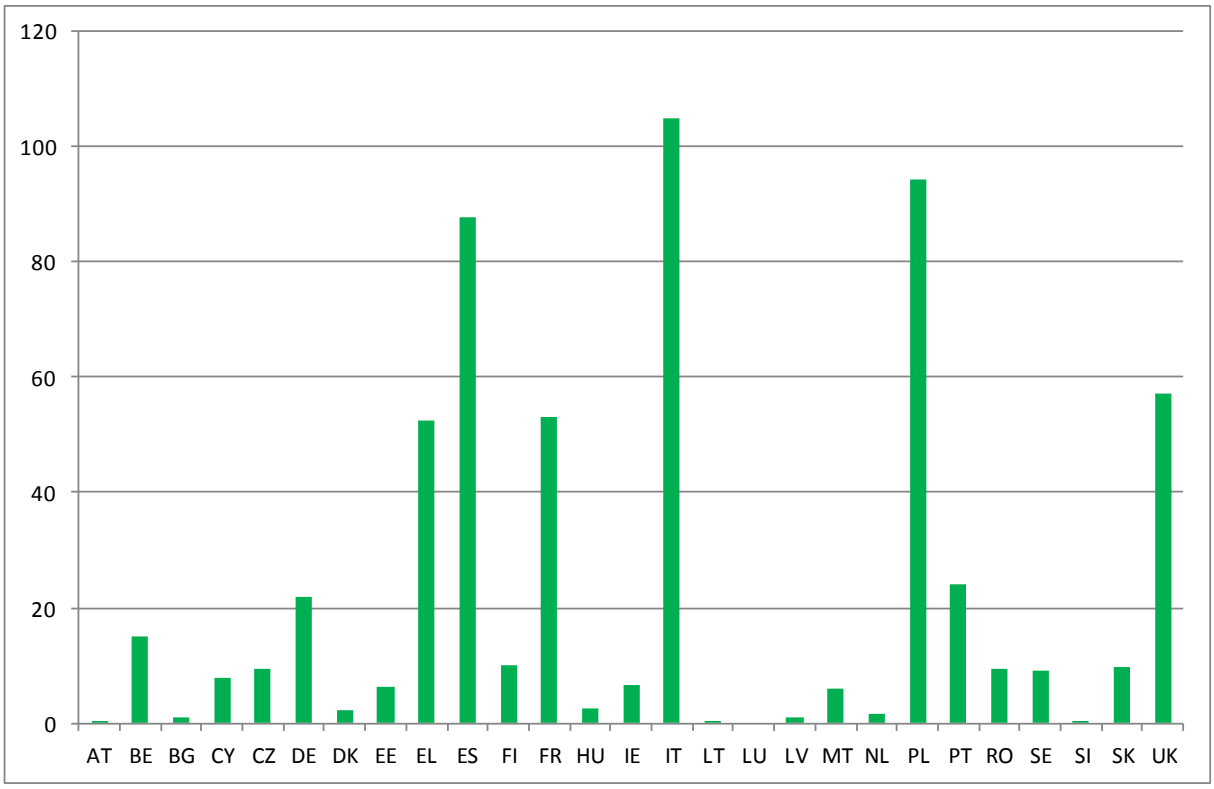
For three Member States, the amount of 'unregulated' emissions under category iii is significantly larger than the EU27 average (4%): Slovakia (66%), Bulgaria (21%) and Romania (19%). The emissions are primarily from the

production of pig iron or steel below 2.5 tonnes per hour, and for Slovakia also from the production of paper and cardboard below 20 tonnes per day.

A few Member States have reported significantly larger category iv emissions than the EU average (47%): Lithuania (100%), Latvia (96%), Denmark (89%), Ireland (89%), Hungary (88%) and Poland (85%). For Hungary, Ireland, Latvia and Poland the source of these emissions is the domestic sector whereas for Denmark it is the shipping sector.

It is noteworthy that Italy, Poland and Spain are the main emitters of nickel in EU contributing 285 tonnes, which is almost half of total EU27 emissions. Figure 4.61 presents the total quantity of nickel emitted by Member State.

Figure 4.61 Overview of nickel emissions to air at Member State level (in tonnes)



4.2.13 Zinc

Description

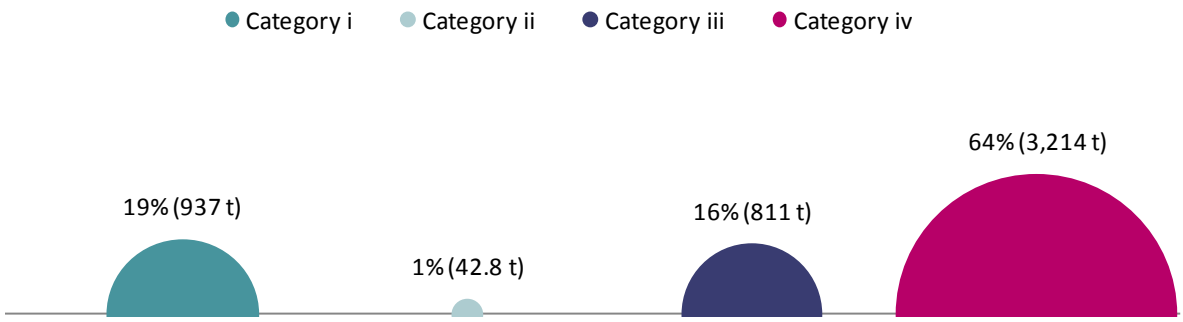
Zinc is a blue/white shiny metal which is brittle and conducts electricity. Compounds of zinc are often highly coloured. Zinc is used in batteries, alloys such as brass and bronze and provides a corrosion resistant coating for other metals (e.g. galvanised steel). It is also used in the manufacture of paints, plastics, rubber tyres, dyes, wood preservatives and cosmetics. Most releases of zinc to the environment are from metal production processes, combustion of coal in power stations, waste incineration and from the wear of vehicle tyres. Exposure to potentially

harmful levels usually occurs only through drinking of contaminated water (due to zinc water pipes or accidental industrial releases). Harmful effects following exposure include nausea and stomach cramps. Zinc can accumulate in fish and other aquatic organisms and create toxic systemic effects the animals that eat them. Emissions of zinc are rarely large enough to cause these damaging levels (E-PRTR, 2013).

Summary

A total of 5 kt of zinc was emitted to the atmosphere across the EU27 in 2010. Figure 4.62 shows that the majority of emissions of zinc (3.2 kt) come from category iv activities and mainly from the road transport. The second most important share of emissions arise from category i (almost 1 t) which is primarily due to the production of pig iron and steel (477 t) and combustion installations above 50 MW (188 t). Emissions under category iii are almost exclusively due to the production of pig iron or steel below 2.5 t per hour. Finally category ii activities contribute slightly more than 42 t of zinc, most of which is emitted from the processing of non ferrous metals below the IED threshold (36 t).

Figure 4.62 Air emissions of zinc by category (in %) (total EU27 emissions = 5 kt)

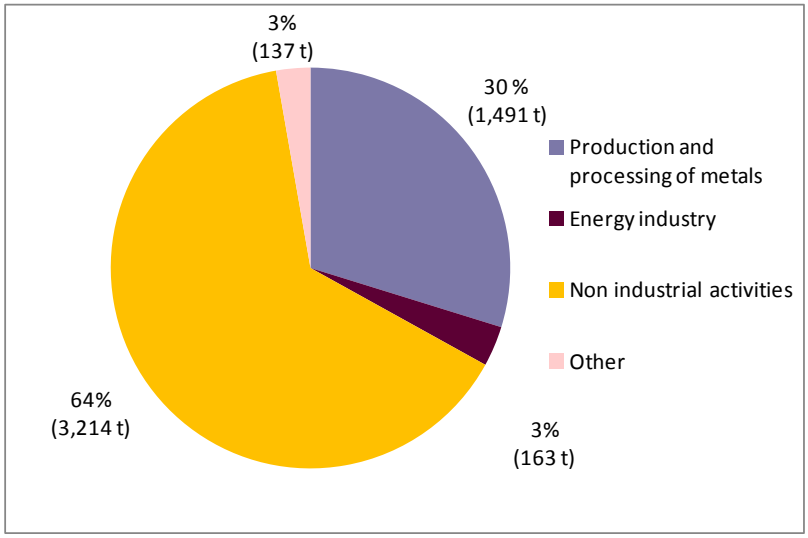


Detailed analysis by group of activities

Overview

Figure 4.63 presents the split of emissions of zinc by main groups of activities. It shows that three main groups of activities are responsible for most of the emissions of zinc with the majority of the emissions from non-industrial activities. The production and processing of metals (nearly 1.5 kt) comes second and is a source of significant emissions of zinc. Finally, emissions from the energy industry sector are also important with a total of 163 tonnes emitted.

Figure 4.63 Split of zinc emissions to air by main group of activities (total EU27 emissions = 5 kt)



Note: emissions from smaller group of activities (mineral industry, chemical industry, waste management other industrial activities and agriculture) have been added to form the 'other' category due to their limited emissions.

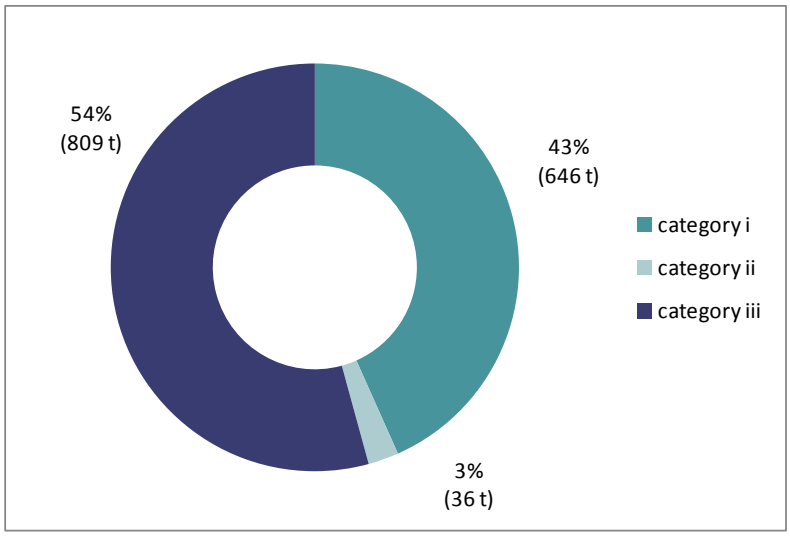
Non-industrial activities

Non-industrial activities are an important source (64%, 3.2 kt) of emissions of zinc arising from the road transport (2.3 kt) and the domestic sector (805 t). The commercial services sector makes a small contribution of nearly 100 tonnes.

Production and processing of metals

This group of activities is an important source of emissions of zinc (1,491 t) in the EU27, in particular from the production of pig iron and steel. Figure 4.64 presents the split of emissions between categories and shows the majority of emissions of zinc are reported under category iii activities, more specifically from the production of pig iron and steel below 2.5 tonnes per hour (809 t). The remainder of the emissions are from category i activities such as the production of pig iron and steel above the IED threshold (477 t), metal ore roasting (48 tonnes) and the processing of non ferrous metals (46 tonnes).

Figure 4.64 Detail of emissions of zinc to air–production and processing of metals (total = 1,491 t)



Energy industry

The energy industry is a source of 163 tonnes of zinc emissions. All of these emissions arise from activities already regulated by the IED (category i). The most important source of emissions in this group is from the combustion of fuels in installations above 50 MWth (118 tonnes) and the refining of mineral oil and gas (44.5 tonnes);

Activities not described above

- **Waste management**: Waste management activities are responsible for 28.5 t of zinc emissions, of which almost all are from activities regulated under the IED (category i) and more specifically from waste incineration (19.8 tonnes);

- **Other industrial activities**: These activities are responsible for 55.5 tonnes of emissions of zinc, almost all of which are from category i (51.3 tonnes) or ii (1.5 tonnes). Emissions from category i arise mostly from the production of paper and cardboard (43.5 tonnes) and pulp (7 tonnes). Emissions from category ii activities are due to the production of paper and cardboard below the IED threshold. Some emissions of zinc are reported under category iii (2.7 tonnes) mostly from the production of paper and cardboard below 20 tonnes per day (2.3 tonnes);

- **Chemical industry**: This activity contributes 36 tonnes of zinc emissions, all of which arise from activities in category i (IED). The main source of emissions is the production of inorganic chemicals (31 tonnes);

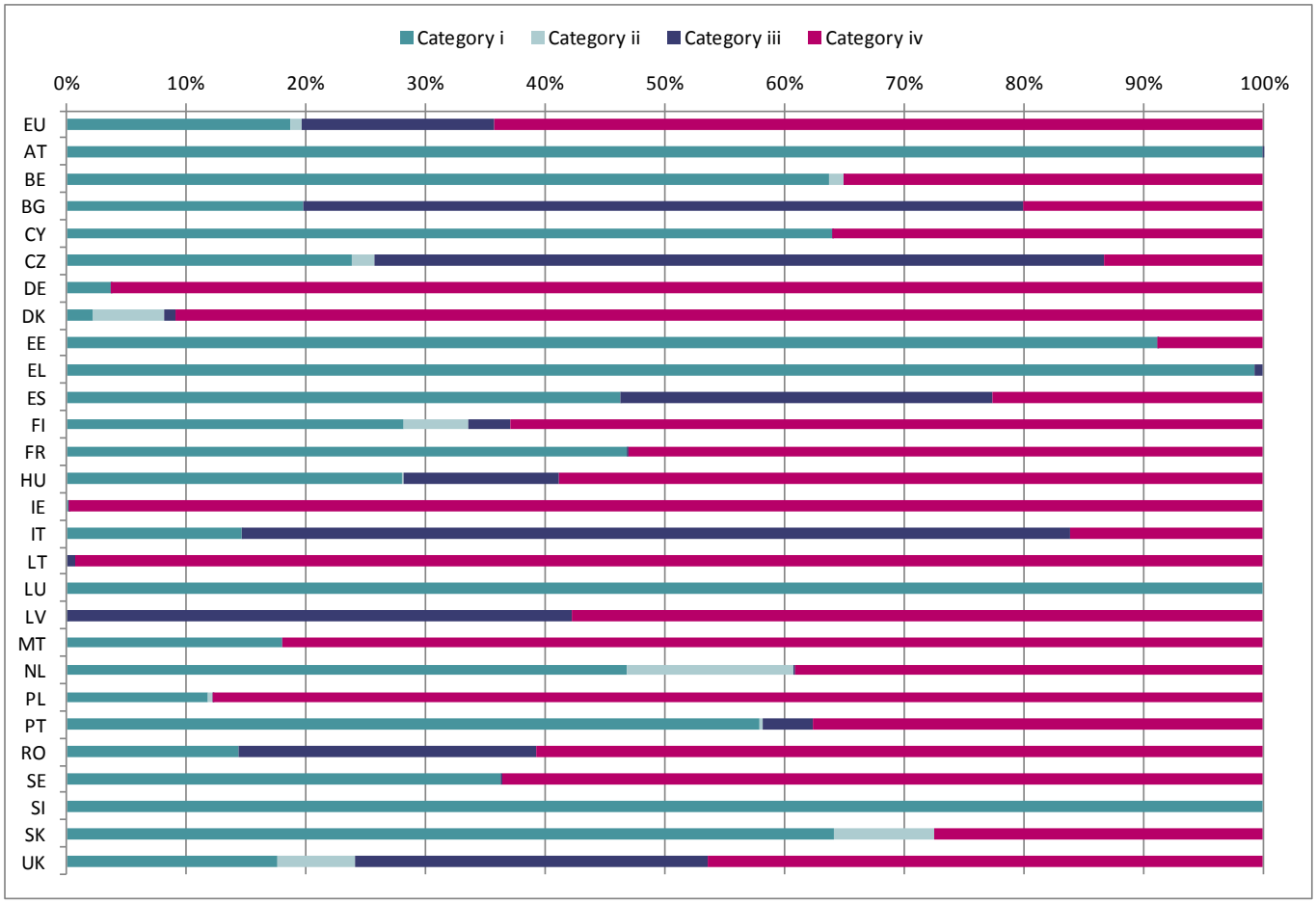
- **Mineral industry**: A total of 17.7 tonnes arises from activities in the mineral industry group. Category i activities are responsible for most of these emissions (13.6 tonnes), in particular the production of cement, lime and magnesium (6.5 tonnes); the manufacture of glass (2.4 tonnes) and the manufacture of ceramics (1.7 tonnes). A small proportion of arises from category ii activities (4 tonnes), mostly from the production of cement below 500 tonnes (3.4 tonnes); and

- **Agriculture**: There are limited emissions of zinc reported from agricultural activities. A total of 0.03 tonnes of zinc have been reported as being emitted from the field burning of agricultural wastes (category iii).

Additional comments at Member State level

While the general EU27 distribution described above can be observed in some Member States Figure 4.65 presents some notable variances.

Figure 4.65 Split of emissions of zinc to air by category at Member State and EU27 as a whole (%)



For the Netherlands, the share of emissions reported under category ii (14%) is significantly larger than the EU27 average (1%). These emissions are from the processing of non ferrous metals.

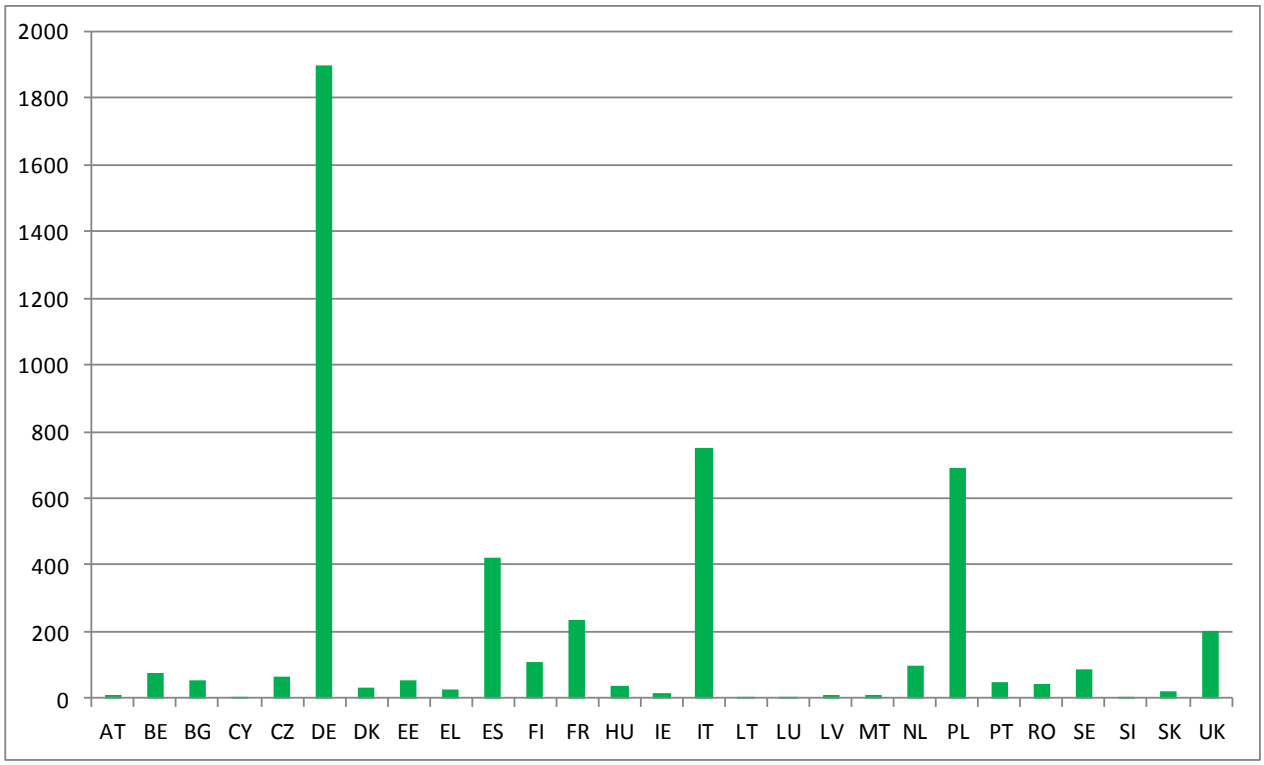
For several Member States, the emissions reported under category iv are higher than the EU average (64%). This is the case for Ireland (100%), Lithuania (99%), Germany (96%), Denmark (91%) and Poland (88%). For Denmark, Ireland, Germany and Lithuania these emissions are due to road transport. More specifically, for Germany it is due

to the automobile tyre and brake wear and for Denmark it is from emissions from passenger cars. In Poland, these emissions are from the domestic sector.

Whilst the EU average for category i emissions is 19%, for several Member States the majority of their emissions arise from category i activities already covered by the IED. This is the case for Austria (100%), Luxembourg (100%), Slovenia (100%), Greece (99%), Estonia (91%), Belgium (64%), Cyprus (64%), and Slovakia (64%).

Figure 4.66 presents the total quantity of zinc emitted per Member State. Analysis of the distributions across the EU27 shows that Germany, Italy and Poland are responsible for more than 60% of the total EU27 emissions. The source of these emissions are diverse, in Germany, most of the zinc emissions are from road transport, in Italy emissions arise mostly from the production of pig iron and steel below 2.5 t per hour and in Poland emissions are mostly from the domestic sector.

Figure 4.66 Total emissions of zinc to air by Member State (in tonnes)



4.2.14 Ammonia

Description

Ammonia is a colourless, odorous and corrosive gas, which can be stored under high pressure as a liquid. Ammonia is both manufactured and produced naturally. It is used for bleaching and cleaning, for fertilisers and in the

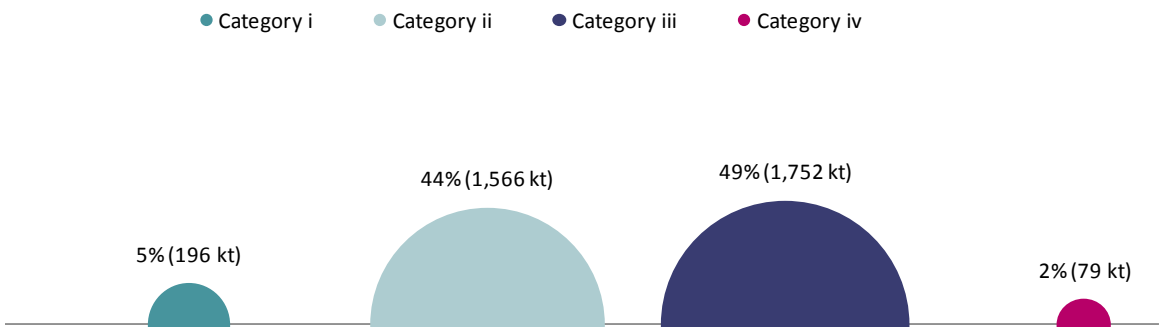
manufacture of plastics, rubber and petrochemicals. It is also used as a refrigerant. Most ammonia released to the environment comes from natural sources such as decaying organic matter, for example, animal manure. Anthropogenic releases, such as from the use of fertilisers, waste disposal sites and industrial processes, are much smaller in comparison. Exposure to ammonia at normal background levels is unlikely to have an adverse effect to health. At high local concentrations (e.g. from decomposing manure) ammonia can cause harm to vegetation, but greater damage is from releases of aqueous ammonia to water bodies as it is very toxic to aquatic organisms. Ammonia releases to the environment contribute to both eutrophication and acidification of eco-systems. Emissions of ammonia to air can also contribute to the formation of particulate matter, an important pollutant in terms of its potential to harm human health (E-PRTR, 2013).

Summary

A total of almost 3.6 million tonnes of ammonia were emitted to the atmosphere in the EU27 in 2010. Figure 4.67 shows that the majority of the emissions are split between categories ii and iii and arise overwhelmingly from the agriculture sector. Some emissions of ammonia are due to category iv activities (79 kt), most of which (71 kt) are emitted by the road transport sector. Emissions of ammonia from category i activities total 196 kt of which 160 kt originates mainly from the following agricultural activities: 78 kt from intensive rearing of pigs, 45 kt from intensive rearing of poultry, 36 kt from intensive rearing of livestock (undetermined pigs or poultry). A further 37 kt is emitted from other category i industrial activities including, inter alia, manufacture of chemicals (16 kt), the production of cement (2.6 kt) and the manufacture of glass (2.5 kt).

Whilst for most of the pollutants emissions sources are very diverse, for ammonia, agriculture is the main contributor to emissions. It is important to note that category i emissions are those reported in the E-PRTR. The E-PRTR emissions reporting threshold for ammonia is 10,000 kg/year, which means that some farms covered by the IED will not have to report emissions data under E-PRTR. Unfortunately, there is no data available on the number of installations that are regulated by IED but whose emissions fall below the E-PRTR reporting threshold. In addition, it is likely that the emissions reported are only emissions from housing; manure spreading is often carried out off site and therefore technically not covered by the IED. Finally, there seems to be some under-reporting from IED regulated farms to the E-PRTR. The total number of facilities that reported in E-PRTR in 2010 for activity 7(a) (including 7ai, 7aii and 7aiii) is 5,405, whilst the IPPC implementation report for 2005-2008 reported by the end of 2008 a total of nearly 16,000 existing installations conducting the intensive rearing of poultry, pigs or sows as defined in the IPPC Directive. The number of facilities that have reported into the E-PRTR represents only 40% of the total existing installations by the end of 2008. As a result, it is almost certain that some of the emissions presented in category iii ‘rearing of poultry’ and ‘rearing of pigs’ are actually emissions of ammonia from installations regulated by IED but unreported by Member States; either through failure to report emissions or by not meeting the emission threshold set in E-PRTR.

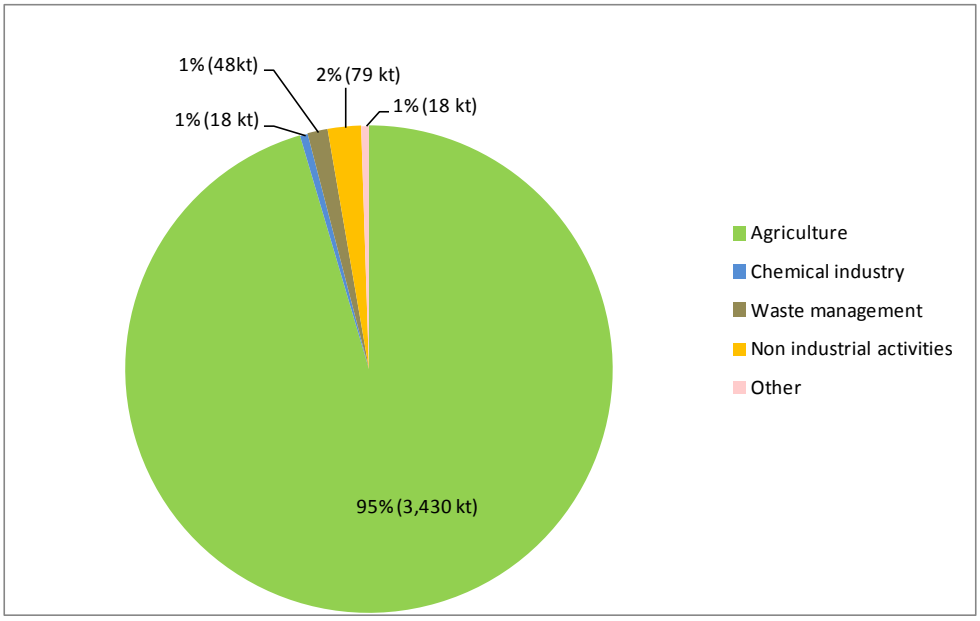
Figure 4.67 Air emissions of ammonia by category (in %) (total EU27 emissions = 3.59 million tonnes)



Detailed analysis by group of activities

Overview

Figure 4.68 Split of emissions of ammonia to air by main group of activities (total EU27 emissions = 3.59 million tonnes)



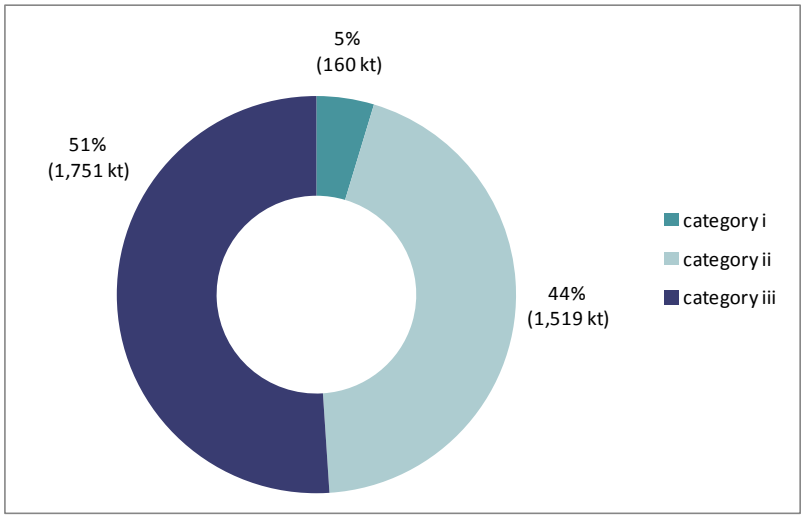
Note: emissions from smaller group of activities (energy industry, production and processing of metals, mineral industry and other industrial activities) have been added to form the 'other' category due to their limited emissions.

Figure 4.68 presents the main group of activities responsible for emissions of ammonia at an EU27 level. The figure shows clearly that the overwhelming majority of emissions of ammonia come from the agriculture sector (3.4 million tonnes). There are other small sources of emissions such as non-industrial activities which contribute 79 kt of ammonia emissions. Waste management and the chemical industry are also responsible for 48 kt and 18 kt of ammonia emitted, respectively.

Agriculture

Agriculture is the main source of emissions of ammonia in the EU27. Figure 4.69 presents the split of emissions between categories. It shows that category iii activities are the source of around half of ammonia emissions (1.7 million tonnes). The activities responsible for most of these emissions are the rearing of dairy cattle (464kt); the rearing of non-dairy cattle (469 kt); the rearing of pigs (391 kt) and poultry (228 kt) below the IED thresholds. The second most important source of emissions is category ii with 1.5 million tonnes of emissions. Under this category, all of the emissions are due to the use of fertilisers and spreading of manure. Around half of the emissions (720 kt) are due to the use of synthetic fertilisers; the other half is divided between emissions from manure from cattle (518 kt), pigs (170 kt) and poultry (100 kt). A total of 160 kt of ammonia was reported as being emitted by intensive livestock installations regulated by the IED although this appears to be significantly underestimated as discussed above. Most of these reported emissions arise from the intensive rearing of pigs (78 kt), poultry (45 kt) and undifferentiated pigs and poultry (36 kt).

Figure 4.69 Split of emissions of ammonia to air– agriculture (total = 3,430 tonnes)



Non-industrial activities

This group is responsible for 79 kt of emissions of ammonia, all of which are part of category iv. The main sources of emission are road transport (71 kt) followed by the domestic sector (6.9 kt).

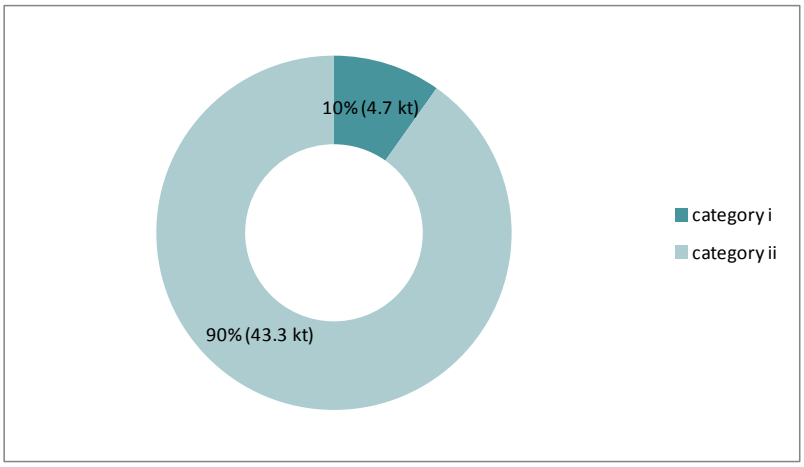
Chemical industry

Emissions of ammonia from the chemical industry amount to 18 kt, all emitted by category i activities. Half of these emissions (9 kt) are due to the production of inorganic chemicals and another 7 kt are emitted during the production of phosphorous, nitrogen or potassium based fertilisers.

Waste management

Waste management activities are responsible for emissions of 48 kt of ammonia. The figure below shows that most of these emissions (43.3kt) are due to category ii activities, and mainly from the recovery or mix of disposal and recovery of non-hazardous waste (26 kt) and landfills (16 kt) below IED thresholds. A small amount of the emissions (4.7 kt) are from category i activities, mostly from landfills (3.6 kt).

Figure 4.70 Split of emissions of ammonia to air– waste management (total = 48 kt)



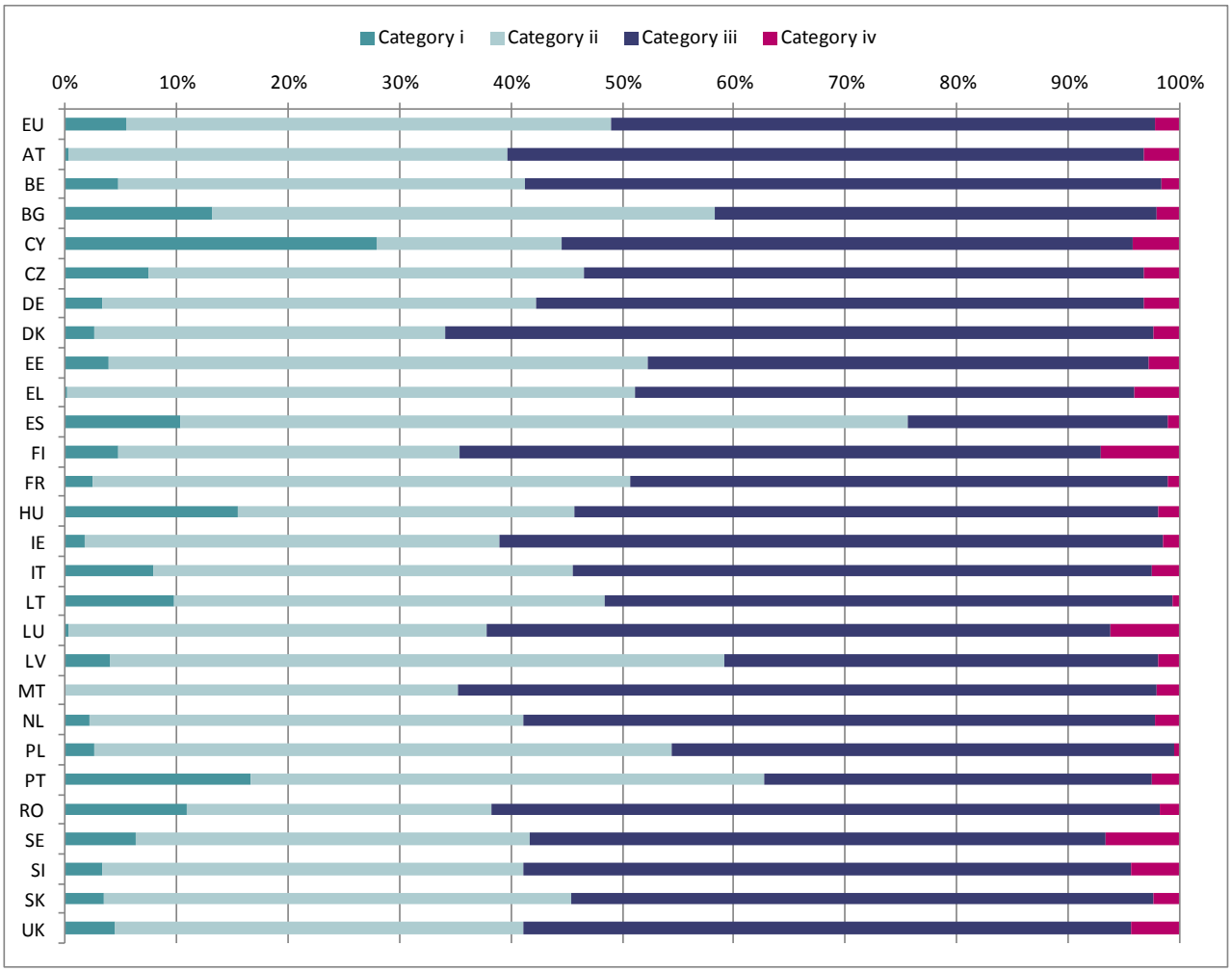
Activities not described above

- **Mineral industry**: Emissions from the mineral industry activity amount to 8 kt of ammonia, the majority of which are from category i activities such as the production of lime, cement and magnesium (2.6 kt), the manufacture of glass (2.5 kt) and the melting of mineral substances (2 kt);
- **Other industrial activities**: A total of 7.3 kt of ammonia was emitted by activities in this group. Emissions from category i (3.1kt) are due mainly to the production of pulp and paper (2.3 kt). Emissions of ammonia under category ii (3.1kt) are due almost entirely to activities using organic solvents below the IED threshold (2.9 kt). Finally, the production of paper and cardboard below 50 tonnes per day contributes all emissions under category iii (1.1 kt);
- **Energy industry**: The energy industry is responsible for 1.2 kt of emissions of ammonia, all of which are emitted by category i activities. Emissions arise mainly from the refining of mineral oil and gas (690 tonnes) and the combustion of fuels in installations above 50MWth (540 tonnes); and
- **Production and processing of metals:** A total of 1.5 kt of ammonia was emitted by activities related to the production and processing of metals. The majority of these emissions arise from category i activities (1.2 kt) and mainly from the processing of ferrous metals (800 tonnes).

Additional comments at Member State level

While the general distribution described above can be observed in most Member States, Figure 4.71 presents some notable variances.

Figure 4.71 Split of emissions of ammonia to air by category at Member State and EU27 as a whole (%)



For two Member States, the share of emissions reported under category i is significantly higher than the EU27 average (5%): Cyprus (28%) and Portugal (17%). It means that for these Member States, more emissions of ammonia than average are covered by the IED.

For three Member States - Denmark (64%), Malta (63%) and Romania (60%) - the share of emissions reported in category iii is higher than the EU average. Considering that most of the emissions of ammonia in category iii are due to the rearing of livestock below the IED thresholds and the rearing of cattle, the share of the emissions depends on the type and amount of livestock reared. For Denmark and Malta, almost half of their emissions under category iii are due to the rearing of pigs below the IED threshold. For Romania, emissions are split almost equally between pig, poultry and cattle.

Two Member States have reported slightly higher category iv emissions than the EU average (2%): Finland (7%) and Sweden (7%). For both of these Member States, road transport is responsible for most of these emissions.

Emissions of ammonia are spread amongst Member States, the highest emitters are France, Germany, Italy and Spain, responsible for 55% of the total EU27 emissions.

4.2.15 Dioxins and Furans

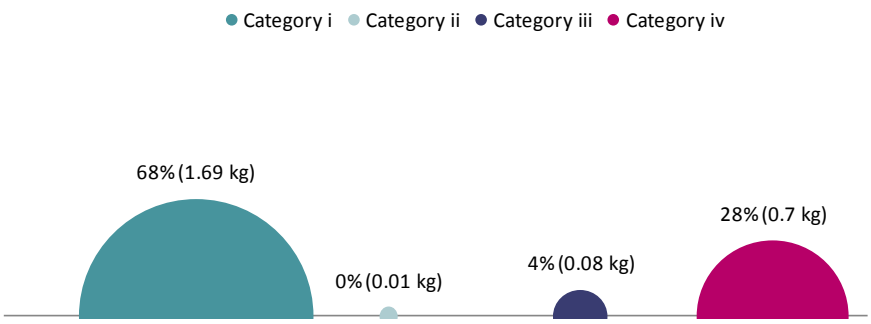
Description

Polychlorinated-p-dioxins (PCDDs) and furans (PCDFs) are commonly known as dioxins and furans. There are many hundreds of different dioxins, which are crystalline solids that dissolve in oils, fats and organic solvents but not readily in water. PCDDs and PCDFs have no applications outside of research and laboratory use and are not intentionally manufactured. They are formed by the combustion of fuels and wastes, processing of metals and the production of pulp and paper. They are also produced naturally in the environment with major sources being forest fires and volcanoes. Exposure to normal background levels of dioxins and furans is unlikely to cause health problems. However, exposure to higher levels may affect the heart, liver, immune system, skin, and thyroid gland. Some PCDDs and PCDFs may cause cancer and may affect the unborn child in low concentrations. PCDDs and PCDFs released to air will eventually be deposited on soil and/or waters. Livestock and wildlife can subsequently ingest them from soil and vegetation, with fish susceptible to uptake from aquatic sediments (E-PRTR, 2013).

Summary

A total of 2.5 kg of dioxins and furans was emitted to air in 2010 at an EU27 level. Figure 4.72 shows that most of the emissions (1.69 kg) were emitted by category i activities, mainly the combustion of fuels in installations above 50 MWth (0.66 kg), the production of organic chemicals (0.47 kg), the production of pig iron or steel (0.2 kg) . The second most important source of emissions (0.7 kg) are activities in category iv and more specifically the domestic sector (0.6 kg). A small share of emissions of dioxins and furans are emitted by category iii activities (0.08 kg), primarily from the production of pig iron or steel below 2.5 tonnes per hour. Finally, there are very limited emissions reported from category ii activities (0.01 kg).

Figure 4.72 Air emissions of dioxins and furans by category (in %) (total EU27 emissions= 2.5 kg)

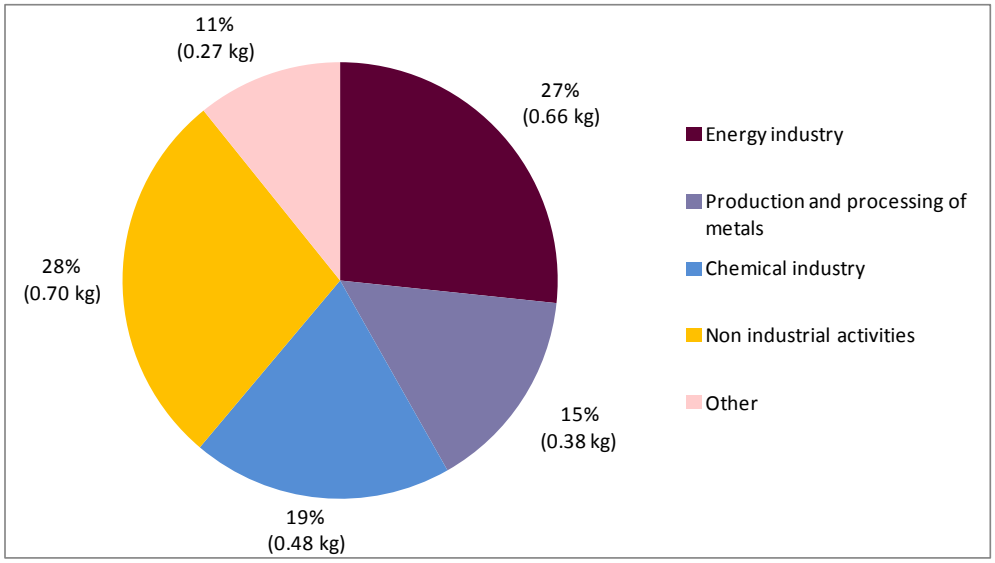


Detailed analysis by group of activities

Overview

Figure 4.73 presents the source of emissions of dioxins and furans by major emitting group of activities. This demonstrates that sources of emissions of dioxins and furans are diverse with a number of activities responsible for small quantities of emissions. The energy industries (0.66 kg) and non-industrial activities (0.70kg) are responsible for more than half of the emissions.

Figure 4.73 Split of emissions of dioxins and furans to air by main group of activities (total EU27 emissions =2.5 kg)



Note: emissions from smaller group of activities (mineral industry, waste management, other industrial activities and agriculture) have been added to form the 'other' category due to their limited emissions.

Energy industry

All of the emissions under this group of activities were emitted by category i activities; from the combustion of fuels in installations above 50 MWth (0.66 kg).

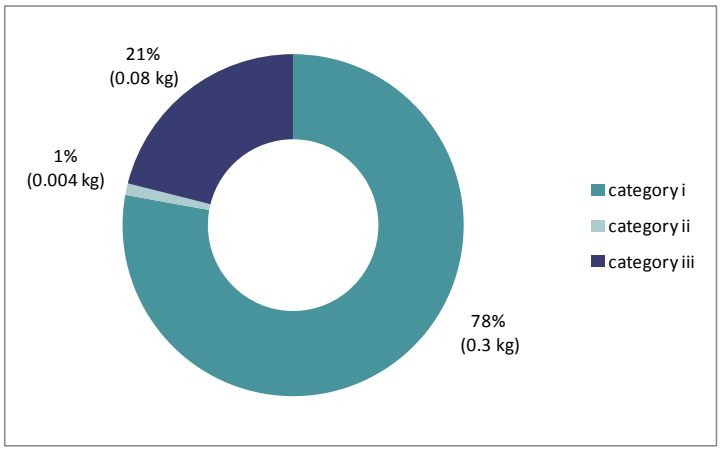
Non-industrial activities

All of the emissions reported by non-industrial activities (0.7 kg) are emitted by category iv activities, and primarily by the domestic sector (0.6 kg)

Production and processing of metals

Figure 4.74 presents the split of emissions of dioxins and furans by category. Out of the total emissions under this group (0.38 kg), the majority (0.3kg) are from category i activities; more specifically the production of pig iron and steel. Emissions under category iii are due to the same activity conducted below the threshold of 2.5 tonnes per hour and amount to 0.08 kg of dioxins and furans.

Figure 4.74 Split of emissions of dioxins and furans to air– production and processing of metals (total = 0.38 kg)



Chemical industry

All of the emissions reported by the chemical industry (0.48 kg) are from category i activities and almost exclusively from the production of organic chemicals (0.47 kg).

Activities not described above

- **Waste management**: Waste management activities are responsible for a total of 0.22 kg of dioxins and furans. Almost all of these emissions are due to category i activities and more specifically from the incineration of waste (0.21 kg). The disposal and recovery of hazardous waste also contributes some dioxins and furans (0.01 kg);

- **Mineral industry**: Emissions from the mineral industry (0.02 kg) are limited to the category i activity of production of cement, lime and magnesium;

- **Other industrial activities**: Other industrial activities are responsible for 0.02 kg of dioxins and furans, which have all been emitted by category i activities involving the production of pulp and paper in IED installations; and

- **Agriculture**: There are no emissions of dioxins and furans from agricultural activities.

Additional comments at Member State level

While the general EU27 distribution described above can be observed in most Member States, Figure 4.75 presents some notable variances.

Figure 4.75 Split of emissions of dioxins and furans to air by category at Member State and EU27 as a whole (%)

Three Member States have a share of emissions from category ii activities that are larger than the EU average (4%): Finland (11%), Ireland (25%) and Slovenia (16%). Ireland emissions of dioxins and furans are due to the production of cement below IED threshold. Finland and Slovenia emissions are from the processing of non ferrous metals conducted below the IED threshold.

For three Member States, emissions included in category iii are significantly larger than the EU average (4%). This is the case for Greece (53%), Luxembourg (38%), Slovakia (29%) and UK (22%). For Luxembourg and the UK, these emissions are from the production of pig iron and steel below 2.5 tonnes per hour. For Greece and Slovakia the emissions are mainly due to the production of paper and cardboard below 20 tonnes per day.

For the following Member States the majority of emissions of dioxins and furans are reported under category iv: Bulgaria (79%), Cyprus (85%), Denmark (100%), Estonia (87%), Lithuania (100%), and Latvia (100%). For Bulgaria, Denmark, Lithuania and Latvia the majority of these emissions are from the domestic sector. For Cyprus and Estonia, the road transport sector is responsible for these emissions.

4.2.16 Non-methane volatile organic compounds

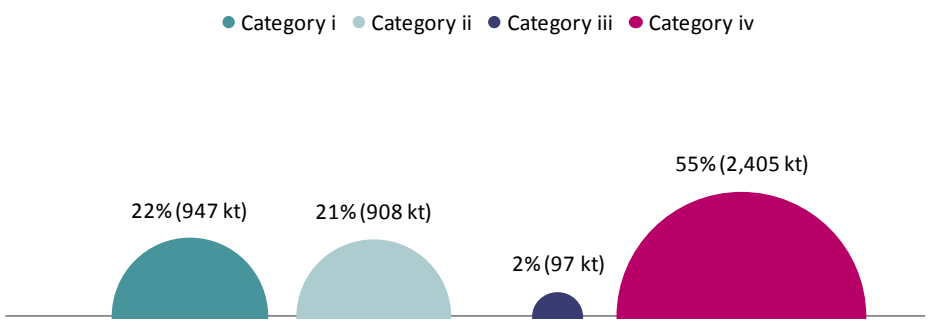
Description

The main sources of NMVOCs are the combustion of fossil fuels, solvents for industrial processes, paints and varnishes. Smaller amounts are released from dry cleaning, the beverage industry and farming. Industrial emissions of VOCs arise from the evaporation of solvents, from accidental spillage or evaporation of petroleum products. Natural sources of NMVOCs are primarily emissions from forests. NMVOCs react with other air pollutants to form ground-level ozone; an important pollutant at local and global scales. Elevated levels of ozone can cause respiratory health problems and can lead to premature mortality. High levels of ozone also damage plants, reducing agricultural crop yields and decreasing forest growth (E-PRTR, 2013).

Summary

A total of 4.3 million tonnes of NMVOC were emitted to air in 2010 across the EU27. Figure 4.76 presents the split of emissions of NMVOC by category and shows that the majority of the emissions (2.4 million tonnes) came from category iv activities and more specifically from road transport (1.1 million tonnes) and the domestic sector (1 million tonnes). Category ii contributes more than 900 kt of NMVOC from activities using organic solvents below the IED thresholds (820 kt) and the use of fertilisers other than manure (25 kt). A total of 947 kt of NMVOC was emitted by category i activities and more specifically from activities using organic solvents covered by the IED (570 kt), refining of mineral oil and gas (123kt), the production of chemicals (76 kt), combustion installations above 50 MWth (46 kt) and the production of pharmaceutical products (18 kt). Finally, the remaining emissions (category iii, 97kt) originate primarily from the field burning of agricultural waste (63 kt).

Figure 4.76 Air emissions of NMVOC by category (in %) (total EU27 emissions= 4.3 million tonnes)

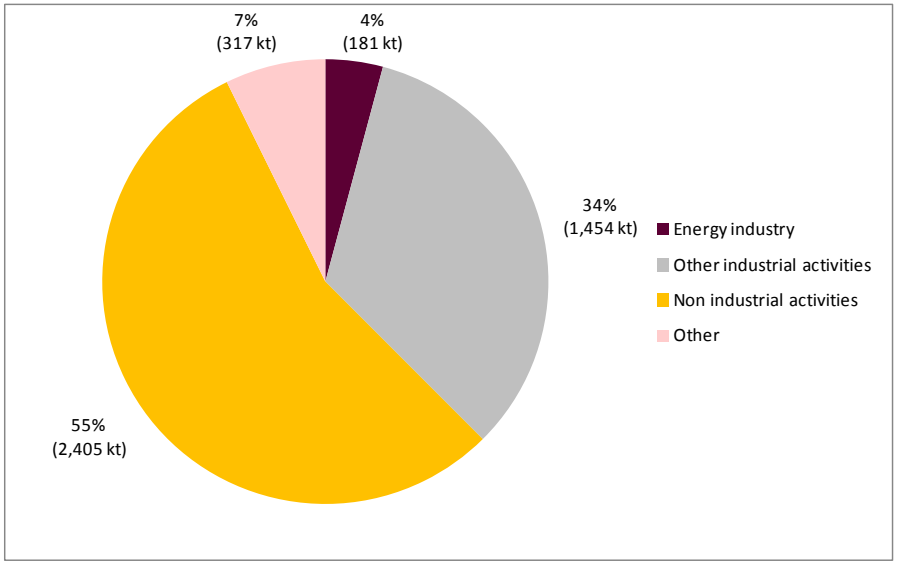


Detailed analysis by group of activities

Overview

Figure 4.77 shows the main group of activities responsible for NMVOCs emissions. It shows that the majority of emissions are from 'unregulated' non-industrial activities (2.4 million tonnes). (Agro-)industrial activities in both categories i and ii reported emissions of 1.4 million tonnes of NMVOCs. Finally, the energy industry is also a notable source of NMVOC emissions (181 kt in total).

Figure 4.77 Split of emissions of NMVOCs to air by main group of activities (total EU27 emissions= 4.3 million tonnes)



Note: emissions from smaller group of activities (production and processing of metal, chemical industry, mineral industry, waste management and agriculture) have been added to form the 'other' category due to their limited emissions.

Non-industrial activities

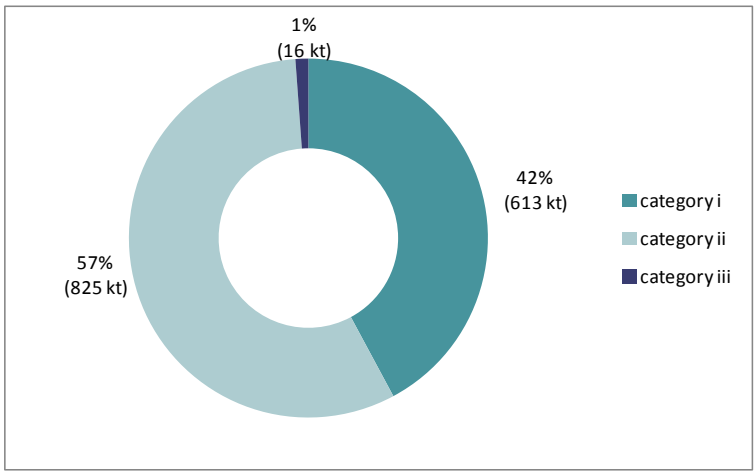
Non-industrial activities (category iv), and in particular road transport and domestic sector, are responsible for the majority of NMVOC emissions. Road transport contributed 1.1 million tonnes whilst the domestic sector was

responsible for 1 million tonnes of emissions. The shipping sector contributed a smaller quantity of emissions (128 kt).

Other industrial activities

Figure 4.78 presents the category of emissions from activities in this group. The majority of the emissions (820 kt out of 825 kt) are from category ii activities which involve the use of organic solvents below the IED threshold. The remainder of the emissions were emitted by category i activities (610 kt) including the use of organic solvents (570 kt) and from the production of pulp and paper (30 kt). Finally a small quantity of emissions (16kt) is 'unregulated' (category iii) and these arise from the production of paper and cardboard below the threshold of 20 tonnes per day.

Figure 4.78 Split of emissions to air– other industrial activities (total = 1,454 kt)



Energy industry

The energy industry contributed 181kt of NMVOC emissions, all of which were emitted by category i activities. The main contributors to emissions were the refining of mineral oil and gas (123 kt) and combustion installations above 50 MWth (46 kt).

Activities not described above

- **Chemical industry:** A total of 97 kt of NMVOC was emitted by the chemical industry with all of the emissions generated by category i activities such as the production of organic chemicals (73 kt) and pharmaceutical products (18.5 kt);

- **Agriculture**: Almost 90 kt of NMVOC were emitted by the agriculture sector. Most of these emissions arise from category iii (64 kt) and are emitted by the field burning of agricultural waste (63kt). The remaining emissions (25 kt) are from category ii activities and specifically the use of fertilisers other than manure;

- **Waste management:** Waste management activities contributed 90 kt of NMVOC in total with the majority from category ii activities (56.9 kt) such as landfills (54.6 kt) below the IED threshold. The remainder of the emissions are from category i activities (33 kt) and mainly from waste incineration (32kt);

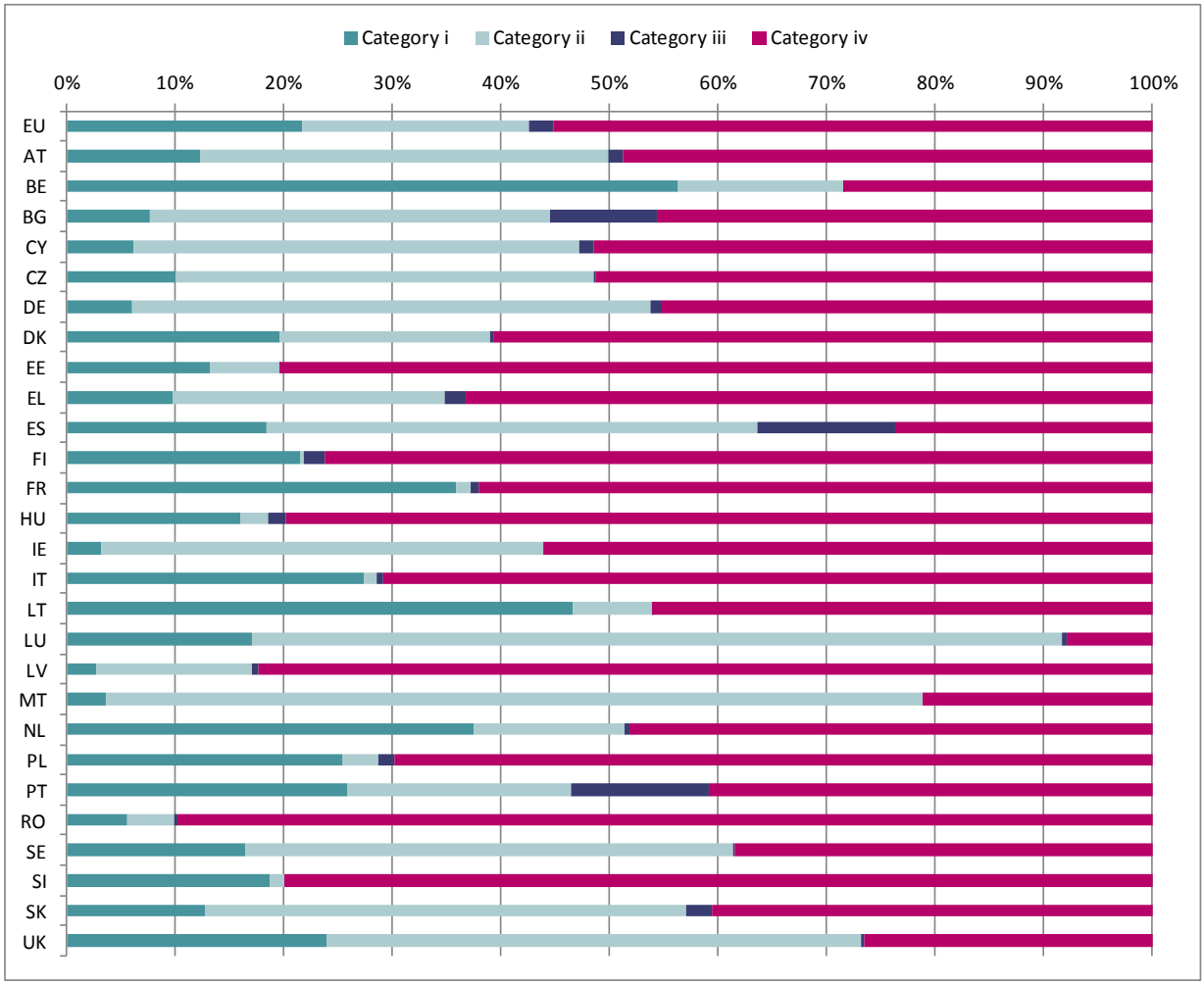
- **Production and processing of metals**: This activity contributed a total of 36kt of NMVOC and these emissions are split between category i and iii activities. Category i activities contributed 19 kt of NMVOC split mainly between the surface treatment of metals and plastic (8kt) and the production of pig iron or steel (6.9 kt). All category iii emissions are due to the production of pig iron or steel below 2.5 tonnes per hour (16 kt); and

- **Mineral industry**: The mineral industry contributed 4 kt of NMVOC mainly from category i activities such as the manufacture of ceramics (1.3 kt) and the production of cement, lime and magnesium (0.5 kt). A small quantity of emissions (1.6 kt) arises from the production of cement below the IED threshold (category ii).

Additional comments at Member State level

Figure 4.79 shows that at a Member State level there are notable variances from the general EU27 distribution of NMVOC emissions by category.

Figure 4.79 Split of emissions of NMVOC to air by category at Member State and EU27 as a whole (%)



Two Member States have a larger share of emissions in category ii than the EU average (21%): Luxembourg (75%) and Malta (75%). These emissions are due to activities involving the use of solvents below the IED threshold.

Two Member States have a larger share of emissions in category iii than the EU average (2%): Spain (13%) and Portugal (13%). Spain's emissions are due to the field burning of agricultural waste whilst for Portugal it is due to the manufacture of paper and cardboard below 20 tonnes per day.

Finally, a few Member States have relatively higher than average (55%) category iv emissions. This includes Estonia (80%), Hungary (80%), Latvia (82%), Romania (90%) and Slovenia (80%). For all of them, emissions from the domestic sector are the most important although for Hungary and Romania, road transport emissions are also significant.

4.2.17 Polycyclic aromatic hydrocarbons

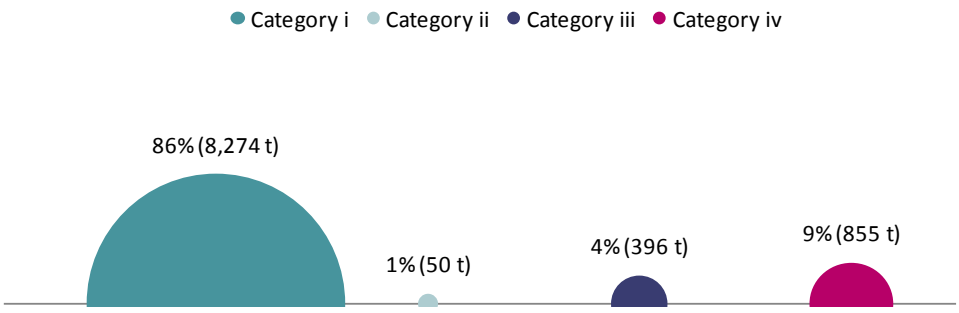
Description

Pure Polycyclic Aromatic Hydrocarbons (PAHs) are found as a crystalline solid. In the environment they will be absorbed onto particles of soot. PAHs have only been used for research purposes and are not intentionally manufactured. The majority of PAHs are released by combustion processes, evaporation from materials treated with creosote, mineral oils, pitch and also from surface run-off from bitumen roads. They can also be released naturally from forest fires. PAHs are a large group of chemicals which contribute to different harmful effects in the environment and to human health. Exposures to high concentrations of PAHs may affect the eyes, liver, skin, and immune system. Some PAHs also may cause genetic damage and cancer. They have an ability to travel long distances in the atmosphere when attached to soot particles. Therefore they can contribute to adverse effects occurring to wildlife in places far from the point of release (E-PRTR, 2013).

Summary

A total of 9.5 kt of PAHs was emitted to air across the EU27 in 2010. Figure 4.80 shows that category i activities contributed the vast majority of emissions (8.2 kt) with the main source being the production of paper and cardboard (8 kt, 82% of total PAH emissions). Category iv emissions amount to 9% of all PAH emissions (856 tonnes) with most arising from the domestic sector (797 tonnes). Overall emissions from category iii activities (396 tonnes) are mainly due to the field burning of agricultural waste (228 tonnes). Finally, 50 tonnes of PAHs were emitted by category ii activities, most of which were emitted by the processing of non-ferrous metals (26 tonnes) and activities using organic solvents (12 tonnes) both below the IED thresholds.

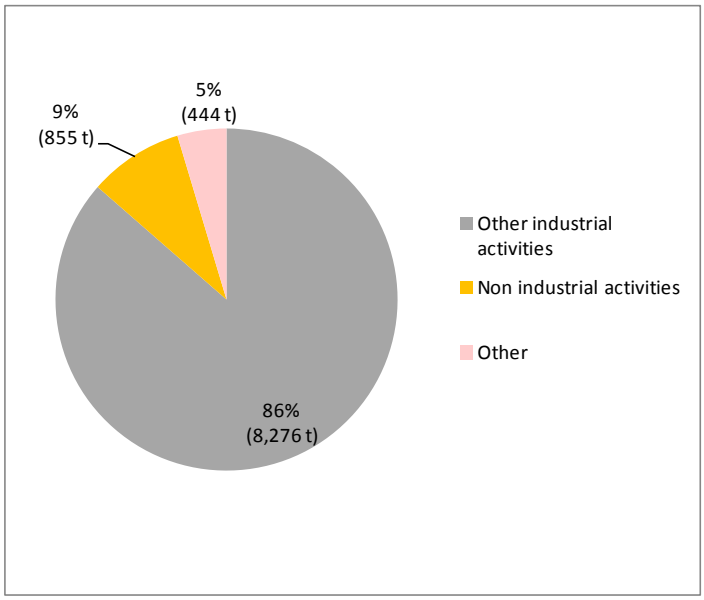
Figure 4.80 Air emissions of PAHs by category (in %) (total EU27 emissions= 9.5 kt)



Detailed analysis by group of activities

Emissions of PAH by main groups of activities are detailed in Figure 4.81 showing that emissions are dominated by other industrial activities.

Figure 4.81 Split of emissions of PAHs to air by group of activities (total EU27 emissions= 9.5 kt)



Note: emissions from smaller groups of activities (energy industry, waste management, production and processing of metals, mineral industry, chemical industry and agriculture) have been added to form the 'other' category due to their limited emissions.

Other industrial activities

A total of 8.2kt of emissions of PAHs has been emitted by this group of activities in 2010 with almost all (98%) arising from category i activities and more specifically from the production of paper and cardboard in IED regulated facilities (8kt). The production of wood panels (category i) accounts for 117 tonnes of PAH emissions.

Non-industrial activities

Within this group the vast majority of PAH emissions originate from the domestic sector (797 tonnes). The other emitters produce much smaller quantities e.g. road transport (30 tonnes) and commercial services (27 tonnes). All the emissions within this group fall in category iv.

Activities not described above

- **Agriculture**: A total of 2.3% of the total emissions of PAHs (228 tonnes) come from the field burning of agricultural waste;
- **Production and processing of metals**: This group of activities contributes 1% of the total emissions of PAHs (117 tonnes). Emissions are from all three categories with the production of pig iron and steel below 2.5 tonnes per hour (category iii) responsible for almost half of the total emissions (50 tonnes). Melting of non-ferrous metals under the IED thresholds (category ii) contributed 25 tonnes and the production of crude metals from ore (category i) contributed 11 tonnes;
- **Waste management**: All of the PAH emissions within this group (64 tonnes) arise from category i activities and in particular from waste incineration (63 tonnes);

- **Mineral industry**: This group of activities is responsible for a very small share (17 tonnes) of the total emissions of PAHs with the main contributors being the manufacture of glass (6.6 tonnes, category i) and the production of cement clinker below the IED threshold (5.3 tonnes, category ii);

- **Energy industry**: Less than 10 tonnes of PAHs have been emitted by the energy industries, the majority of which (5 tonnes) come from the refining of mineral oil and gas and combustion installations above 50 MWth (2 tonnes); and

- **Chemical industry**: The chemical industry is responsible for 9 tonnes of PAHs with all emissions from category i activities. The two largest emitting activities within this group are the manufacture of fertilisers (7.3 tonnes) and the production of organic chemicals (1.3 tonnes).

Additional comments at Member State level

The source of emissions of PAH varies greatly between Member States with no clear pattern of distribution as demonstrated in Figure 4.82.

Figure 4.82 Split of emissions of PAH to air by category for each Member State and EU27 as a whole (%)

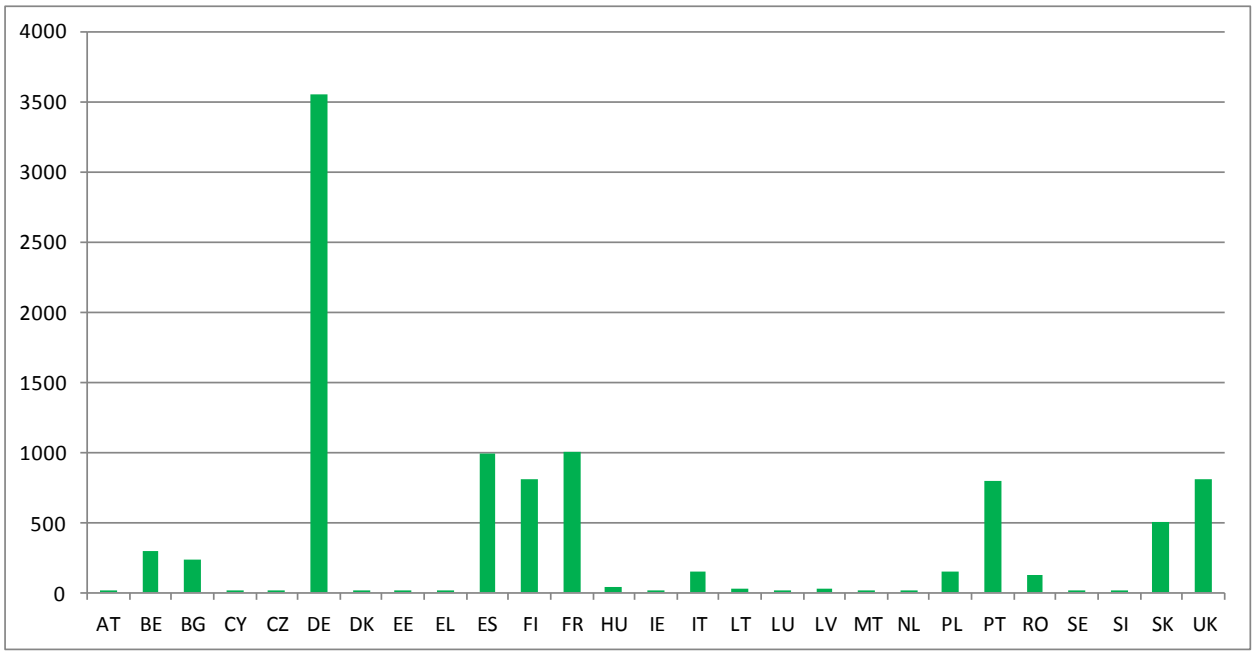
For almost half of the Member States, the majority of PAH emissions arise from category iv activities. This is particularly notable for Lithuania (100%), Luxembourg (100%), Ireland (99%), Latvia (99%), Malta (99%), Slovenia (99%), Estonia (97%), Sweden (95%), Poland (94%) and the Czech Republic (86%) where almost all emissions come from the residential sector.

When considering the Member States with the largest absolute quantities of emissions of PAHs (Germany, Spain, France, Finland, UK and Portugal - whose combined PAH emissions amount to 83% of the total EU27 emissions), it is apparent that the majority of their emissions are from category i and specifically from pulp and paper production.

For the following Member States the share of emissions from category iii is significantly larger than the EU average (4%): Greece (100%), Hungary (38%) and Cyprus (24%). These emissions are due to field burning of agricultural waste for Cyprus and Hungary and paper and cardboard production below 20 tonnes for Greece.

Figure 4.83 shows that there is a significant difference in the absolute quantities of PAHs emitted between Member States. It also shows that Germany is responsible for a large part of these emissions (36%) due to emissions from the production of paper and cardboard (category i).

Figure 4.83 Total emissions of PAH to air by Member State (in tonnes)



4.2.18 Polychlorinated biphenyls

Description

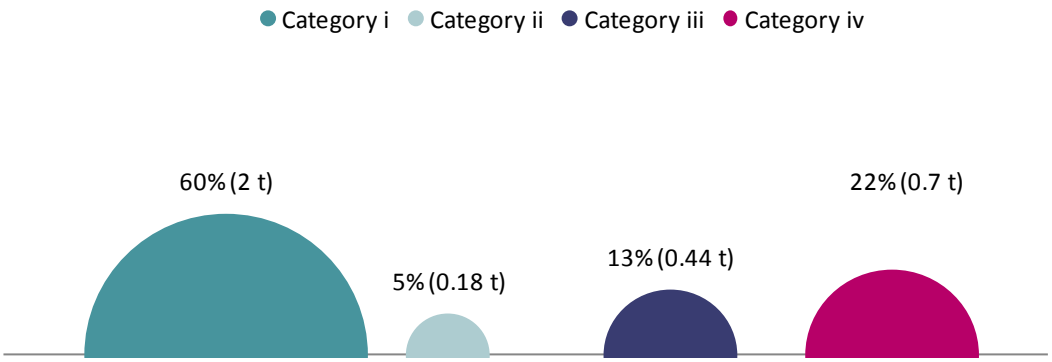
Polychlorinated biphenyls (PCBs) are usually colourless or yellow oily liquids or solids that have no odour. They are used mainly as electrical insulating material in capacitors and transformers and may be used as flame retardants. The main source of releases has been from their manufacture and use and leakage during disposal of PCB containing equipment. There are no natural sources of PCBs. Excessive exposure to PCBs may affect the brain, eyes, heart, immune system, kidneys, liver, reproductive system, skin, and thyroid gland. PCBs may also cause cancer and affect the unborn child. PCBs are toxic to wildlife, particularly aquatic organisms. They can cause serious reproductive and developmental problems and damage to the immune system. PCBs are categorised as a persistent organic pollutant (POP) (E-PRTR, 2013).

Summary

A total of 3.4 tonnes of PCBs was emitted to the atmosphere in 2010 at an EU27 level. Figure 4.84 presents the share of emissions by category. More than half of the emissions of PCBs fall within category i activities (2 t) primarily from waste incineration (1.2 tonnes), the manufacture of glass (0.45 t) and the production of paper and cardboard (280 kg). Emissions from non-industrial activities represent 0.7 tonnes of PCBs, of which 0.57t arise

from the domestic sector. A small share of emissions come from category iii activities (440 kg) and these are almost exclusively emitted by the production of pig iron or steel below 2.5 tonnes per hour. Finally, a total of 180 kg of PCBs was emitted by category ii activities from the recovery of non-hazardous waste (62 kg) and activities using organic solvents (63 kg) below the IED thresholds.

Figure 4.84 Air emissions of PCBs by category (in %) (total EU27 emissions = 3.4 tonnes)

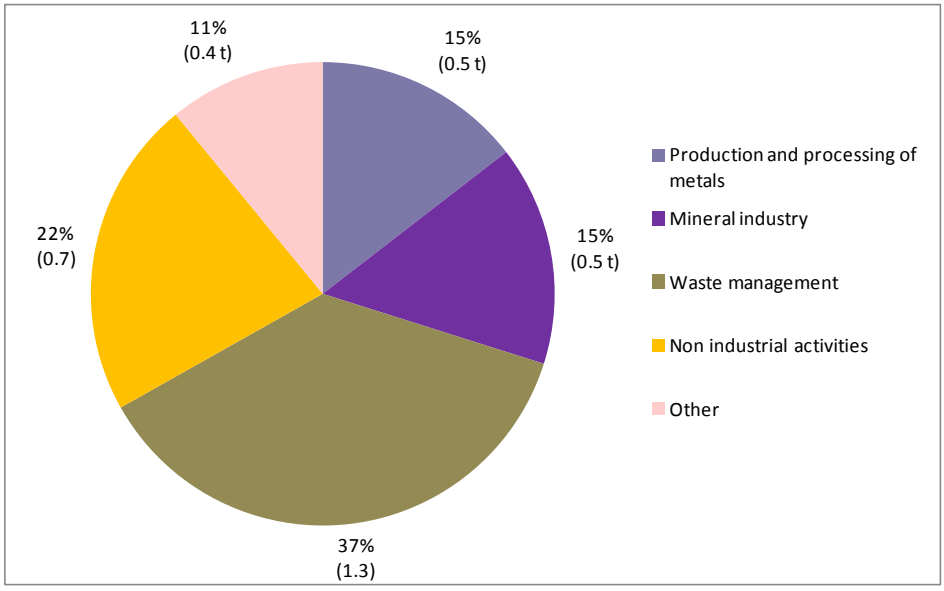


Detailed analysis by group of activities

Overview

Figure 4.85 presents the main sources of emissions of PCBs by main group of activities. It shows that more than half of the emissions (3.9 tonnes) arise from non-industrial activities. Waste management also contributes a significant share (1.2 tonnes) followed by the mineral industry (524 kg) and the production and processing of metals (500 kg).

Figure 4.85 Split of emissions of PCBs to air by group of activities (total EU27 emissions = 3.4 t)



Note: emissions from smaller groups of activities (energy industry, chemical industry, other industrial activities and agriculture) have been included in the category "Other" due to their limited emissions.

Waste management

A total of 1.26 tonnes of PCBs are emitted by activities included in this group, mostly from waste incineration (1.19 tonnes).

Non-industrial activities

The vast majority of emissions (0.57 tonnes out of 0.75 t) within this group come from the domestic sector. The road transport sector is responsible for 135 kg and is the second largest emitter in this group.

Mineral industry

A total of 525 kg of PCBs was emitted by the mineral industry with the majority from category i: the manufacture of glass (455 kg) and the production of cement clinker (40 kg). Emissions from category ii activities add up to less than 30 kg.

Production and processing of metals

From the total emissions arising from this group of activities (0.5 t), the large majority of emissions (430 kg) are from category i activities and specifically the production of pig iron and steel. Emissions under category iii are mostly due to the same activity conducted below the threshold of 2.5 tonnes per hour and amount to 41 kg of PCBs. The only category ii activity within this group for which emissions of PCBs were estimated is the melting of non-ferrous metals below the IED thresholds which accounts for 23 kg;

Activities not described above

- **Other industrial activities:** This group of activities is responsible for 360 kg of PCB emissions. The large majority arise from activities within category i and more specifically from the production of paper and cardboard (280 kg);
- **Energy industry**: Very few emissions (12 kg) of PCBs are emitted by the energy industry, all of which arise from category i activities;
- **Chemical industry**: No emissions of PCBs appear to arise from the chemical industry; and
- **Agriculture:** No emissions have been reported for the agricultural sector.

Additional comments at Member State level

Figure 4.86 shows that there is no consistent distribution of emissions of PCBs across the Member States. Furthermore, emissions data are missing for Austria, Denmark, Greece, Lithuania and the Netherlands.

Figure 4.86 Split of emissions of PCBs to air by category for each Member State and EU27 as a whole (%)

For some Member States such as Belgium, Spain and Portugal, PCB emissions are almost entirely arising from activities in category i, which is larger than the EU average (60%). Conversely for Bulgaria, Malta, Cyprus, Latvia, Estonia, Sweden and to a lesser extent Slovakia, category iv activities are responsible for almost all PCB emissions. For Bulgaria, Cyprus, and Estonia these emissions are from the domestic sector whilst in Latvia a significant part is from the commercial sector. For Malta and Sweden they arise from the shipping sector and in Slovakia from road transport.

For the Czech Republic, Germany, France, Hungary, Italy, Romania and the UK, most of the emissions arise from category iii and more specifically from the production of pig iron or steel below 2.5 tonnes per hour.

For Ireland, Finland, Romania and Slovenia, a significant share of emissions of PCBs arises from category ii activities. For Ireland and Finland these emissions are mainly due to the recovery of non hazardous waste below the IED thresholds whereas in Slovenia, they are from activities involving the use of solvents below the IED thresholds. For Romania, they arise from the processing of non-ferrous metals below the IED threshold.

Portugal, Poland and Spain are the main emitters of PCBs in Europe, their combined emissions represent 72% of the total EU27 emissions. It is of note that there are substantial differences between Member States in the sources of the emissions. In Poland almost all the emissions arise from the domestic sector. In Portugal, waste management activities are the main source of emissions accounting for 83% of total national emissions whilst in Spain, most emissions (89%) arise from the manufacture of glass.

5. Results: Water Emissions

5.1 Overview

The following section presents, for each pollutant, the total emissions to water broken down by activity and category. As described in Section 2, it is difficult to be precise as to the categorisation of activities that are not regulated under the IED or other EU legislation as, in theory, all pollutant sources that can affect the achievement of the objectives of EU water related legislation should be subject to appropriate measures. Therefore, they may or may not be 'regulated' depending on whether these objectives are at risk and whether the Member States have implemented EU water related legislation correctly.

Throughout this section of the report the following colours are used to distinguish the four defined categories:

Figure 5.1 Overview of the colour-coding per category

- category i
- category ii
- category ii/ iii
- category iv

As discussed in Section 3.3, it was not possible to combine the data from E-PRTR and Waterbase due to problems of data comparability, different reporting periods, reporting thresholds, etc. As a consequence, this section presents two separate sets of results: the first presents data for categories i and ii based on E-PRTR data (which provides a more robust dataset for IED activities) whilst the second shows results based on Waterbase, which provides a wider but less precise picture and for less Member States. It was not possible to separate out categories ii and iii within the Waterbase dataset, and for this reason data for category ii and category iii are presented as a combined category ii/iii. Category iv presents emissions data from non (agro-)industrial activities.

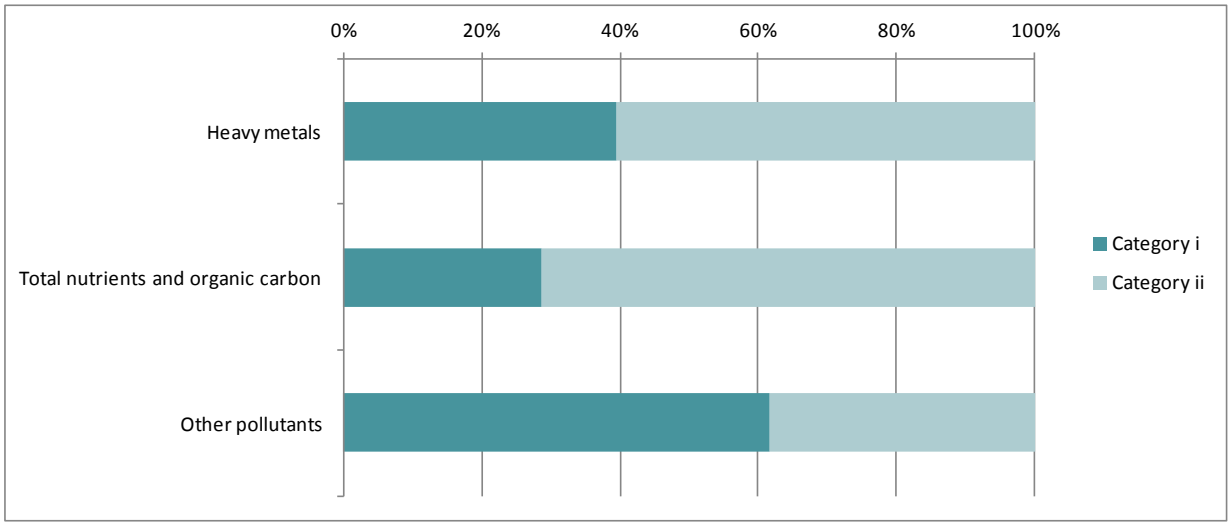
5.1.1 Summary of emissions

A summary of the total emissions to water reported in the E-PRTR for each pollutant is provided in Figure 5.2. In order to facilitate the presentation of resulting data in this overview, pollutants have been placed in three groups. The split has been informed by the nature of the pollutants (e.g. heavy metals) with a third category providing a catch-all of 'other pollutants'. The groups are:

- **Heavy metals**: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;
- **Nutrients and TOC**: nitrogen, total organic carbon, phosphorous; and

- **Other**: 1,2-dichloroethane, chlorides, cyanides (as total CN), Di (2-ethylhexyl) phthalate (DEHP), fluorides, halogenated organic compounds, phenols.

Figure 5.2 Overview of relative split by category from water pollutant emission groups based on E-PRTR data

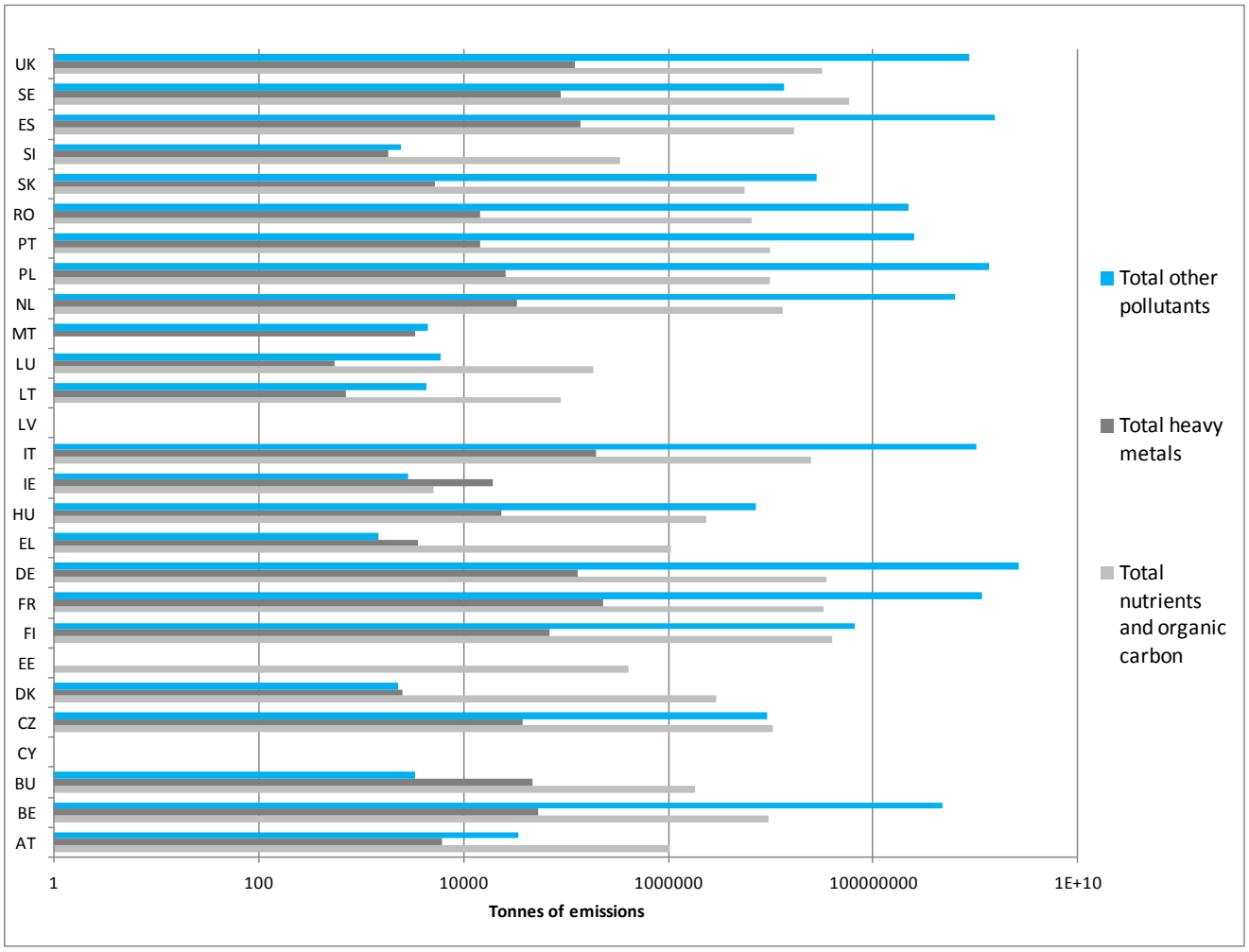


For the three pollutant groups, category ii activities contribute a substantial percentage to the total emissions. This is particularly apparent for total nutrients and organic carbon (major pollutants from UWWT plants), and for a range of heavy metals which enter into waste water, but which are less of a focus for treatment prior to discharge. In contrast, more than 60% of emissions from 'other pollutants' are in category i and captured under the IED.

5.1.2 Overall emissions by Member State

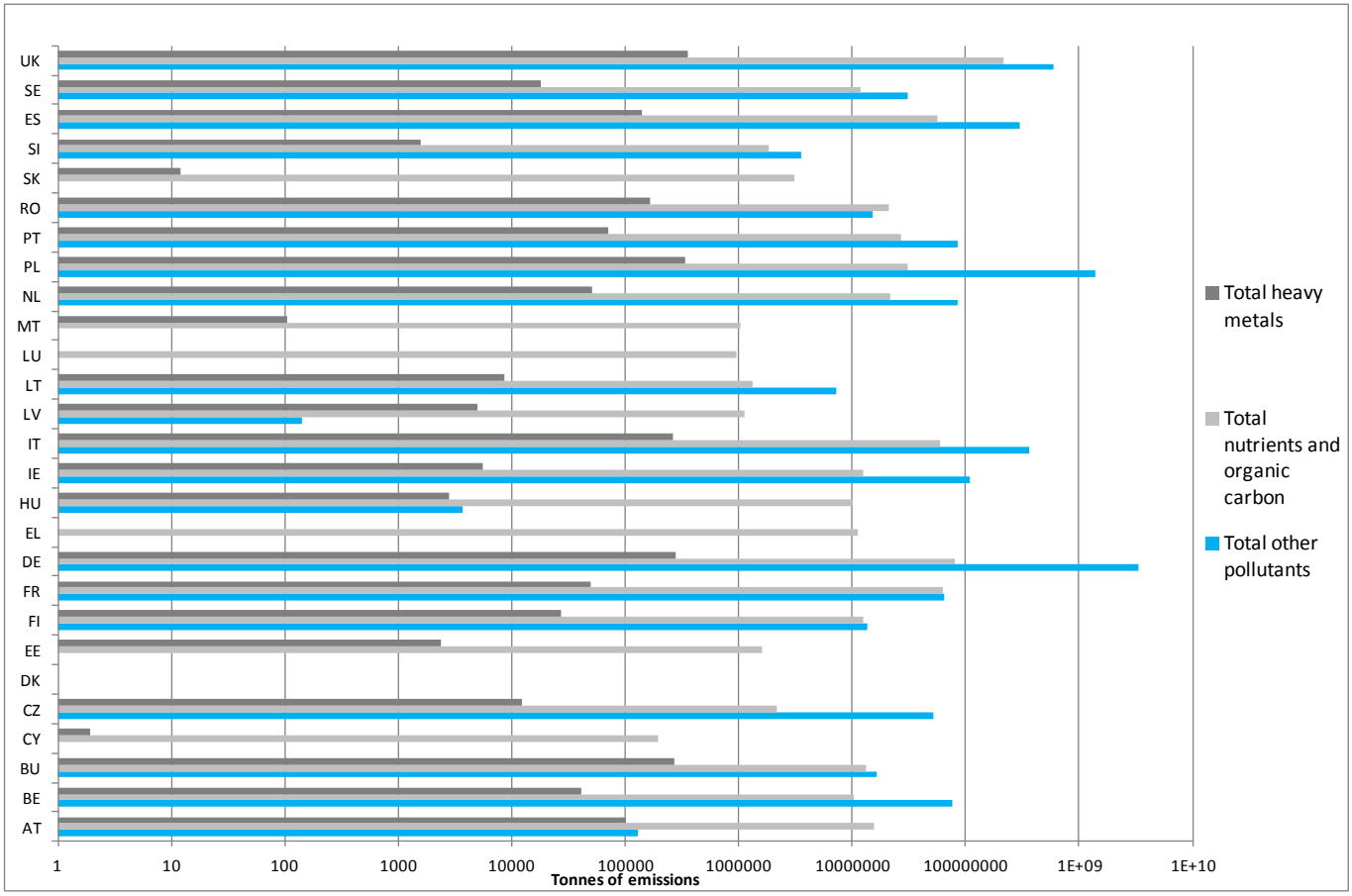
It should be noted, however, that these results only provide an indication of the level of emissions captured under the IED or other EU legislation. For some activities there are a few instances where substances are reported only once, it is not clear whether this reflects the rarity of its discharge or the limited reporting (and/or possible limitations of the E-PRTR emissions reporting thresholds. Data for some pollutants is skewed by individual Member States reports. For example, the UK reports high emissions of ethyl benzene from thermal power stations, which is not the case for other Member States. The variation in Member State reporting is illustrated by Figure 5.3 and Figure 5.4 for category i and category ii emissions broken down by the three main pollutant groups as described above.

Figure 5.3 Emissions of water pollutants by Member State for category i reported in E-PRTR (in tonnes, 2010)



Note: Results are presented on a logarithmic scale

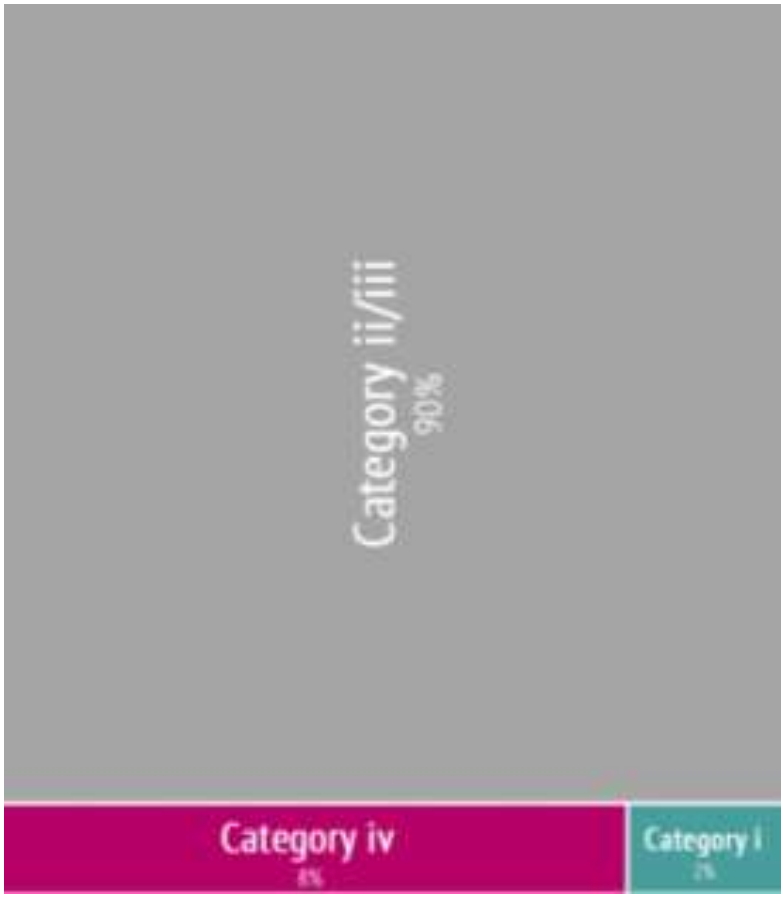
Figure 5.4 Emissions of water pollutants by Member State for category ii reported in E-PRTR (in tonnes, 2010)



Note: Results are presented on a logarithmic scale

Figure 5.5 presents the sum and relative splits (based on mass) of emissions to water for the 20 pollutants examined aggregated for the categories as reported in Waterbase.

Figure 5.5 Overall partition of emissions of water pollutants per category in 15 Member States (Source: Waterbase)



The key conclusions that can be drawn from this are:

- Due to the focus of EU water legislation, the majority of emissions reported by Member States are from (agro-)industrial activities that are considered to be subject to EU legislation affecting emissions but not specifically targeting them. Category ii and iii emissions therefore make up the overwhelmingly largest share of the total (90%) but it remains unclear to what extent these could be considered 'unregulated';

- IED regulated activities (Category i) make up only 2% of the total share using Waterbase data. E-PRTR data suggests this figure is higher and may lie at or above 20%; and

- Non (agro-)industrial activities (Category iv) make up only a small proportion as the water discharges from commercial, domestic and other activities should, in the main, be captured by the UWWTD.

As with the presentation of the E-PRTR data, to facilitate presentation pollutants have been combined into three groups as informed by the nature of the pollutants, namely:

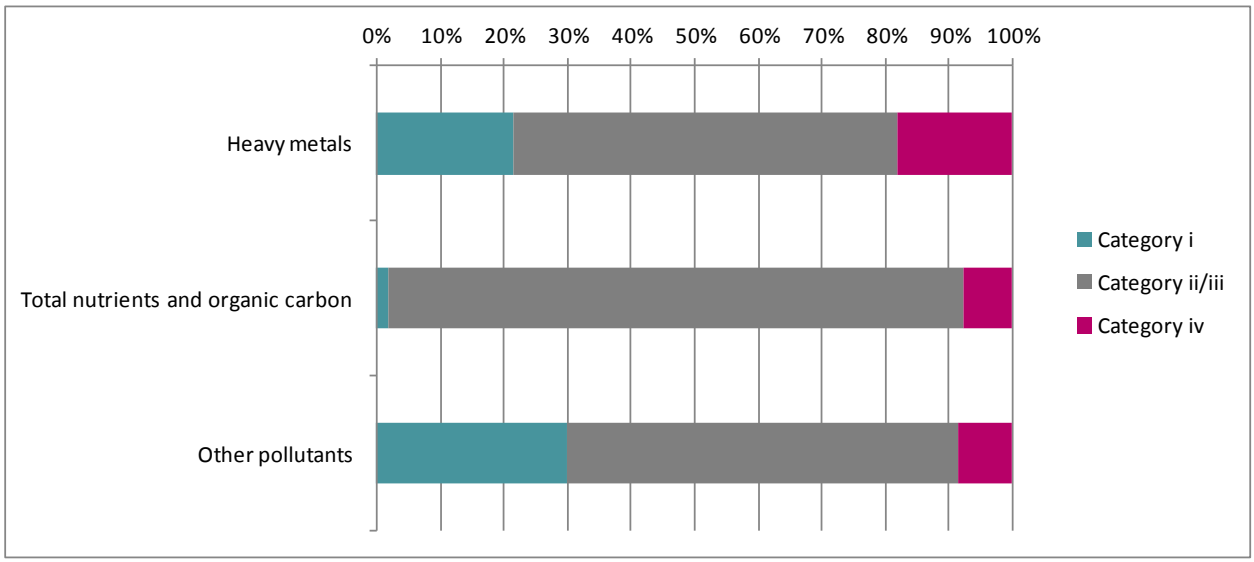
- **Heavy metals**: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;

- **Nutrients and TOC**: nitrogen, total organic carbon, phosphorous; and

- **Other**: 1,2-dichloroethane, chlorides, cyanides (as total CN), Di (2-ethylhexyl) phthalate (DEHP), fluorides, halogenated organic compounds, phenols.

Using Waterbase data, Figure 5.6 presents the percentage of emissions belonging to each category for the three key pollutant groupings. Figures 5.6, 5.7 and 5.8 further delineate the data, to present the categories' partitions by pollutant.

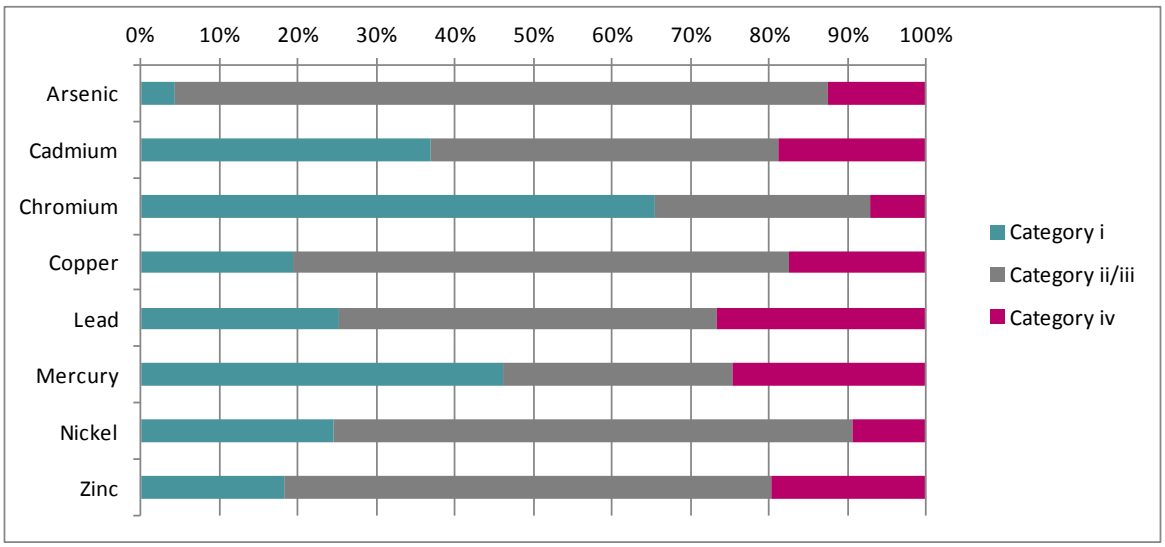
Figure 5.6 Overview of relative partitions for categorisation of main water pollutant emission groups (Waterbase data)



The data shows that for the three groups of pollutants, the majority of the emissions are included in category ii/iii. Category i emissions are variable, for heavy metals and other pollutants, category i represents between 20-30% of the total emissions. However, for nutrients and organic carbon, the share of regulated emissions is smaller with around 3% of the total emissions. Emissions from non-industrial activities are more important for heavy metals, representing almost 20% of the total emissions.

5.1.3 Heavy metals

Figure 5.7 Overview of relative partitions for categorisation of heavy metal water pollutants

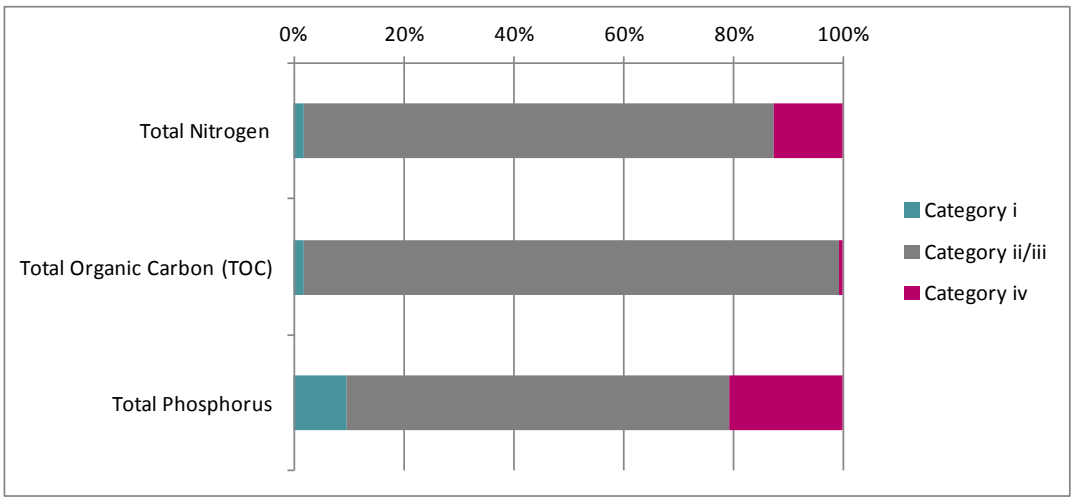


The following observations can be made based on the results presented in Figure 5.7:

- Copper, lead, nickel and zinc emissions' partitions are similar with 20-25% of emissions in category i, 10-25% of emissions in category iv and the rest in category ii/iii;
- Arsenic is the pollutant with the most emissions from category ii/iii; and
- Cadmium, chromium and mercury have a significant part (35-65 %) of their emissions already regulated by the IED (category i).

5.1.4 Nutrients and total organic carbon

Figure 5.8 Overview of relative partitions for categorisation of nutrients and TOC pollutants

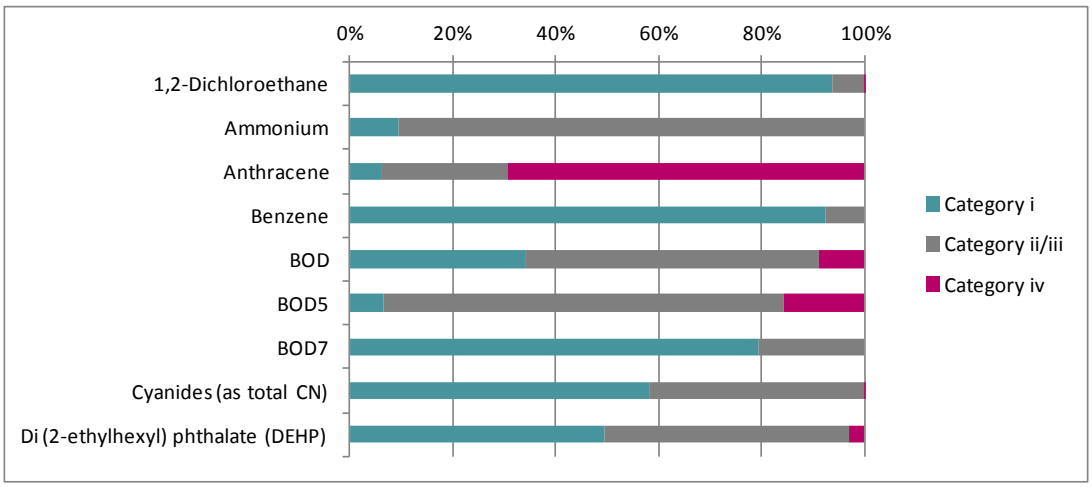


The following observations can be made based on the results presented in Figure 5.38:

- Emissions of total nitrogen and phosphorus are mainly emitted from category ii/iii activities, with 15-20% due to non-industrial activities. A share of emissions of total phosphorus is already regulated with nearly 10% of emissions in category i, whereas total nitrogen emissions in category i represent less than 5% of the total emissions; and
- Emissions from total organic carbon are almost entirely due to category ii/iii activities.

5.1.5 Other pollutants

Figure 5.9 Overview of relative partitions for categorisation of other pollutants



The following observations can be made based on the results presented in Figure 5.9:

- 1,2-Dichloroethane, benzene and to a lesser extent BOD7 have the majority of their emissions in category i (80-95%). This means that for these pollutants, most of the emissions reported under Waterbase seems to already be regulated;
- Ammonium, anthracene and BOD5 have a smaller share of emissions from category i activity (5-10%) with most of their emissions from category ii/iii (ammonium and BOD5) and category iv (anthracene); and
- Cyanides and Di phthalate emissions are split almost equally between category i and category ii/iii, with a small share of emissions from category iv activities.

The following sections describe the sources of emissions for the selected pollutants. The pollutants chosen are those with good data coverage in E-PRTR and/or Waterbase (see Section 3.3).

5.2 Emissions by pollutant and activities

This section presents the results of emissions to water by pollutant using a standard structure designed to provide information, in line with the terms of reference for the study, across a number of different areas including:

- The initial summary presents emissions data per category (i, ii, ii/iii and iv where relevant) as reported in the E-PRTR and Waterbase (one chart per source); and
- The discussion part includes an analysis of the emission data and comparison of the reported data when present under both databases.

5.2.1 1,2-dichloroethane (DCE)

Summary

Figure 5.10 provides an overview of the emissions of DCE (in kg) for category i and category ii from the E-PRTR for 2010.

Figure 5.10 Emissions to water of 1,2-dichloroethane (DCE) by category (in %) (total = 7,097 kg) (Source: E-PRTR)

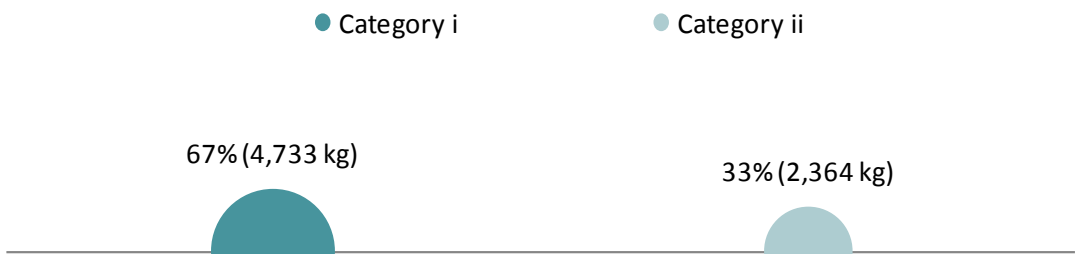
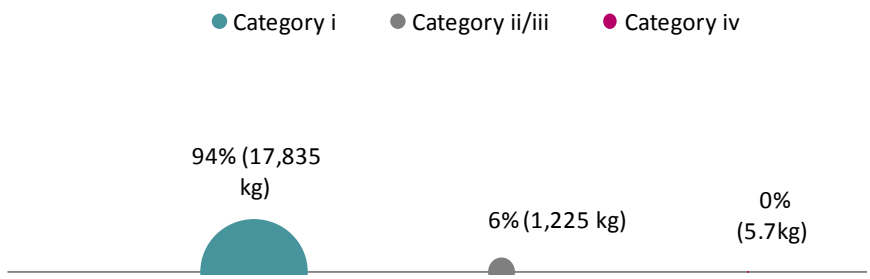


Figure 5.11 provides a breakdown of emissions of DCE by category from Waterbase data.

Figure 5.11 Emissions to water of 1,2-dichloroethane (DCE) by category (in %) (total = 19,066 kg) (Source: Waterbase)



Discussion

E-PRTR data are relatively limited, however the percentage of emissions from category ii activities is around 33% of the total E-PRTR emissions. Eleven Member States did not provide any reports of DCE emissions. For category i, France is responsible for about 30% of total emissions reported, followed by Spain and Hungary. For category ii, Italy is responsible for 60% of the total emissions reported, with Poland reporting a further 21% of emissions.

IED emissions (category i) are entirely from installations manufacturing plastics and chemicals and are most prominent in the larger manufacturing Member States (France, Hungary, Poland, Slovakia and Spain). All non-IED emissions are reported from discharges from waste water treatment plants (i.e. sewage).

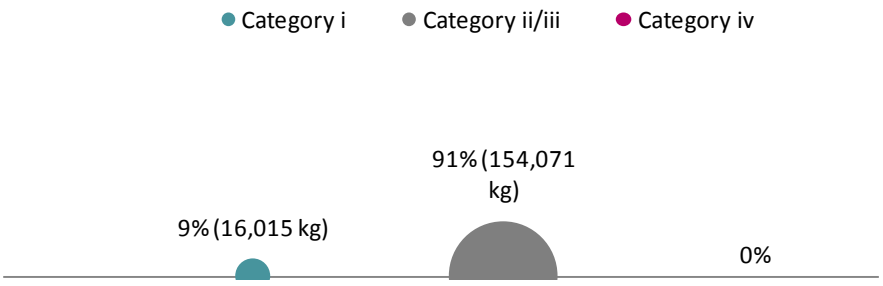
Waterbase data shows that reported emissions of DCE are almost entirely (94%) from IED regulated industrial sources, with the other 6% reported for category ii/iii activities (all from sewage sources). Interestingly, the relative importance of sewage as a source compared to industry is much lower in Waterbase than in E-PRTR.

5.2.2 Ammonium

Overview

E-PRTR does not report emissions of this pollutant to water. Figure 5.12 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.12 Emissions to water of ammonium by category (in %) (total = 170,086 kg) (Source: Waterbase)



Discussion

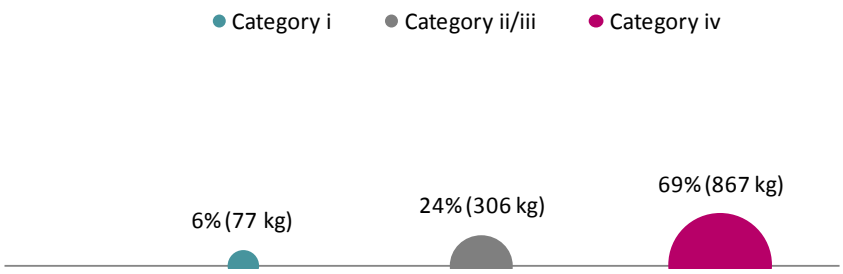
Category i industrial activities account for 9% of emissions, whilst sewage sources and unspecified direct discharges (all category ii/iii) account for 91% of emissions reported in Waterbase. The importance of wastewater treatment is to be expected given its importance as a source of nitrogen emissions to water and the reducing conditions within WWTPs generating ammonium. It should be noted that Waterbase reports no emissions from the agriculture sector, although some might be expected, such as where ammonium sulphate is used as a fertiliser.

5.2.3 Anthracene

Overview

The data reported under E-PRTR are too limited to be of use in this analysis. Figure 5.13 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.13 Emissions to water of anthracene by category (in %) (total = 1,250 kg) (Source: Waterbase)



Discussion

Anthracene is used in manufacturing processes such as for dyes. Only 6% of the reported anthracene emissions are from industrial sources (category i). 24% of sources are from WWT and direct unspecified discharges (category ii/iii). The largest emissions (69%) are reported within category iv (diffuse and atmospheric sources).

5.2.4 Arsenic and compounds

Overview

Figure 5.14 provides an overview of the emissions of arsenic and arsenic compounds (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.14 Emissions to water of arsenic and compounds by category (in %) (total = 53,736 kg) (Source: E-PRTR)

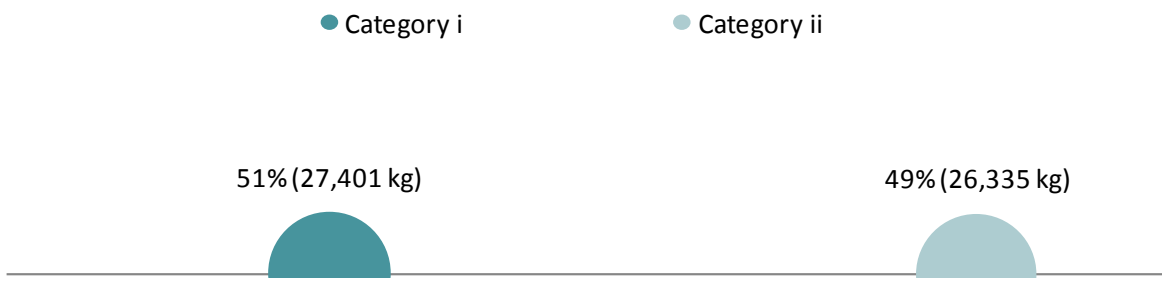
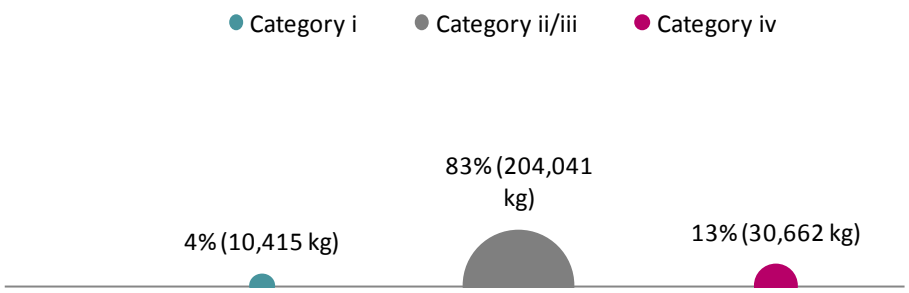


Figure 5.15 presents a breakdown of emissions by major sources reported in Waterbase.

Figure 5.15 Emissions to water of arsenic and compounds by category (in %) (total = 245,118 kg) (Source: Waterbase)



Discussion

The E-PRTR data shows that less than 50% of emissions of arsenic arise from category ii activities. Data has been reported by most Member States within E-PRTR, with the largest emissions arising from the larger, manufacturing Member States (Italy, UK, Ireland, Italy, Bulgaria and Poland). Three Member States do not provide any reports of arsenic emissions. For category i, Italy is responsible for over a third of reported emissions, significantly higher than the next largest emitters – the UK, France and Spain, with important secondary emissions from pulp processes. For category ii, Italy also reports about a third of the total emissions, followed by the UK and Poland. The category ii activity that emits most arsenic is sewage sources. Small additional emissions are reported from sawmills and mining. Given the limited data reported for the mining sector in E-PRTR, it is likely that this source is under reported and that the emissions are higher.

Waterbase presents a very different picture for arsenic discharges, with far higher total values reported. By far the largest source of emissions recorded is riverine inputs to coastal waters. This difference may be explained by the fact that E-PRTR only covers category i and a small part of category ii emissions, as a result emissions from riverine inputs to coastal waters are not accounted in E-PRTR.

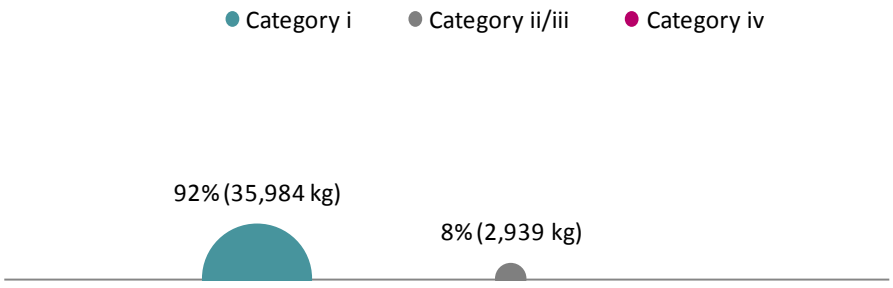
5.2.5 Benzene

Overview

The data reported under E-PRTR are too limited to be of use in this analysis as most of the emissions are reported from the UK and for IED activities (category i).

Figure 5.16 provides a breakdown of emissions of benzene by major sources from Waterbase data.

Figure 5.16 Emissions to water of benzene by category (in %) (total = 38,923 kg) (Source: Waterbase)



Discussion

Benzene arises from several sources. Industrial (category i) emissions provide the majority (92%) of the total reported emissions in Waterbase. Category ii account for around 8% of the total benzene emissions with most of them emitted from WWTPs.

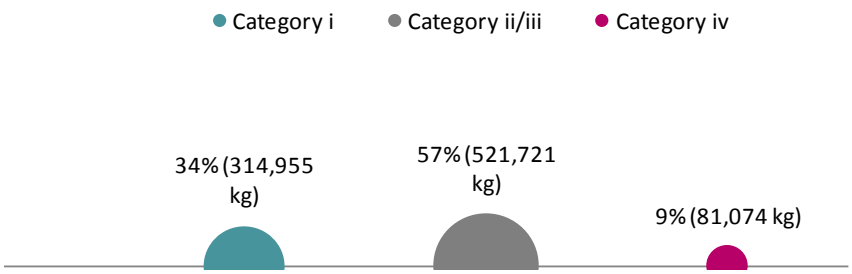
5.2.6 Biological Oxygen Demand (BOD)

Overview

E-PRTR does not report emissions of this pollutant to water.

Figure 5.17 provides a breakdown of emissions of BOD by major sources from Waterbase data.

Figure 5.17 Emissions to water of BOD by category (in %) (total = 917,750 kg) (Source: Waterbase)



Discussion

BOD emissions can arise from several sources with industrial sources (category i) accounting for 34% of reported emissions. Category iv accounts for a smaller share of reported emissions (9%), which mostly arise from urban diffuse pollution. Finally, category ii accounts for the largest proportion of reported emissions (57%). This is overwhelmingly due to emissions from WWTPs, which are a well-known source of BOD. Agricultural emissions are reported, but these are negligible compared to the overall emissions within category ii.

5.2.7 Cadmium and compounds

Overview

Figure 5.18 provides an overview of the emissions of cadmium (in kg) for categories i and ii from the E-PRTR data for 2010.

Figure 5.18 Emissions to water of cadmium and compounds by category (in %) (total = 18, 026 kg) (Source: E-PRTR)

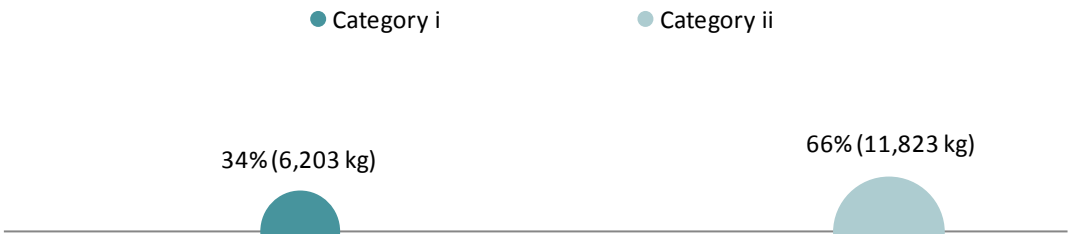
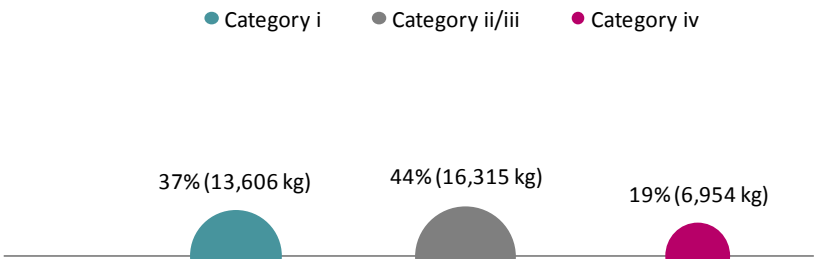


Figure 5.19 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.19 Emissions to water of cadmium and compounds by category (in %) (total = 36,875 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that 66% of cadmium emissions arise from category ii activities. Cadmium emissions are reported by a number of Member States under E-PRTR, although there are some gaps. Five Member States did not report cadmium emissions. For category i several Member States reported significant emissions, including Italy, Bulgaria, the UK and France. For category ii, the largest reports are provided by Italy, Bulgaria, France, Poland and Portugal. The main category i sources of emissions are different metal processing activities, glass manufacture, pulp processing, waste activities, etc. Member States report a number of category ii activities as being important for cadmium discharges including sewage sources and mining. Within limited reporting on the last activity, the importance of category ii is likely to be greater than is suggested by the data.

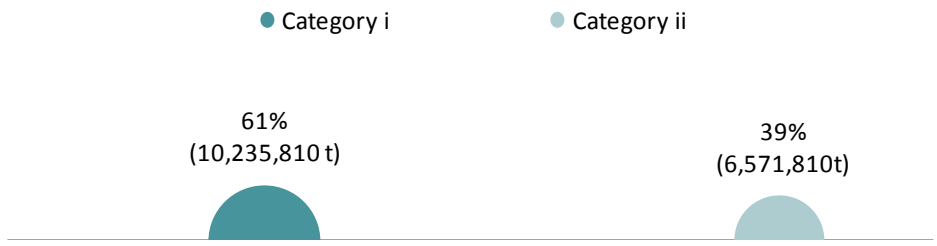
Cadmium is reported for most activities within Waterbase. Industrial discharges (category i) is one of the largest source of emissions which account for nearly 37% of reported emissions. Emissions from category ii sources account for 44% and emanate mainly from sewage sources. Agriculture is also an important contributor with nearly 9% of the total cadmium emissions. Category iv activities account for 19% of emissions, and originate largely from urban diffuse sources.

5.2.8 Chlorides

Overview

Figure 5.20 provides an overview of the emissions of chlorides (in tonnes) for categories i and ii from E-PRTR data for 2010. Eight Member States did not report any chloride emissions. For category i emissions, the largest reports were provided by Germany, Spain, Poland, France and Italy. For category ii the largest reports were provided by Germany and Poland.

Figure 5.20 Emissions to water of chlorides by category (in %) (total = 16,807,620 tonnes) (Source: E-PRTR)



Emissions of chlorides are not reported under Waterbase.

Discussion

The E-PRTR data show that 39% of chloride emissions arise from category ii activities. The majority of the emissions are emitted by a wide range of category i activities, including refineries, gasification, chemicals processes and metal processes. Within category ii, the most commonly reported source of chloride emissions is sewage sources. However, where it is reported, mining is a major source, in particular for mining of underground salt.

5.2.9 Chromium and compounds

Overview

Figure 5.21 provides an overview of the emissions of chromium and chromium compounds (in kg) for categories i and ii from E-PRTR data for 2010. Four Member States did not provide reports of chromium emissions. For

category i, the largest emission reports were from Italy (41%) followed by Spain and Germany. For category ii, Italy is also responsible for the largest reports (36%), followed by the UK and Poland.

Figure 5.21 Emissions to water of chromium and compounds by category (in %) (total = 258,605 kg) (Source: E-PRTR)

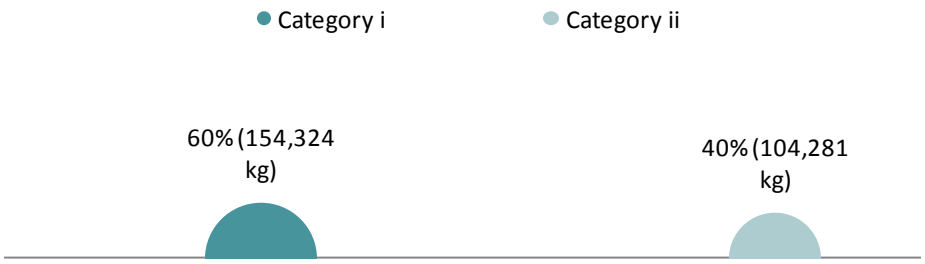
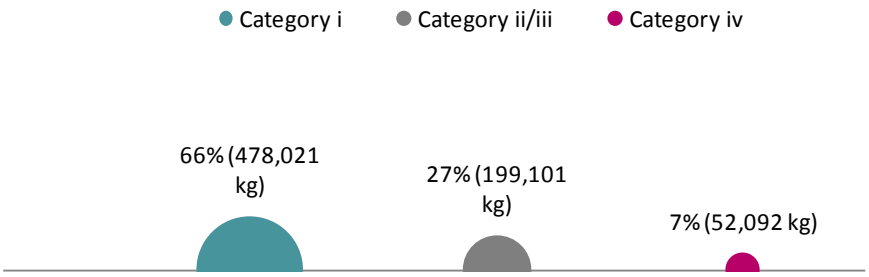


Figure 5.22 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.22 Emissions to water of chromium and compounds by category (in %) (total = 729,214 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that the principle sources of chromium emissions (60%) are activities located within category i such as thermal combustion, metal, some chemical processes and pulp processing. The 40% of chromium emissions remaining arise from category ii activities. Within category ii a range of sources are reported, however sewage is the main significant source. Some emissions are reported for mining activities, but these are limited and this source is probably under reported.

Industrial sources (category i) are also the largest contributors to chromium emissions within Waterbase (66%). Category ii activities account for 27% of emissions reported in Waterbase (mainly from sewage and a small contribution from agriculture). Other large sources are reported within Category iv (7%), by far the largest of which are urban diffuse sources.

5.2.10 Copper and compounds

Overview

Figure 5.23 provides an overview of the emissions of copper and copper compounds (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.23 Emissions to water of copper and compounds by category (in %) (total = 454, 168 kg) (Source: E-PRTR)

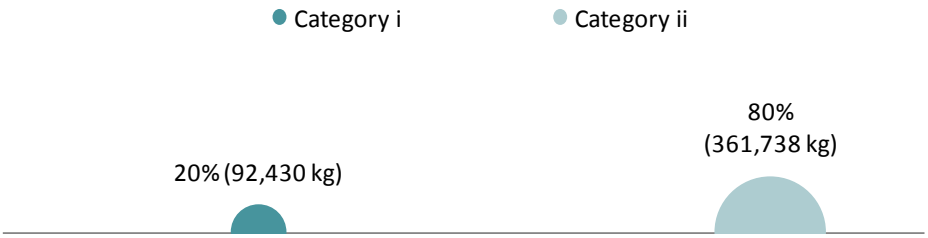
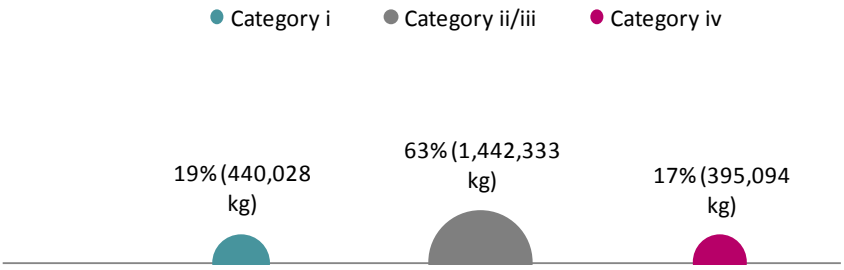


Figure 5.24 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.24 Emissions to water of copper and compounds by category (in %) (total = 2,277,455 kg) (Waterbase)



Discussion

The E-PRTR data show that 80% of emissions of copper arise from category ii activities. Only Cyprus did not report emissions of copper. For category i the largest reported emissions are from German, Italy, the UK and France. For category ii, 30% of emissions are reported by the UK, with large emissions reported also by Romania, Germany, France and Italy. Within category ii the most commonly reported source is sewage, which accounts for most emissions. However, mining is also reported as a key contributor and open cast mining in Romania is responsible for 20% of the total reported category ii emissions for copper. Furthermore, the UK reports an additional activity, aquaculture, which is responsible for 17% of the total reported category ii emissions for copper. Given that emissions reported for both of these types of activities are limited within E-PRTR, it is likely that category ii is of greater importance than is evident from the data. The remaining emissions arise from a wide range

of different category i activities, including thermal combustion, waste incineration, metal and chemical processes. Pulp processes are minor contributors to category i emissions.

Within Waterbase copper is reported as emitted from most of the categories of activities. For example industrial sources (category i) account for 19% of reported emissions and activities in category ii account for 63% of the total emissions. The main activity within category ii is sewage sources, but agricultural emissions account for 8% of overall copper emissions in Waterbase. Category iv accounts for the largest proportion of emissions (17%). Contributions within this group include urban diffuse sources and atmospheric deposition.

5.2.11 Cyanides

Overview

Figure 5.25 provides an overview of the emissions of cyanides (in kg) for categories i and ii from E-PRTR data for 2010. Eight Member States did not provide reports of cyanide emissions. For category i, Italy accounts for 23% of emissions, with large emissions reported also from Spain, the Netherlands and Germany. For category ii, Italy accounts for 30% of the emission reports, with large reports also from the UK, Portugal, Germany and Poland.

Figure 5.25 Emissions to water of cyanides by category (in %) (total = 198,226 kg) (Source: E-PRTR)

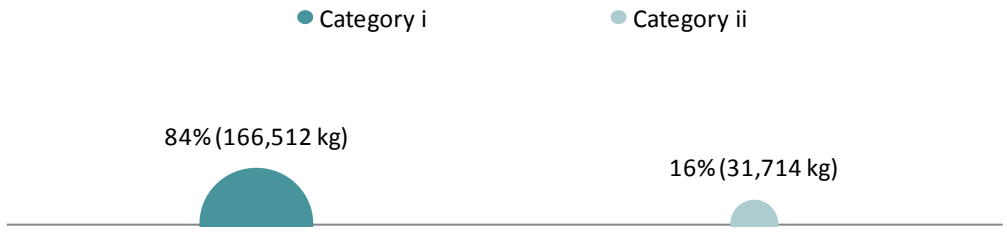
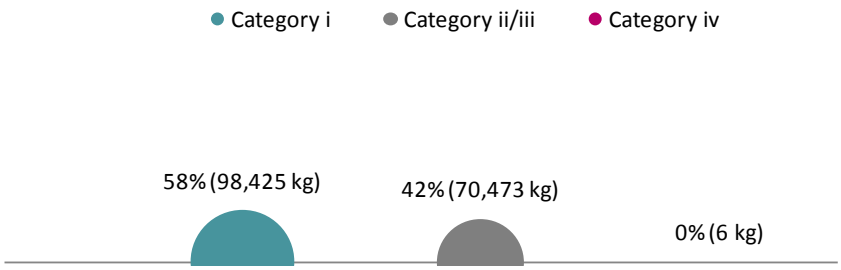


Figure 5.26 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.26 Emissions to water of cyanides by category (in %) (total = 168,904 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that 16% of emissions of cyanides arise from category ii activities. The remaining emissions (84%) reported in E-PRTR are from category i sources which include a wide range of types of installations such as refineries, metal processes and chemical processes. Within category ii sewage sources contribute the most to cyanide emissions. However mining activities are also a source of emissions.

For Waterbase, industrial sources (category i) account for 58% of reported emissions. Category ii activities account for 42% of emissions of which direct discharges to coastal and transitional waters are the largest contributors. They are followed by emissions from sewage sources. Category iv is represented by a negligible input from atmospheric deposition.

5.2.12 Di-(2-ethyl hexyl) phthalate (DEHP)

Overview

Figure 5.27 provides an overview of the emissions of DEHP (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.27 Emissions to water of di-(2-ethyl hexyl) phthalate (DEHP) by category (in %) (total = 24, 752 kg) (Source: E-PRTR)

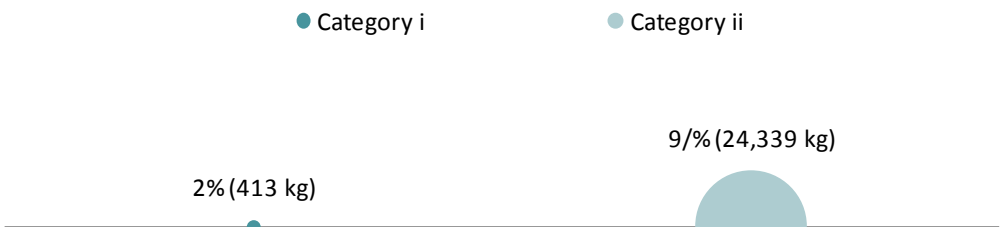
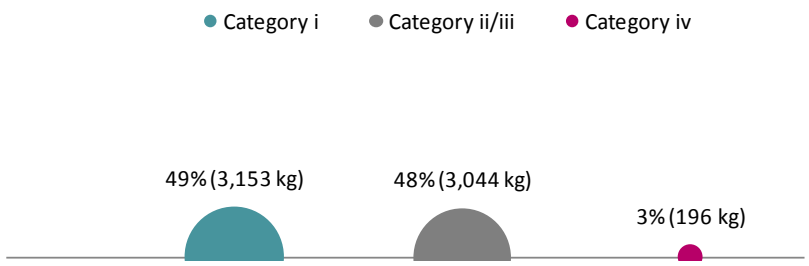


Figure 5.28 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.28 Emissions to water of di-(2-ethyl hexyl) phthalate (DEHP) by category (in %) (total = 6,393 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that the overwhelming majority of emissions (98%) arise from category ii activities, and more specifically from WWTPs. However, ten Member States did not report DEHP emissions. For category i, France accounts for about half of the reported emissions, with significant share of emissions also reported from the Netherlands and Slovakia. For category ii, 88% of emissions are reported by the UK. Overall, small quantities of DEHP are emitted by a wider range of category i installations which includes refineries, landfills, chemical manufacture, smelting and paper and paperboard manufacture.

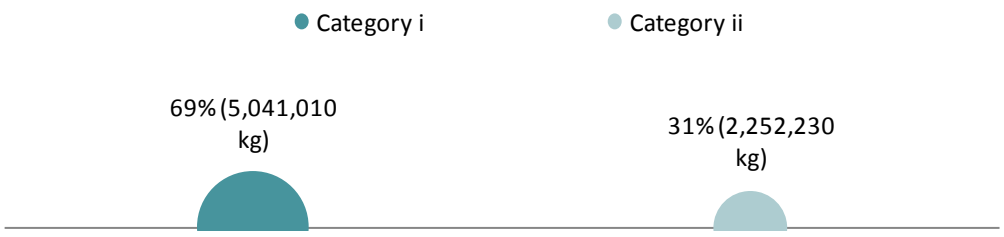
In Waterbase industrial discharges (category i) are an important contributor of emissions (49%) and, in contrast to E-PRTR, category ii emissions account for only 48%, of which WWTPs are the largest contributor. There are also important contributions from direct discharges to coastal and transitional waters. Category iv is responsible for only 3% of reported emissions, all of which are of atmospheric origin.

5.2.13 Fluorides

Overview

Figure 5.29 provides an overview of the emissions of fluorides (in kg) for categories i and ii from E-PRTR for 2010.

Figure 5.29 Emissions to water of fluorides by category (in %) (total = 7,293,240 kg) (Source: E-PRTR)



Fluoride emissions are not reported under Waterbase.

Discussion

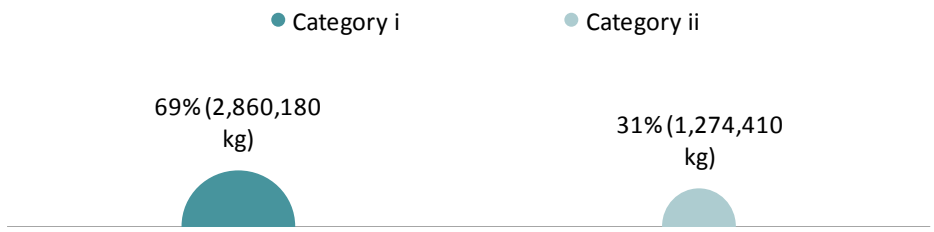
The E-PRTR data show that 31% of emissions of fluorides arise from category ii activities. Six Member States did not report fluoride emissions. For category i, nearly 25% of emissions were reported by Bulgaria, with very significant reports from Poland, Germany, the UK and the Netherlands. For category ii, half of emissions are reported by the UK. The remaining emissions are split between other reporting Member States with only Germany reporting more than 10% of total emissions. The remaining emissions (69%) are from an extremely wide range of category i activities including thermal power stations, refineries, most metal processing and coating activities, manufacture of fertilisers and different chemical processes. Within category ii, sewage is the most commonly and largest reported source of fluorides (e.g. it accounts for all UK emissions in category ii which represents half of the total E-PRTR fluoride emissions). Both underground and open-cast mining are sources of emissions but the fluoride emissions reported are very limited and it is possible that the quantities of emissions are under reported.

5.2.14 Halogenated organic compounds

Overview

Figure 5.30 provides an overview of the emissions of halogenated organic compounds (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.30 Emissions to water of halogenated organic compounds by category (in %) (total = 4,134,590 kg) (Source: E-PRTR)



Halogenated organic compounds emissions are not reported under Waterbase.

Discussion

The E-PRTR data show that around 31% of emissions of halogenated organic compounds arise from category ii activities. Emissions reported are limited with ten Member States not reporting halogenated organic compound emissions. The emissions reported are also uneven, with about a third of category i emissions reported by Finland and large share of emissions from Sweden, Spain, France and Hungary. For category ii, the emissions reported by the UK account for about a third of emissions, followed by Poland and Spain. The most important source in this category is sewage. The majority of the emissions (69%) arise from category i installations such as refineries, metal processes, surface treatment, chemicals manufacture (e.g. plastics, biocides), pulp and paper processes and landfills.

5.2.15 Lead and compounds

Overview

Figure 5.31 provides an overview of the emissions of lead and lead compounds (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.31 Emissions to water of lead and compounds by category (in %) (total = 155,184) (Source: E-PRTR)

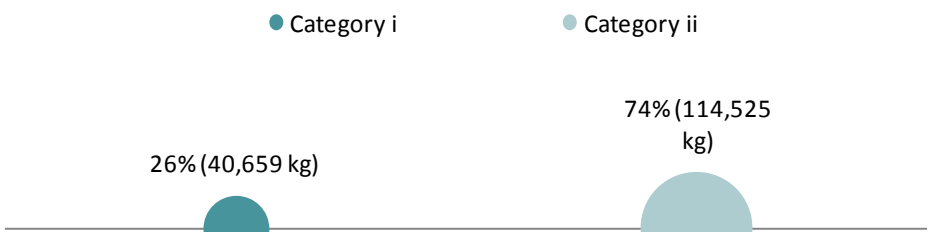
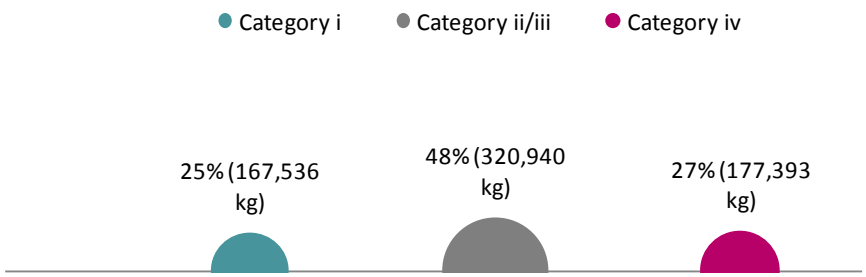


Figure 5.32 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.32 Emissions to water of lead and compounds by category (in %) (total = 665,869 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that the majority (74%) of emissions of lead arise from category ii activities with the most commonly reported source of emissions sewage treatment works, followed by underground and open cast mining. Emissions from open cast mining are reported by a limited number of Member States and it is expected that this source is in reality more important than depicted in the E-PRTR data. For category i, emissions are distributed across the Member States, with the largest reported by Italy, Spain and the UK. Emissions reported under category ii are more uneven, with the largest emissions reported from Poland and Italy (41% and 16% of emissions respectively), followed by France, UK and Bulgaria. The remaining emissions (26%) are from category i emissions from installations such as thermal power stations, refiners, metal processing activities, landfills, pulp and paper manufacture and animal raw materials processing.

Waterbase includes sources of emissions of lead under most categories. Industrial sources (category i) account for 25% of emissions and activities included in category ii account for 48% of the total emissions. Most of category ii emissions are from sewage sources, however almost 8% of total reported lead emissions are from the agriculture sector. Category iv is responsible for 27% of the reported lead emissions, with most of these originating from urban diffuse sources.

5.2.16 Mercury and compounds

Overview

Figure 5.33 provides an overview of the emissions of mercury and mercury compounds (in kg) for categories i and category ii from E-PRTR data for 2010.

Figure 5.33 Emissions to water of mercury and compounds by category (in %) (total = 4,217 kg) (Source: E-PRTR)

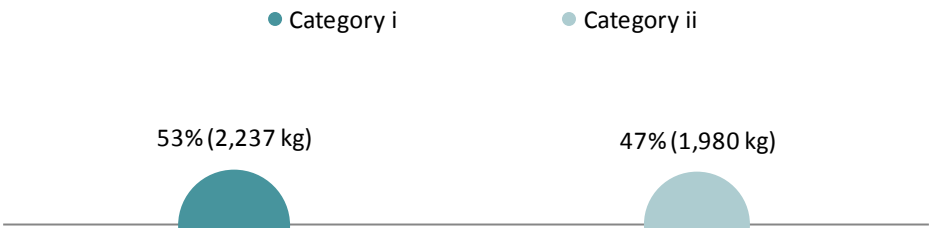
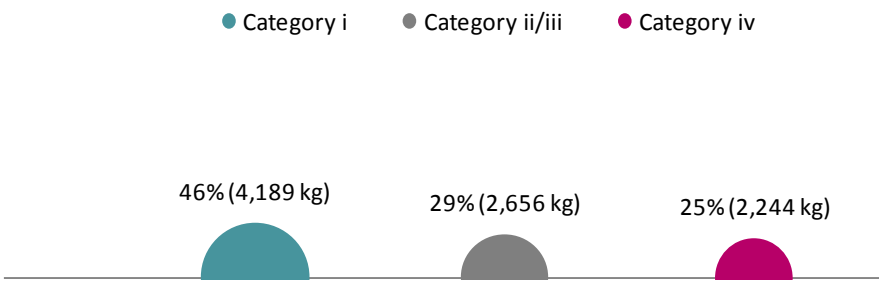


Figure 5.34 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.34 Emissions to water of mercury and compounds per category (in %) (total = 9,089 kg) (Source: Waterbase)



Discussion

E-PRTR data show that emissions are split almost equally between categories i and ii. Three Member States (Austria, Cyprus and Malta) did not report any emissions. For both categories i and ii, emission reported are distributed across the Member States. For category i the largest emissions are from Italy, Romania, Slovakia, Spain and the UK. For category ii the largest emissions are from Poland, Italy, Germany and Portugal. Category i

emissions (53%) are from a wide range of activities including thermal power stations, refineries, hazardous waste facilities, metal processing, chemical processing, landfills and production of explosives. For category ii, waste water treatment is the most commonly reported source of mercury emissions. Underground and open-cast mining is reported as an important source by only a few Member States.

Waterbase includes mercury emissions from activities in all categories. Industrial sources (category i) are the largest source of emissions with 46% of the total emissions. Category ii emissions account for 29% of reported emissions, which largely originate from sewage sources. Reported emissions of mercury from agriculture are negligible. Category iv accounts for 25% of total emissions; mainly from urban and other diffuse sources.

5.2.17 Nickel and compounds

Overview

Figure 5.35 provides an overview of the emissions of nickel and nickel compounds (in kg) for categories i and category ii from E-PRTR data for 2010.

Figure 5.35 Emissions to water of nickel and compounds by category (in %) (total = 295,363 kg) (Source: E-PRTR)

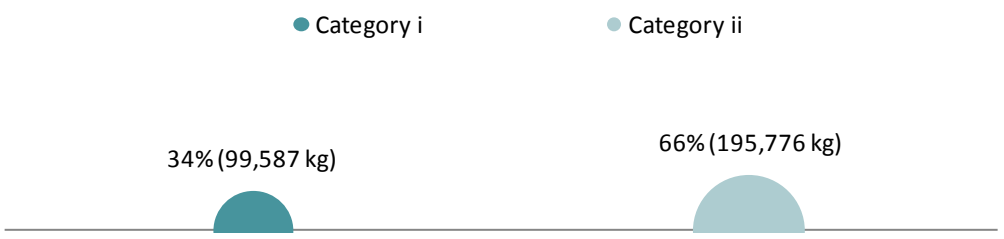
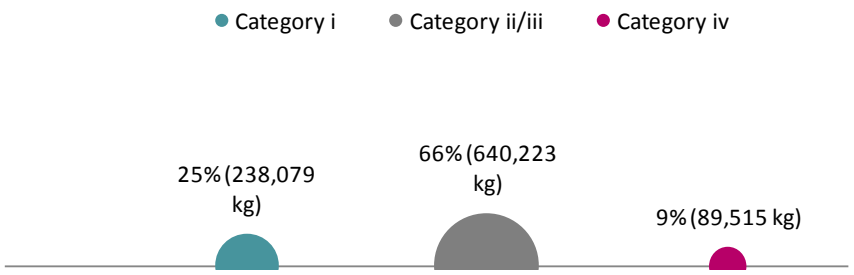


Figure 5.36 provides a breakdown of emissions of nickel by major sources from Waterbase data.

Figure 5.36 Emissions to water of nickel and compounds by category (in %) (total = 967,817 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that the majority (66%) of emissions arise from category ii activities. Cyprus is the only Member State not to report emissions of nickel emissions. For both categories i and ii, Italy reported about 20% of the total emissions, with significant emissions reported from France, Germany and the UK and, for category ii, from Bulgaria, Ireland, the Netherlands, Poland, Portugal and Romania. The remaining emissions (33%) are reported from a wide range of category i activities including thermal power stations, refineries, hazardous waste facilities, metal processing, chemical processing of almost all types, landfills, pulp and paper processes and surface treatment. For category ii, waste water treatment is the most commonly reported source of nickel emissions. Underground and open-cast mining is reported as an important source of nickel emissions but only by a few Member States. It is possible that this activity is under reported.

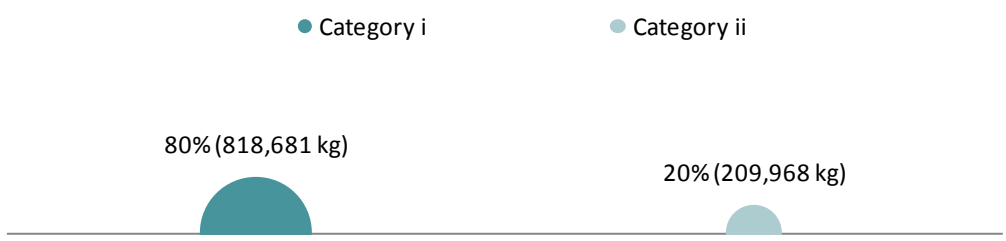
Waterbase includes reports for nickel emissions for most types of activity. For industrial sources (category i), the reported emissions account for 25% of the total emissions. Category ii emissions account for 66% of reported emissions which are mostly from sewage sources and direct discharges to coastal and transitional waters. Agricultural emissions within category ii account for 6% of the total reported nickel emissions. Category iv accounts for 9% of the total emissions of nickel reported under Waterbase.

5.2.18 Phenols (as total C)

Overview

Figure 5.37 provides an overview of the emissions of phenols (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.37 Emissions to water of phenols (as total C) by category (in %) (total = 1,028,649 kg) (Source: E-PRTR)



Emissions of total phenols are not reported under Waterbase.

Discussion

Six Member States do not report phenol emissions and low emissions are reported by several Member States. Over 90% of category i emissions are reported by the UK, which confirms the unevenness in reporting. For category ii reporting is more distributed, although 21% of emissions are reported by Italy alone. The majority of emissions (80%) are from a wide range of category i activities including thermal power stations, refineries, rolling mills,

gasification, metal processing, polymer production, landfills, production of explosives and surface treatment. For category ii (20% of emissions), waste water treatment is the most commonly reported source and underground and open-cast mining also being reported as small source (Poland).

5.2.19 Total nitrogen

Overview

Figure 5.38 provides an overview of the emissions of total nitrogen (in kg) for categories i and ii from E-PRTR data for 2010. The majority of emissions are for category ii and the data show that the UK contributes about a third of reported category ii emissions (followed by Germany, France, Italy and Spain). For category i the largest reports are from Germany.

Figure 5.38 Emissions to water of total nitrogen by category (in %) (total = 386,493,763 kg) (Source: E-PRTR)

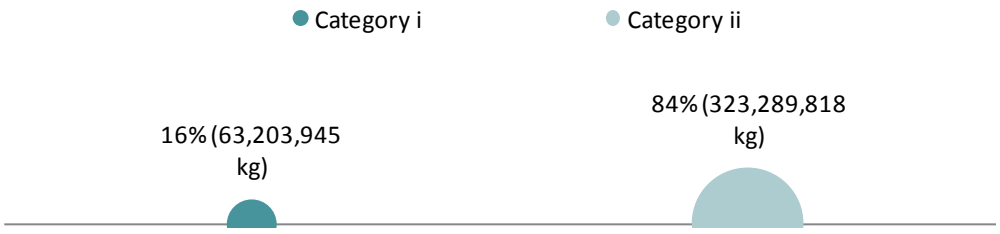
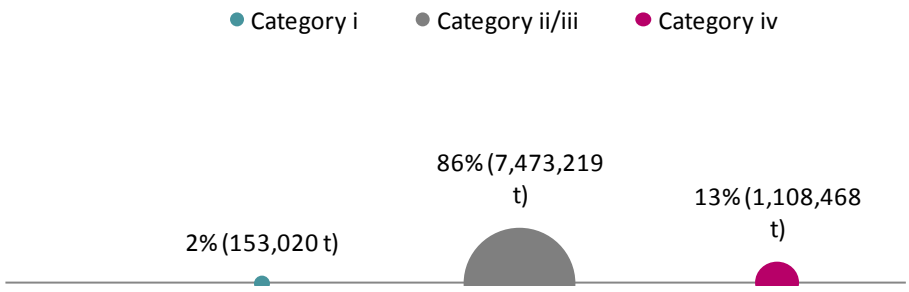


Figure 5.39 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.39 Emissions to water of total nitrogen by category (in %) (total = 8,734,707 t) (Source: Waterbase)



Discussion

The E-PRTR data show that the majority of emissions (84%) of total nitrogen arise from category ii activities with WWTP the largest source. It is interesting to note that Poland reports underground and open-cast mining as a source of total nitrogen emissions, and Malta and the UK report aquaculture as an important source. These activities are not widely reported by other Member States for total nitrogen and, therefore, it is likely that the

analysis presented here is highlighting this under-reporting. Consequently, the relative importance of category ii is likely to be greater. The rest of the emissions (16%) are from a wide range of category i activities including thermal power stations, refineries, chemicals processes, landfills, slaughterhouses and processes for animal and vegetable raw materials.

Within Waterbase total nitrogen emissions are reported for most activities although industrial sources (category i) account for only 2% of total reported emissions. Category ii accounts for 86% of reported emissions. Within this category the vast majority of the reported emissions are from WWTPs. Emissions from agriculture are important and account for a third of total reported emissions. Category iv emissions account for 13% of the reported emissions with the largest emissions originating from background emissions and atmospheric deposition.

5.2.20 Total organic carbon (TOC)

Overview

Figure 5.40 provides an overview of the emissions of total organic carbon (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.40 Emissions to water of total organic carbon by category (in %) (total = 563,768,200 kg) (Source: E-PRTR)

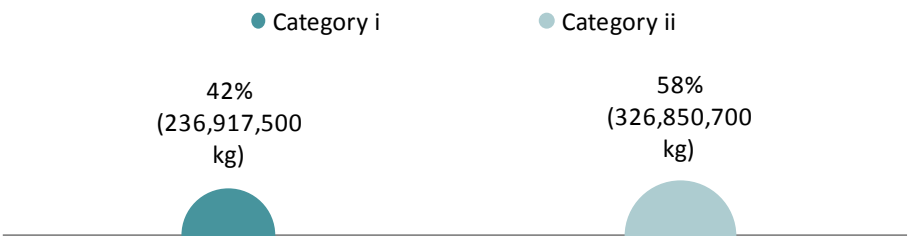
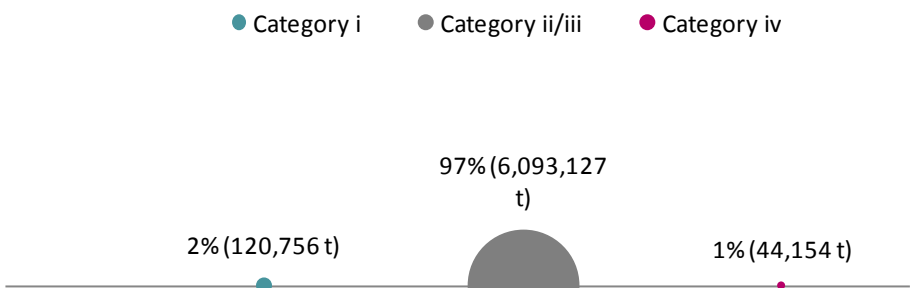


Figure 5.41 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.41 Emissions to water of total organic carbon by category (in %) (total = 6,258,037 t) (Source: Waterbase)



Discussion

The E-PRTR data show that the majority of TOC emissions (58%) arise from category ii activities. All but five Member States report emissions in category i and all but three in category ii. Nearly 25% of category ii emissions are reported by the UK, with significant reports also from Germany and several other Member States. For category i, 25% of emissions arise from Sweden, with significant reports from Finland, France, Germany and the UK. The remaining emissions (42%) are from a wide range of category i activities including thermal power stations, refineries, chemicals processes, pulp and paper production, pharmaceuticals and processes for animal and vegetable raw materials. For category ii, emissions are mostly originating from WWTPs. Germany and Poland report underground and open-cast mining as a source of TOC emissions, whilst Malta and the UK report aquaculture as an important source.

In Waterbase, total organic carbon emissions are reported for several activities but noticeably not for agriculture. Industrial activities (category i) account for only 2% of the total TOC emissions. Category ii emissions account for 97% of emissions and the vast majority of these emissions are from WWTPs. Category iv inputs account for 1% of TOC emissions.

5.2.21 Total phosphorus

Overview

Figure 5.42 provides an overview of the emissions of total phosphorus (in kg) for categories i and ii from E-PRTR data for 2010.

Figure 5.42 Emissions to water of total phosphorus by category (in %) (total = 50,544,430 kg) (Source: E-PRTR)

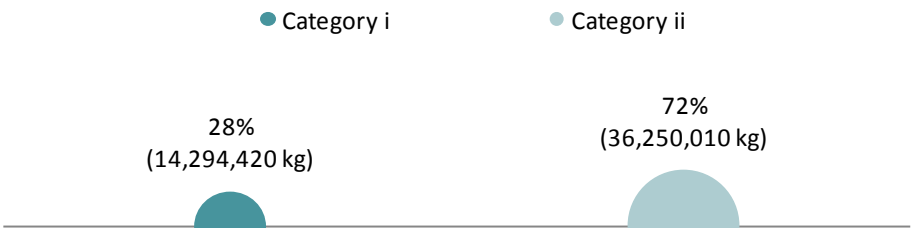
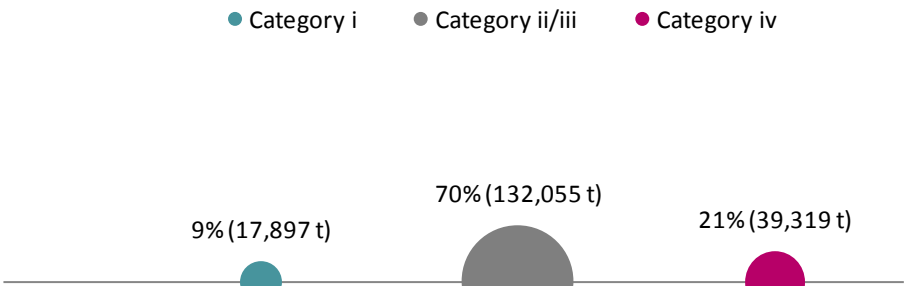


Figure 5.43 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.43 Emissions to water of total phosphorus by category (in %) (total = 189,271 t) (Source: Waterbase)



Discussion

The E-PRTR data show that the majority (72%) of emissions arise from category ii activities. The data shows that the UK reports about half of all reported emissions (followed by Italy and Spain). Furthermore, all Member States except Denmark report emissions under category ii, but seven do not report emissions under category i. The remaining emissions (28%) arise from a wide range of category i activities including thermal power stations, refineries, chemicals processes and processes for animal and vegetable raw materials. For category ii, waste water treatment is the most commonly and largest reported source.

Poland reports underground and open-cast mining as a source. Malta and the UK report aquaculture as important sources of emissions of total phosphorus. Phosphorous emissions from these activities are not widely reported by other Member States. It is likely that they are under reported and that the relative importance of category ii is greater.

Within Waterbase total phosphorus emissions are reported for most activities. Industrial activities (category i) account for 9% of total phosphorus emissions. Category ii emissions account for 71% of emissions and the vast majority of these emissions are from WWTPs. Within category ii, emissions from the agricultural sector are responsible for 9% of total phosphorus emissions reported in Waterbase. Category iv inputs account for 21% of total emissions and of these diffuse sources and background inputs are the most important.

5.2.22 Zinc and compounds

Overview

Figure 5.44 provides a breakdown of emissions of zinc (in kg) for categories i and ii from E-PRTR data by Member State for 2010.

Figure 5.44 Emissions to water of zinc and compounds by category (in %) (total = 2,241,921 kg) (Source: E-PRTR)

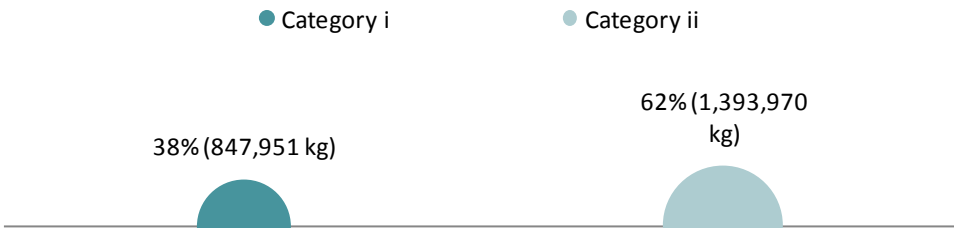
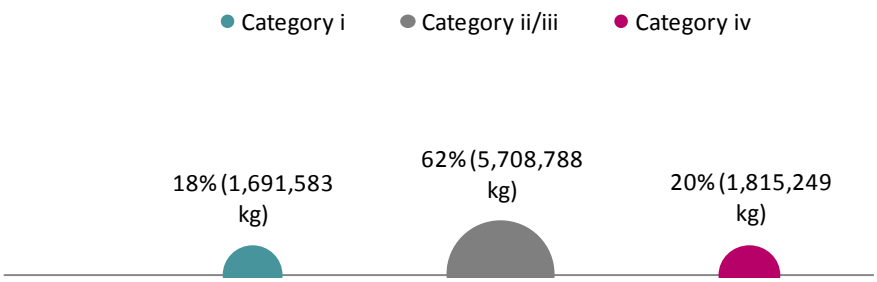


Figure 5.45 provides a breakdown of emissions by major sources from Waterbase data.

Figure 5.45 Emissions to water of zinc and compounds by category (in %) (total = 9,215,620 kg) (Source: Waterbase)



Discussion

The E-PRTR data show that 62% of emissions arise from category ii activities. Emissions are reported from all MS except for Cyprus and Greece. For category i, France reports the largest proportion of emissions, followed by Germany, the UK and Spain. For category ii the largest reports are from Germany, Poland, the UK, Spain and Bulgaria. The 38% remaining emissions are reported from a wide range of category i activities including thermal power stations, refineries, chemicals processes, fertiliser manufacture, slaughterhouses and disposal of hazardous waste. For category ii, waste water treatment is the largest reported source of zinc emissions.

In Waterbase, zinc emissions are reported for most activities. Industrial activities (category i) account for 18% of the total emissions. Category ii emissions account for 62% of emissions and the sources of these emissions are roughly evenly split between unspecified point sources, WWTPs and agriculture (the latter account for 11% of total

zinc emissions). Category iv inputs account for 21% of total emissions with diffuse sources and background inputs the main contributors.

6. Conclusions

6.1 Results of pollutant emissions analysis

The results of this study suggest that the IED is an effective instrument in regulating a significant proportion of Europe's total pollutant emissions. The headline figures (which take into consideration all sources) show emissions from activities currently regulated by the IED are approximately 23% by mass of the total loading to the atmosphere and 2% by mass of the total loading to water[12]. As the analysis in this report focussed on data for 2010 it is likely that this share of emissions coverage under the IED would have been significantly larger prior to October 2007 as after this date existing installations had to comply with the IPPC Directive. The requirements under the various sectoral Directives also came into force for existing installations at various stages before 2010. Furthermore, reporting under the E-PRTR (which formed the basis of estimating IED regulated emissions for air primarily) has its limitations both in terms of potential reporting gaps as well as the emissions reporting thresholds which apply (below which installations do not need to report) so coverage is expected to be greater than estimated.

Air emissions: These figures hide the fact that 60% of total air emissions do not arise from (agro-)industrial sources, meaning the adjusted percentage of emissions covered by IED rises to 57% (i.e. well over half of all air emissions from (agro-)industrial sources are currently regulated by the IED). For air emissions emitted from activities that fall under other EU legislation (category ii) the general picture is one of a relatively small component (7%) of the total; but when adjusted to include only emissions from (agro-)industrial activities (i.e. categories i-iii only) the contribution becomes a more substantial 17%. Air emissions from activities that are currently not regulated under EU law (category iii) contribute 10% of the total, but account for 25% when adjusted to include only (agro-)industrial activities. However, it is worth noting that these 'unregulated' emissions are still impacted to some extent by the National Emission Ceilings Directive and the Air Quality Directive depending on the specific circumstances at a Member State level, e.g. where air quality limit values are being breached, the competent authority could require industrial emitters contributing to the exceedence to take measures to reduce their emissions.

With respect to the specific pollutants (or groups of pollutants), the analysis shows that of the main combustion pollutants[13], SO_2 emissions are the most regulated (i.e. 70% of the total falls directly under category i activities) followed by NO_x, CO and PM_{10}. The share of emissions for these key combustion pollutants within category ii does vary slightly (with PM_{10} having the greater share of the four) but is more consistent for category iii (unregulated) although again PM_{10} has the largest share of emissions in category iii. Removing the emissions from category iv, the conclusion from the analysis is that, overwhelmingly, emissions of key combustion pollutants are regulated by EU law and predominantly by the IED. Those emissions not currently regulated by the IED or any other EU legislation are primarily from combustion installations below 20MWth. As part of the review of the Thematic

[12] The figure for water is based on Waterbase data with acknowledged imprecision and uncertainty due to limitations of the dataset and limited geographical coverage.

[13] NOx, CO, PM_{10} and SO_2

Strategy for Air Pollution the Commission has published at the end of 2013 a Clean Air Policy Package which includes proposals for a Directive setting minimum emission limit values for air emissions from 1-50MWth combustion installations[14].

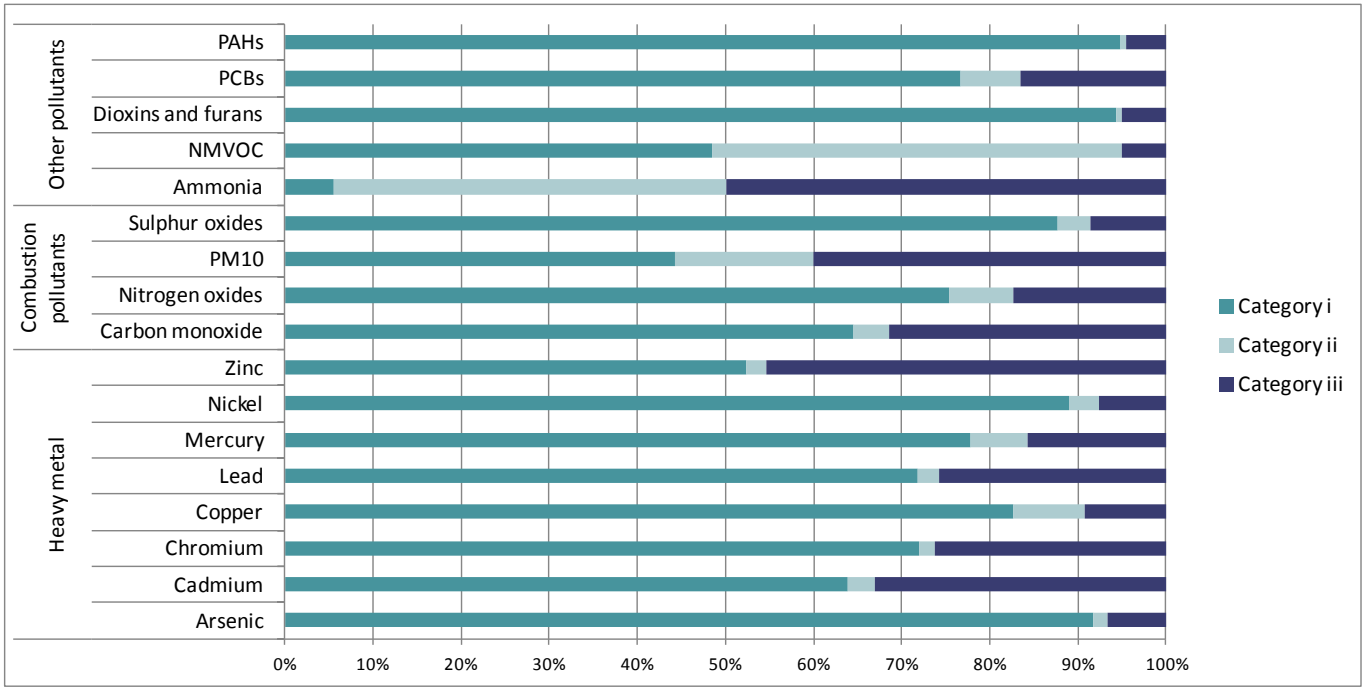
Regarding heavy metals, the analysis shows that certain metals and their compounds (e.g. mercury and arsenic) have a higher total proportion of emissions from category i activities than other categories and thus can be considered to be regulated directly (i.e. via conditions in the permit such as emission limits values). For mercury, category iv emissions comprise a less significant proportion of the total than for the other metals assessed. In all cases, emissions from category ii (activities regulated under other EU laws) are the least significant component.

Of the other air pollutants, PAHs and PCBs are emitted primarily from (agro-)industrial activities subject to regulation under the IED. Anthropogenic sources of ammonia from category iv activities are very low with the majority of emissions being from category ii or iii and specifically agricultural sources. The predominant source of NMVOCs is from non (agro-)industrial sources such as road transport and domestic emissions, with the remainder being split relatively equally between categories i and ii.

For air emissions, the results indicate that domestic, commercial and transport (amongst others) sources are more significant contributors to Europe's air pollutant emissions than (agro-)industrial activities. When the figures are adjusted to include only the figures for (agro-)industrial emissions, and hence provide a representative picture of the contribution to air emissions made by industry, the analysis indicates that the majority of emissions of key reported pollutants can be generally considered to be regulated at an EU level, predominantly but not exclusively by the IED. Figure 6.1 presents the share of emissions regulated by the IED compared to emissions indirectly regulated and unregulated (categories ii and iii). With the notable exceptions of ammonia, and to a lesser extent PM_{10} and NMVOCs, the IED tends to cover more than 60% of the total agro-industrial emissions.

[14] Available from: http://ec.europa.eu/environment/air/clean_air_policy.htm

Figure 6.1 (Agro-)industrial emissions to air by pollutant



For ammonia emissions, it is expected that the share of category i emissions is under-estimated due to Member States not (or under) reporting emissions and the impacts of the emissions reporting threshold set in E-PRTR.

Emissions of PM_{10} from category ii and iii are mostly due to the combustion plants below 50 MWth. As discussed above, the Commission's proposals for a Directive targeted at these plants aims to reduce their emissions.

Water emissions: The situation is not comparable for water emissions, since EU water legislation regulates (or should in principle) all emissions to water where such emissions could have a detrimental impact on the quality of the receiving water body. This being the case, it is no surprise that, based on the Waterbase data, category ii/iii (for the purposes of this study combined) activities make up the bulk of the pollutant contribution, at 90%, and category iv activities make up only 8%. Emissions from IED regulated activities (category i) are calculated to be 2% of the total mass emissions based on Waterbase data.

For water, the challenges around segmenting activities into those subject to EU legislation affecting emissions (category ii) and those not (category iii), have proved too great to provide a similar level of granularity as for air emissions. Discounting the obvious flaws in the data and uncertainty in the results, the above conclusion masks the fact that water emissions from domestic and commercial activities are captured under EU legislation (typically the UWWTD) whereas no similar arrangement exists for air. EU framework directives on air are typically not activity based and therefore, whilst they interact to some degree with unregulated and non (agro-)industrial activities, there is limited direct influence on emissions or a lack of evidence on the extent of any influence.

Overall: For both air and water pollutants, there is generally significant variance in the relative partitions between categories for individual pollutants. As a consequence of this varied pattern, any consideration of the need for further or refined controls on emissions from (agro-)industrial activities might be best examined at the pollutant or

activity level, rather than relying on broader-based legislation to effectively control unregulated emissions. This strategy, which to some degree must be based on harm and hazard potential, has been effectively applied for pollutants such as mercury which, of all the heavy metals, has the highest level of emissions already regulated under the IED.

An added complication is that there is also substantial variance between Member States at the pollutant level; therefore further regulation may be appropriate in one Member State but, on the basis of the analysis presented in this study, may not appear to be appropriate in another. This may be a consequence of data reporting issues, some of the flexibilities inherent in the directives to aid subsequent transposition into national legislation and regulatory frameworks (including the potential to require tighter controls) and partly because of the varying patterns of industrial activity across the Member States.

In conclusion, there are gaps and uncertainties in the source data that are believed to be irreconcilable without substantial investments of time and resources. Any further work to explore the relative partitions would need to consider a range of approaches to address these uncertainties and may require substantial lead-in times whilst fundamentally updated and more comparable datasets are developed. Exposure to, and familiarity with, the reporting protocols for datasets such as E-PRTR and Waterbase is likely to lead to improvements in the completeness over time, as well as development of new datasets.

Study Limitations and Uncertainties

This study presented a considerable challenge to accurately categorise a vast range of different (agro-)industrial activities; to research and interrogate a range of data and supporting sources on a number of key pollutants across air and water media; and to ensure coverage across the EU27 at a MS level. Inevitably, there has been an over-reliance on those datasets that offered the greatest coverage and completeness (E-PRTR, LRTAP, Waterbase). Whilst generally these have been fit for purpose (because better sets do not yet exist), it is acknowledged that each comes with its own set of uncertainties and inaccuracies, which may be magnified when data are combined to produce a unified estimate of the allocation of pollutant emissions.

For the categorisation and calculation of **air pollutant emissions**, there has been a heavy reliance on E-PRTR and LRTAP inventories; each of which are developed differently and for different purposes. E-PRTR is an under-estimate of emissions since many installations below the emissions reporting thresholds do not have to report. To be able to identify certain pollutant emissions, a comparison was often undertaken by subtracting E-PRTR reported emissions from LRTAP; which in some cases has resulted in an overestimation. Where data gaps exist, it has not always been possible to accurately fill these using surrogate data or even to conduct bottom-up estimates (because in many cases the level of available production and capacity information is insufficient to support such a calculation).

For the categorisation of **water pollutant emissions**, Waterbase offered a reduced coverage (15 Member States) and a reporting structure that could not be aligned to the four study categories or to the activity list used for air emissions. This renders comparisons between the Waterbase data and that extracted from E-PRTR very difficult. Simple addition and subtraction of portions would result in a flawed outcome and thus the most accurate picture is one presented by comparison of each dataset in isolation. It is believed that the data reported into E-PRTR can be

used to gauge a relatively accurate picture of the level of emissions from category i activities but category ii is under reported. Waterbase data provides a good (albeit geographically limited) view of the level of unregulated non (agro-)industrial emissions (category iv). As a consequence of these data comparability issues, there is a much greater level of uncertainty placed on the accuracy of the representation of water emission partitions provided in this report. Broadly, some patterns are discernible (e.g. vastly more (agro-)industrial activities with relevant pollutant emissions fall into categories ii and iii than i) but until such time as a more complete single source of data is available, the water emission estimates in this report should be treated with some caution.

The reporting of data by Member States under E-PRTR, LRTAP and Waterbase is often variable. Some have not provided as complete datasets as others, and it has often not been possible to accurately validate what Member States have reported in category iv (domestic emissions, commercial services emissions), particularly for water pollutant emissions.

On data coverage and reliability, the estimates presented in this study (where these are based on actual data points) are as good as they can be taking into account the limitations inherent within the data sets and the uncertainties / inaccuracies stemming from forcing data sets together to provide a headline estimate. It is unlikely that further work by the Commission to fill existing gaps and close down current uncertainties would have any additional benefits in terms of dramatically increasing the accuracy of the analytical outputs. At some point in the next three years (2015 planned) there will be a much more complete set of data on water emissions by Member State developed as part of the implementation of the Water Framework Directive. It may therefore be of value to revisit the analysis of water emissions once this data becomes available.

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Appendix A
List of activities and categories for air emissions

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
Energy industry	001	Combustion of fuels in installations with a total rated thermal input of 50 MW or more	x			
	002	Refining of mineral oil and gas	x			
	003	Production of coke	x			
	004	Gasification or liquefaction of coal or other fuels	x			
	112	Coal rolling mills with a capacity of 1 tonne per hour	x			
	114	Installations for the manufacture of coal products and solid smokeless fuel	x			
	061	Combustion of fuels in installations with a total rated thermal input above 20 MW and below 50MW (except in installations for the incineration of hazardous or municipal waste)		x		
	101	Combustion plants below 20 MWth			x	
Production and processing of metals	006	Metal ore (including sulphide ore) roasting or sintering	x			
	007	Production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2.5 tonnes per hour	x			
	007-1	Installations for the processing of ferrous metals	x			
	008	Processing of ferrous metals: operation of hot-rolling mills with a capacity exceeding 20 tonnes of crude steel per hour	x			
	009	Processing of ferrous metals: operation of smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power used exceeds 20 MW	x			
	010	Processing of ferrous metals: application of protective fused metal coats with an input exceeding 2 tonnes of crude steel per hour	x			
	011	Operation of ferrous metal foundries with a production capacity exceeding 20 tonnes per day	x			
	012	Processing of non-ferrous metals: production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes	x			
	013	Processing of non-ferrous metals: melting, including the alloyage, of non-ferrous metals, including recovered products and operation of non-ferrous metal foundries, with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals.	x			
	014	Surface treatment of metals or plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30 m3	x			
	056	Processing of ferrous metals: operation of hot-rolling mills with a capacity lower than 20 tonnes of crude steel per hour		x		
	057	Processing of ferrous metals: operation of smitheries with hammers the energy of which is below 50 kilojoule per hammer, where the calorific power used is lower than 20 MW		x		

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
	058	Processing of ferrous metals: application of protective fused metal coats with an input below 2 tonnes of crude steel per hour		x		
	059	Operation of ferrous metal foundries with a production capacity lower than 20 tonnes per day		x		
	060	Processing of non-ferrous metals: melting, including the alloyage, of non-ferrous metals, including recovered products and operation of non-ferrous metal foundries, with a melting capacity below 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals.		x		
	092	Production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity lower than 2.5 tonnes per hour			x	
	093	Surface treatment of metals or plastic materials using an electrolytic or chemical process where the volume of the treatment vats is below 30 m3			x	
Mineral industry	015-1	Installations for the productions of cement, lime and magnesium not specified	x			
	015	Production of cement, lime and magnesium oxide: production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other kilns with a production capacity exceeding 50 tonnes per day	x			
	016	Production of cement, lime and magnesium oxide: production of lime in kilns with a production capacity exceeding 50 tonnes per day	x			
	017	Production of cement, lime and magnesium oxide: production of magnesium oxide in kilns with a production capacity exceeding 50 tonnes per day	x			
	018	Manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day	x			
	019	Melting mineral substances including the production of mineral fibres with a melting capacity exceeding 20 tonnes per day	x			
	020	Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain with a production capacity exceeding 75 tonnes per day and/or with a kiln capacity exceeding 4 m3 and with a setting density per kiln exceeding 300 kg/m3	x			
	062	Production of cement clinker in rotary kilns with a production capacity below 500 tonnes per day or in other kilns with a production capacity below 50 tonnes per day		x		
	063	Production of lime in kilns with a production capacity lower than 50 tonnes per day		x		
	064	Melting mineral substances including the production of mineral fibres and manufacturing of glass including glass fibre with a melting capacity below 20 tonnes per day		x		
	065	Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain with a production capacity below 75 tonnes per day and/or with a kiln capacity below 4 m3 and with a setting density per kiln below 300 kg/m3		x		
	090	Production of magnesium oxide in kilns with a production capacity below 50 tonnes per day			x	

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
Chemical industry	021	Production of organic chemicals, such as: (a) simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic); (b) oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters and mixtures of esters, acetates, ethers, peroxides and epoxy resins; (c) sulphurous hydrocarbons; (d) nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates; (e) phosphorus-containing hydrocarbons; (f) halogenic hydrocarbons; (g) organometallic compounds; (h) plastic materials (polymers, synthetic fibres and cellulose-based fibres); (i) synthetic rubbers; (j) dyes and pigments; (k) surface-active agents and surfactants.	x			
	022	Production of inorganic chemicals, such as: (a) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride (b) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids (c) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide; (d) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate; (e) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide.	x			
	023	Production of phosphorous-, nitrogen- or potassium-based fertilisers (simple or compound fertilisers)	x			
	024	Production of plant protection products or of biocides	x			
	025	Production of pharmaceutical products including intermediates	x			
	026	Production of explosives	x			
Waste management	027	Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving one or more of the following activities (a) biological treatment; (b) physico-chemical treatment; (c) blending or mixing prior to submission to any of the other activities listed in points 5.1 and 5.2; (d) repackaging prior to submission to any of the other activities listed in points 5.1 and 5.2; (e) solvent reclamation/regeneration; (f) recycling/reclamation of inorganic materials other than metals or metal compounds; (g) regeneration of acids or bases; (h) recovery of components used for pollution abatement; (i) recovery of components from catalysts; (j) oil re-refining or other reuses of oil; (k) surface impoundment.	x			
	028	Waste incineration	x			

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
	030	Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving one or more of the following activities, and excluding activities covered by Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (i) biological treatment; (ii) physico-chemical treatment; (iii) pre-treatment of waste for incineration or co-incineration; (iv) treatment of slags and ashes; (v) treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components.	x			
	031	Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, and excluding activities covered by Directive 91/271/EEC (When the only waste treatment activity carried out is anaerobic digestion, the capacity threshold for this activity shall be 100 tonnes per day.): (i) biological treatment; (ii) pre-treatment of waste for incineration or co-incineration; (iii) treatment of slags and ashes; (iv) treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components	x			
	032	Landfills as defined in Article 2(g) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste(1) OJ L 182, 16.7.1999, p. 1., receiving more than 10 tonnes of waste per day or with a total capacity exceeding 25 000 tonnes, excluding landfills of inert waste	x			
	053	Independently operated treatment of waste water not covered by Directive 91/271/EEC and discharged by an installation covered by Chapter II	x			
	066	Disposal or recovery of hazardous waste with a capacity below 10 tonnes per day involving one or more of the following activities (a) biological treatment; (b) physico-chemical treatment; (c) blending or mixing prior to submission to any of the other activities listed in points 5.1 and 5.2; (d) repackaging prior to submission to any of the other activities listed in points 5.1 and 5.2; (e) solvent reclamation/regeneration; (f) recycling/reclamation of inorganic materials other than metals or metal compounds; (g) regeneration of acids or bases; (h) recovery of components used for pollution abatement; (i) recovery of components from catalysts; (j) oil re-refining or other reuses of oil; (k) surface impoundment.		x		

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
	069	Disposal of non-hazardous waste with a capacity below 50 tonnes per day involving one or more of the following activities, and excluding activities covered by Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (i) biological treatment; (ii) physico-chemical treatment; (iii) pre-treatment of waste for incineration or co-incineration; (iv) treatment of slags and ashes; (v) treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components.		x		
	070	Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity below 75 tonnes per day involving one or more of the following activities, and excluding activities covered by Directive 91/271/EEC (When the only waste treatment activity carried out is anaerobic digestion, the capacity threshold for this activity shall be below 100 tonnes per day.): (i) biological treatment; (ii) pre-treatment of waste for incineration or co-incineration; (iii) treatment of slags and ashes; (iv) treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components		x		
	071	Landfills as defined in Article 2(g) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste(1) OJ L 182, 16.7.1999, p. 1., receiving less than 10 tonnes of waste per day or with a total capacity below 25 000 tonnes, excluding landfills of inert waste		x		
	113	Urban waste-water treatment plants		x		
Other industrial activities	035	Production in industrial installations of: (a) pulp from timber or other fibrous materials;	x			
	036	Production in industrial installations of: (b) paper or card board with a production capacity exceeding 20 tonnes per day;	x			
	037	Production in industrial installations of: (c) one or more of the following wood-based panels: oriented strand board, particleboard or fibreboard with a production capacity exceeding 600 m3 per day	x			
	052	Preservation of wood and wood products with chemicals with a production capacity exceeding 75 m3 per day other than exclusively treating against sapstain	x			
	074	Production in industrial installations of paper or card board with a production capacity below 20 tonnes per day			x	
	078	Preservation of wood and wood products with chemicals with a production capacity equal to or lower than 75 m3 per day other than exclusively treating against sapstain		x		
	094	Production in industrial installations of one or more of the following wood-based panels: oriented strand board, particleboard or fibreboard with a production capacity below 600 m3 per day			x	
	038	Pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of textile fibres or textiles where the treatment capacity exceeds 10 tonnes per day	x			
	039	Tanning of hides and skins where the treatment capacity exceeds 12 tonnes of finished products per day	x			
	075	Pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of textile fibres or textiles where the treatment capacity is below 10 tonnes per day			x	
	085	Tanning of hides and skins where the treatment capacity is below 12 tonnes of finished products per day			x	

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
	040	Operating slaughterhouses with a carcass production capacity greater than 50 tonnes per day	x			
	041-1	Treatment and processing intended for the production of food and beverage product	x			
	041	Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed from: (i) only animal raw materials (other than exclusively milk) with a finished product production capacity greater than 75 tonnes per day;	x			
	042	Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed from: (ii) only vegetable raw materials with a finished product production capacity greater than 300 tonnes per day or 600 tonnes per day where the installation operates for a period of no more than 90 consecutive days in any year;	x			
	043	Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed from: (iii) animal and vegetable raw materials, both in combined and separate products, with a finished product production capacity in tonnes per day greater than: — 75 if A is equal to 10 or more; or, — [300- (22,5 × A)] in any other case, where 'A' is the portion of animal material (in percent of weight) of the finished product production capacity. Packaging shall not be included in the final weight of the product.	x			
	044	Treatment and processing of milk only, the quantity of milk received being greater than 200 tonnes per day (average value on an annual basis).	x			
	045	Disposal or recycling of animal carcases or animal waste with a treatment capacity exceeding 10 tonnes per day	x			
	086	Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed from: (i) only animal raw materials (other than exclusively milk) with a finished product production capacity lower than 75 tonnes per day			x	
	087	Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed from: (ii) only vegetable raw materials with a finished product production capacity lower than 300 tonnes per day or 600 tonnes per day where the installation operates for a period of no more than 90 consecutive days in any year			x	
	088	Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed from: (iii) animal and vegetable raw materials, both in combined and separate products, with a finished product production capacity in tonnes per day greater than: — 75 if A is below 10; or, — [300- (22,5 × A)] in any other case, where 'A' is the portion of animal material (in percent of weight) of the finished product production capacity. Packaging shall not be included in the final weight of the product.			x	

Group of activity	Activity code in project dataset	Activity	Category i	Category ii	Category iii	Category iv
	089	Treatment and processing of milk only, the quantity of milk received being lower than 200 tonnes per day (average value on an annual basis).			x	
	050	Activities using organic solvents listed in Part 1 of Annex VII to IED and where applicable reaching the consumption thresholds set out in Part 2 of that Annex.	x			
	083	Activities using organic solvents listed in Part 1 of Annex VII to IED below the consumption thresholds set out in Part 2 of that Annex.		x		
	051	Production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitisation	x			
	054	Underground mining and related operations		x		
	055	Opencast mining and quarrying where the surface of the area effectively under extractive operation equals 25 hectares		x		
Agriculture	046	Intensive rearing of poultry or pigs: (a) with more than 40 000 places for poultry	x			
	047	Intensive rearing of poultry or pigs: (b) with more than 2 000 places for production pigs (over 30 kg)	x			
	048	Intensive rearing of poultry or pigs: (c) with more than 750 places for sows	x			
	146	Intensive rearing of poultry or pigs not specified	x			
	080	Spreading of manure - pigs		x		
	081	Spreading of manure - cattle		x		
	082	Use of fertilisers other than manure (synthetic N-fertilisers)		x		
	079	Spreading of manure - poultry		x		
	095	Rearing of poultry below 40 000 places for poultry, excluding manure			x	
	096	Rearing of pigs with less than 2 000 places for production pigs (over 30 kg) and / or with less than 750 places for sows - excluding manure			x	
	098	Field burning of agricultural waste			x	
	099	N-excretion on pasture range and paddock unspecified			x	
	100	Storage, handling and transport of agricultural products on and off-farm			x	
	102	Rearing of livestock other than poultry, pigs or cattle			x	
	103	Rearing of cattle for dairy - excluding manure			x	
	104	Rearing of cattle non-dairy - excluding manure			x	
Non-industrial activities	106	Aviation				x
	107	Road transport: passenger cars, light duty vehicles, heavy duty vehicles, mopeds & motorcycles, gasoline evaporation, automobile tyre and break wear, automobile road abrasion				x
	108	Railways				x
	109	Shipping				x
	110	Domestic emissions (all)				x
	111	Commercial services				x

Appendix B
Review of air emission data sources

Table B1. Review of main available data sources on air emissions – national level data, facility level data, sectoral reports and models

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
National level databases and inventory sources										
European dataset on emissions of air pollutants submitted to the Long Range Transboundary Air Pollutants (LRTAP) Convention WEBLINK	Dataset contains consolidated responses for all countries as well as for each country individually submitted under the LRTAP Convention.	CO, NH_3, NMVOC, NO_x, PM10, PM2.5, SO_x, TSP, As, benzo(a), benzo(b), benzo(k), Cd, Cr, Cu, Hg, Indeno, Ni, Pb, Se, total PAH, Zn, HCB, HCH, PCB, Dioxins and furans	Reported annually, latest data available for years 2005-2010	EU-27 Each Member State individually Iceland, Lichtenstein, Norway, Switzerland, Turkey No data available for Croatia	Uses NFR09 and NFR02 sector classification	✓	✓	✓	✓	Data supported and processed by European Topic Centre on Air and Climate Change (ETC/ACC)
National Emissions Ceilings (NEC) Directive Inventory Weblink	Dataset on emissions of air pollutants reported by MS to the European Commission under Directive 2001/81/EC on National Emission Ceilings for certain pollutants.	NH_3, NMVOC, NO_X, SO_2	Reported annually, latest data available for 2010	EU-27 Each Member State individually No data available for Croatia	Uses NFR09 classification	✓	✓	✓	✓	
EEA aggregated and gap-filled air emissions data	Data set showing aggregated emissions of air pollutants and greenhouse gases as used in the EEA indicator factsheets and assessment reports. Data are based on the information submitted under the NEC Directive, LRTAP and	CH_4, CO, Acidifying gas, NH_3, NMVOC, NO_x, Particulate formation, PM10, PM2.5, SO_x, TOFP	1990-2006	EU-27 Each Member State individually Iceland, Liechtenstein, Switzerland, Norway No data available for Croatia	EEA sector classification. Data provided for the following sectors: Energy industries; Fugitive emissions; Industry (energy); agriculture, waste, other (energy), oad transport,	✓	✓	✓	✓	

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
	Monitoring Mechanism.				other transport, industry (processes), other (non energy), Energy industries (power production), unallocated					
WebDab-EMEP Weblink	Emissions database of the Co-operative programme for monitoring and evaluation of long range transmission of air pollutants in Europe (EMEP), reporting data submitted on the LRTAP. Unreported emissions are gap-filled	CO, NH_3, NMVOC, NOx, SO_x, PM10, PM2.5, TSP, As,Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, Aldrin, benzo(a), benzo(b), benzo(k), chlordan, chlordecone, DDT, dieldrin, DIOX, endrin, HCB, HCH, heptachlor, hexabnomobip, indeno, mirex, PAH, PCB, PCP, SCCP, Toxaphene	2003-2010	EU-27 Each Member State individually Other parties to the Convention: Belarus, Canada, Croatia, Iceland, Monaco, Norway, Russia, Switzerland, Macedonia, Ukraine	Different reporitng formats are used NFR01, NFR02 and NFR09 and SNAP	✓	✓	✓	✓	Three different types of datasets can be accessed: - officialy reported data on emissions, - emissions as used in EMEP models: national totals, sector data and maps showing emission data (gridded emissions) based on emissions reported, with gaps filled in / corrected, - officially reported activity data.
Facility level databases and inventory sources										
European Pollutant Release and Transfer Register (E-PRTR) Weblink	Emission data for individual facilities based on datasets officially reported by countries to the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP) and United Nations Framework Convention on Climate Change (UNFCCC).	Covers 91 substances including CH_4, CO_2, N_2O, NMVOC, NO_x,NO_2 PFCs, SO_x, SO_2, PM10, nitrogen, phosphorus	Register is updated every May. Data are entered since 2007. Reports are produce d on past two years. Latest	EU-27 Each Member State individually Iceland, Lichtenstein, Norway, Serbia and Switzerland No data available for Croatia	In general, sector disaggregation follows the activities covered by the IED. In addition, data are reported on: coal rolling mills with a capacity of >1 tonne per hour; installations for the manufacture of coal products and solid	✓	✓	✓		

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
			data available are for 2010.		smokeless fuel; installations for the building of, and painting or removal of paint from ships with a capacity for ships >100 m long; intensive aquaculture with a production capacity of >1000 tonnes of fish or shellfish per year					
Large combustion plants (LCP) emissions inventory Weblink	Emissions data for facilities falling within the scope of the Large Combustion Plants Directive (2001/80/EC). LCP are combustion plants with a rated thermal input equal to or greater than 50 MW, irrespective of the type of fuel used (solid, liquid or gaseous).	SO_2, NO_x, dust	2007 - 2009	EU-27 Each Member State individually No data available for Croatia	Large combustion plants; data reported per facility	✓				Inventory is broken down into five categories of fuel: biomass, other solid fuels, liquid fuels, natural gas and other gases.
Sectoral reports										
AMEC, 2012, *Collection and analysis of data to support the Commission in line with Article 73(2)(b) of Directive 2010/75/EU on industrial emissions on the need to control emissions from the intensive*	The report aimed to gather and analyse data in line with the requirements of IED Article 73(2), to assess whether emissions from the intensive rearing of cattle should be further controlled. Data were collected, and the report undertook to re-appraise the assessment of impacts.	NH_3 ,N_2O, CH_4, Noise, Odour, N, P	1990-2009 or 2009 Data set is not complete for all years	EU 27. Information was received from 21 MS, other sources were used for the remaining MS (BG, EL, LT,LU,MT,NL)	Intensive rearing of cattle Agriculture sector			✓		Report also contains estimates of the cost of compliance.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
rearing of cattle										
AMEC, 2012, *Collection and analysis of data to support the Commission in line with Article 73(2)(a) of Directive 2010/75/EU on industrial emissions on the need to control emissions from the combusion of fuels in installations with a total rated thermal input below 50 MW* Weblink	This report looked at the need to control emissions from the combustion plants below 50 MW. The scope of the study was plants from 1MW to 50 MW. The project consisted in gathering a reliable data set, supported by a MS consultation, and the assessment of options (costs and benefits) proposed by the Commission.	Dust / PM 10, SO_2/SO_x, NO_x		EU 27	Focus on small scale combustion plant, with a distinction between fuel types, the type of combustion technique employed and the sector in which the plant operates.		✓	✓		Assumptions, extrapolations and estimates were used to fill the data gaps. Further refinement of these data is the focus of an on-going project. There were uncertainties regarding some of the data presented in this report. MS were consulted, of which BG, DK, EL,HU, LT, LU, LV, MT did not provide responses, other MS mainly provided partially complete or partially representative data (for example BE, DE, and UK).
AMEC, 2012, *Collection and analysis of data to inform certain reviews required under Directive 2010/75/EU on industrial emissions (IED): (a) Differentiated thresholds for the rearing of different poultry species; and (b) Capacity threshold for the simultaneous rearing of*	The IPPC review made it obvious that the common threshold for all species was not appropriate as different species produced different volumes of pollutants. The aim of the report was to look at the issue and revisit it with additional data gathering. It involved direct consultation with selected MS, literature review and modelling done in previous reports.	NH_3, CH_4, N_2O, N	2008 data for NH_3, 2007 for N, Various years on MS consultation reporting (2009,2010,2011)	EU-27	The report looks at poultry and pig sectors. The first part focuses on the different poultry species and their associated emissions, the second part looks at combined (agro-)industrial activities such as pigs + poultry			✓		The data sets are uneven, MS did not answer with the same level of detail. Reporting years are also different according to the availability of the information. MS consulted were: BE, DE, DK, ES, FR, IT,NL,PL, RO, UK. DK, NL and PL provided no or very little data. Industry association were consulted: Copa-Cogeca and Avecpoultry.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
different types of animal currently in the scope of the IED within the same installation ' Weblink										
AEA, 2007, *Assessment of the benefits and costs of the potential application of the IPPC Directive (EC/96/61) to industrial combustion installations with 20-50 MW rated thermal input'* Weblink	Study looked at informing the Commission of the potential benefits to expand the scope of the IPPC to small combustion plants between 20MW and 50 MW. it involved gathering data on combustion installations (emissions, abatement measures and their costs, emission reduction potential) and existing emission legislation in selected Member States.	NO_X, SO_2 and PM		The report focused on representatives MS: FI, IT,SI,RO,PL,BE, UK but used a EU-27 baseline	The report looks at combustion plants with a thermal input between 20MW and 50MW		✓			Data were mainly taken from database and MS ELVs. Data from consultation were not always obtained or complete. This information was then extrapolated to the other Member States and the whole EU. A baseline emission scenario was developed and then compared with several potential emission control scenarios. Data on emissions were extracted from: Member State ETS Data, ELVs, Corinair emission factor guidebook, ETS database (installation) and GAINS model.
IEEP, BIO and VITO , 2006 *Data Gathering and Impact Assessment for a Possible Review of the IPPC Directive* Weblink	This work aimed to collect data on a range of issues seen as areas for consideration for potential "technical" amendments to the IPPC Directive. This was to identify different options that could address these issues, and explore the pros and cons of different options. The work included the development of	NO_x, SO_2, NH_3, NMVOC, PM2.5, PM10		EU-25 + BG, RO,SW,NO,	Report looks at IPPC Directive in general, and various approach: Permitting, ELVs, Monitoring, Inspection, Water Discharges, Sevilla Process,Combustion and Aquaculture.	✓	✓	✓		One of the factsheets presents the data,from an IIASA 2004 data set (Gains model). A data set for SCP 20MW to 50MW is included in Annex C (Factsheet C1). Another factsheet looks at emissions from aquaculture: CH_4, N_2O,NH_3, NO_x, SO_x and VOC. Souces of data include

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
	methodologies to assess the environmental, economic and social impacts of different options and to develop substantiated arguments for the various options. The report is supplemented by 'fact-sheets'; one of which looks at the threshold for the application of IPPC.				On emissions from aquaculture, data are available for the production of Finnish trout, salmon, French rainbow trout and other fish.					Corinair and UNECE .
European Commission – DG Environment, 2004, *Data gathering and impact assessment for a possible review of the IPPC Directive – Part II* Weblink	This work follows up on the previous studies on the potential review of the IPPC Directive and includes the collection of country specific data and insights on the current practices, as well as identification and assessment of different issues. RAINS10 model describing the fate and deposition of acidifying substances was adapted to LCA and UNECE trajectory model. Similar to the Part I report, it includes fact sheets on key sectors.	SO_2, NO_x, VOC, CO, N, P	Data from Corinair is from 2006, EPER is from 2004 EU-25	Some of the factsheets include set of estimated emissions per type of industrial activity. The data are from US EPA. Emissions of particular types on installations for example chipdryer are also given. This might be useful to feed into projection or estimation database.	This part of the report looks at industrial activities, fact sheets are on: foundries, ceramics, chemicals (including biofuels), food, glassification, primary wood, coal fuel, wood preservation, soil, independently operated industrial wastewater treatment plants and waste incineration.	✓				This report does not have a database of emissions by MS, but it offers various sets of emissions data linked to product specifications.
European Commission – DG Environment, 2007, *Data gathering and impact assessment for a review and*	This work aimed to analyse the economic, environmental and social impacts relating to some potential "technical" amendments to the IPPC Directive with regard to waste treatment activities. The	Odour,CH_4, N_2O, NH_3, NMVOC, Dust, NO_x	2005 and 2004 mainly	EU-27	Report is accompanied by factsheets on specific sectors; sometimes with details on emission per activity type. They cover:	✓				Not all pollutants are treated consistently in each worksheet.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
possible widening of the scope of the IPPC Directive in relation to waste treatment activities Weblink	work includes the collection of country specific data and insights on the current practices, the identification of different options to address these issues and the exploration of the pros and cons of the different options.				waste activities, biological treatment, waste fuel, construction and demolition waste, off-site treatment installations for slag and ashes for recycling, sludge, plastic recycling, rubber recycling, mineral recycling, scrap metal preparation, used edible fats and oils, gypsum based products.					
ENTEC, 2010, *Assessment of the Possible Development of an EU-wide NO_x and SO_2 Trading Scheme for IPPC Installation*, Weblink	The overall objective of this project is to assess the desirability of a potential NO_x and SO_2 emissions trading system for IPPC installations. The report includes an installation database, which contains over 5,000 installations, plants or processes from all over EU-27. Data are extracted from various sources, EPER, LCP Emissions Inventory. Modelling is done using a reference scenario and GAINS model scenario.	NO_x, SO_2	2004 - 2006	EU-27	Public power and district heating sector (combustion plants > 50 MW), refineries, steel, cement, glass, paper, and other industrial combustion (> 50 MW).		✓			These installations contribute approximately 90% of SO_2 and NO_x emissions from IPPC sectors.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
AEA, 2007, *Evaluation of the costs and benefits of the implementation of the IPPC Directive on Large Combustion Plant* Weblink	This report presents the cost-benefit analysis (CBA) of scenarios developed by IIASA using the GAINS model to assess the impact of different emission levels resulting from variation in the interpretation and implementation of BAT on Large Combustion Plant under the IPPC Directive. Two scenarios have been developed: one with implementation of the upper end of the BAT AEL level and the other one with implementation of the lower end of the BAT AEL. One of the sections looks at the impact on emissions.	SO_2, NO_x, PM 2.5.	Scenarios were established and compared to the 2020 baseline scenario	EU 27	Emissions from large combustion plants	✓				
Alterra, 2007, *Integrated measures in agriculture to reduce ammonia emissions* Weblink	The report looks at defining the most appropriate, integrated and consistent actions to reduce nitrogen (N) emissions from agriculture to atmosphere, groundwater and surface waters.	N-derived pollutants: NH_3, NO_3, N_2, N_2O, NO	Reference year for the models: 2000; projection for 2010 and 2020	EU-27	Agriculture	✓		✓		Although there is a strong focus on emissions to water, the background for the service contract is explicitly stated as the Thematic Strategy on Air Pollution. A parallel project running alongside the previous one was led by IIASA and looked at updating the data for the RAINS modelling using all the new data gathered in the recent studies Weblink
European Commission, 2007, *Assessment of the*	The report includes a summary of the data collection and analysis that has been undertaken looking at	NO_x, SO_2, Dust	Baseline 2004; projections are develop	Data was collected for 43 case studies in selected MS: Czech Republic, Denmark, Finland, Germany,	Combustion installations with multiple boiler units	✓				Detailed data for each individual case study of installation are provided in the appendices.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
environmental impacts and costs arising from the implementation of the LCP and IPPC Directive for combustion installations with multiple boiler units. Weblink	the environmental impacts and costs arising from the implementation of the LCP and IPPC Directives for combustion installations with multiple boiler units. The report realised an assessment of costs and benefits, using data and models from CAFE		ed for the period 2008-2015	Greece, Poland, Slovenia, Spain, UK.						
European Commission, 2007, *Assessment of the application and possible development of community legislation for the control of waste incineration and co-incineration* Weblink	The objective of the study was to assess implementation of the Waste Incineration Directive, propose amendments of the Directive and assessments of those possible amendments. The project did case-studies of some installations. These contain data from MS who responded to the consultation.	Dust, SO_2, NO_x, Heavy metals, POPs,	The MS questionnaire asked for data from the past two years.	EU-27	Focus on waste incineration and looks at different activities: hazardous waste incinerators, municipal waste incinerators, cement plants, lime plants, power station and expanded clay plant. The report also contains a more detailed breakdown.	✓				Data reported are not complete, some MS reported one data measuring instead of the two required. Interestingly one table in the report looks at the quality of the data available per type of activity (p.167).
IIASA, 2012, *Emissions from agriculture and their control potentials* IIASA	The report looks at recent developments in control of agricultural emissions and suggests concrete steps to incorporate these new developments into the GAINS integrated assessment model through modified definitions of mitigation options, adjusted data on emission removal efficiencies and their	NH_3, PM 2.5, PM10		EU-27 + neighbours	Agricultural emissions			✓		The report looks at various abatement options, their costs and their impacts on emissions. No data set is provided in the report.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
	applicability, and emission control costs.									
Environment Agency, 2012, *Sustainable Business Report 2011* Weblink	Report looks at the performance record of businesses in England and Wales. The report provides comparison of the share of regulated activities with other sectors such as other industrial activities, domestic sources and transport.	SO_x, NO_x, NH_3, PM10	2000, 2005, 2008, 2009, 2010, 2011	UK	Intensive farming, Combustion (incineration), Cement and other minerals, Chemicals, Combustion (power), Food and drink, Metals, Paper and textiles, Refineries and fuel production, Bio-waste, Landfill, Waste storage treatment transfer and use, water companies	✓	✓			Limited to the UK, general data.
JRC, 2010 *Regulating Air Emissions from Ships* Weblink	Report summarises the key findings of several years' research activity and provides a reference framework for analytical tools designed to support the regulation of air emissions from ships. Outlines the 'state of the art' with regard to the main methodological aspects of designing policy measures to regulate air emissions from maritime transport, namely identification of the impacts, estimation of emissions, and identification and selection of technological and policy	SO_2, NO_2, VOCs, PM	2009/2010	Data provided per techniques.	Maritime transport				✓	The report also contains a list of data sources in relation to maritime emissions.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
	options to abate air emissions from ships.									
EEA, 2011 *Laying the foundations for greener transport — TERM 2011: transport indicators tracking progress towards environmental targets in Europe* Weblink	An annual indicator-based assessment of how well transport and environment policy is performing. The report looks at emissions from transport and ways to make this sector more sustainable. The reports look at the reduction targets that are in place in relation to transport, for different pollutants. The TERM process has got a set of indicators, of particular relevance are TERM03, TERM04.	NO_x, SO_x, NMVOCs, NH_3, PM,	1990, with more recent data provided when available	Aims to cover all 32 EEA member countries i.e. 27 EU Member States, one candidate country (Turkey), and Iceland, Liechtenstein, Norway and Switzerland. Where data are not complete, this is generally noted in the metadata section, where different country groupings are also described. For some indicators, EU-27 data have been prioritised, as policy targets and goals are specifically developed for these countries.	Transport				✓	There is a focus on GHG, but other air pollutants are present.
IIASA, 2012 *Future emissions of air pollutants in Europe – Current legislation baseline and the scope for further reductions* Weblink	Report presents an outlook into the likely development of emissions and resulting air quality impacts that emerges from the latest expectations on economic development and the implementation of recent policies on energy, transport, agriculture and climate change.	SO_2, NO_x, NH_3, PM,VOC	Projections up to 2030	43 European countries	Energy, Transport, Land use and agricultural activities. More categories are covered in sections on individual pollutants (power generation, domestic sector, industrial combustion, industrial processes, fuel extraction, solvent use, road transport, non-road		✓		✓	The baseline assumes full implementation of existing air pollution control legislation in the European Union.

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
					mobile, waste treatment and agriculture).					
IIASA, 2012, *Factors determining recent changes of emissions of air pollutants in Europe,* Weblink	Compares the final baseline emission projection developed in 2005 within the Clean Air For Europe (CAFE) programme for the Thematic Strategy on Air Pollution against the recent baseline projection prepared for the revision of the Thematic Strategy in 2012 (the TSAP- 2012 baseline) – see previous entry. The aim is to realign the baseline scenario by updating it with observation.	SO_2, NO_x, PM 2.5,NH_3, VOC	2010 data and 2020 projection	The study covers each EU Member State; however, results are reported for groups of countries, i.e., EU-15) and the new Member States (NMS-12) that joined the EU after 2004.	Report looks at overall emission quantities, but does not distinguish sectors.	✓	✓	✓	✓	The available data do not provide sufficient detail that would allow a full quantification of the role of efficiency improvements. The analysis compares costs for emission controls as estimated in 2005 by the Thematic Strategy with the recent estimates of the baseline projection for the 2012 revision of the Thematic Strategy.
IIASA, 2012, *Emissions from households and other small combustion sources and their reduction potential* Weblink	Report explores the potential contribution of Eco-design product standards to the achievement of the targets of the Thematic Strategy on Air Pollution. It develops different scenarios for the implementation of more stringent emission limit values to small combustion sources. Concludes that emissions from small combustion sources could be reduced with the introduction of Eco-design standards.	PM2.5, PM10, NMVOC, Black Carbon, NO_x	2012 Baseline	EU-27	Domestic emissions and small combustion. Some data presented per type of boiler/stove.				✓	Report emphasises the large uncertainties associated with measuring emissions of PM and NMVOC from small combustion installations. Emissions depend heavily on fuel quality (humidity) and the actual operating conditions. Consequently, real-life emissions are quite different from those measured in the laboratory.
VITO, 2012, *Specific evaluation of*	Scope of this report is to present the methodology of building	NO_x, SO_2	Baseline (BL) year is	EU sea region	Transport / Shipping				✓	Distinguishes between existing Sulphur Emission Control Areas (SECAs), new

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
emissions from shipping including assessment for the establishment of possible new emission control areas in European Seas	up the international shipping emissions inventory, the assumptions chosen for developing the baseline emissions and the current legislation baseline (CLE) projections, the development of scenarios to explore different policy measures, the assumptions adopted in estimating the costs of the proposed scenarios, and as assessment of the results. EMEP and IIASA will use the data provided to assess the benefit of proposed scenarios.		2005, and the report developed Current Legislation Projection (CLE) emissions for 2020, 2030 and 2050							ECAs that reduce NOx emissions (NECAs), and new ECAs that control SO_2 emissions (new SECAs). The report worked on further developing the EX-TREMIS/ EUROSTAT (EE) dataset. The emission factors are based on fleet dynamics (fleet renewal, size increase); fuel consumption based on activity data; and emission factors, in terms of kg per kg fuel. A compatibility matrix is setup, linking propulsion technology with the different vessel types and size classes.
AMEC, 2011, *Industrial emissions of nanomaterials and ultrafine particles* Weblink	Objectives were to summarise the current knowledge on the release of NMs (nanomaterials) and UFPs (ultrafine particles) in EU-27, provide an overview of the impacts on health, recommendations on how to address the knowledge gaps and review whether the EU legislation addresses UFPs and NMs appropriately. The report identifies key gaps such as the very little information available on emissions from NMs from industrial sources. The same is applicable for UFPs.	PM (PM10, PM0.1)	Used data submitted under CLTRAP reporting obligation and point source emissions data from E-PRTR, 2008 data.	EU-27	Report looked at the share of emissions for the following sectors: power generation, industrial combustion, residential and commercial, road transport, other transport and machinery, industrial processes, agriculture and other. The industrial sector is divided into NFR sector: metals, heat and electricity, petroleum			✓		Most of the published work on emissions of UFPs relates to road transport activities. There is very little information available on emissions from specific industrial sources and considerable uncertainties about factors such as emitted quantities, and variation in size particles between the different industrial sectors and activities. The same is applicable for NMs. Other limitations detailed are the limited availability of information on costs, the fact that most information obtained came from experimental laboratory and the little information available for the reliability

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories: (i)	(ii)	(iii)	(iv)	Comments
	The study used a limited set of data with a lot of uncertainties on the impacts of different abatement techniques. Data on PM10 and PM2.5 emissions were used to calculate PM0.1 emissions.				refining, iron and steel, chemicals, pulp and paper, food and beverages and other.					and repeatability of testing.
Emission models										
The Greenhouse Gas and Air Pollution Interactions and Synergies (Gains) model Weblink	Gains model provides information on economic activities (causing emissions), emission control strategies (scenarios), emission scenarios, control costs (for given scenario), impacts (environmental and human health). The model can be operated in two ways: - scenario analysis which is tracking the emissions from source to impact, or in the "optimisation mode" – where the most cost effective way to reduce emissions is calculated.	NH_3, CO_2, CH_4, NO_x, N_2O, TSP, PM10, PM2.5 and PM1, SO_2, VOC Some scenarios also contain: CO and F-gases	Multiple future and past emissions projections are available depending on the scenario	EU-27 Each Member State individually Norway, Switzerland, Croatia, Russia, Turkey, Ukraine and others.	In general, activities are divided into several categories: macroeconomic drivers, energy-use, data on buildings, industrial processes, agriculture and transport (mobile). Activities do not follow a single reporting format however Gains activities can be mapped onto NFR01 activities	✓	✓	✓	✓	

Appendix C
Review of water emission data sources

Main data sources

The emissions data for water were identified from the main following sources.

Table C.1 Water emissions sources

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories:			
						(i)	(ii)	(iii)	(iv)
E-PRTR	PRTR database	Wide range	2007-2010	By country, region or river basin	PRTR sectors	x	x		
Waterbase	Detailed data sets of emissions to water. Data set in 4 parts: hazardous substances diffuse and point and nutrients diffuse and point.	Haz subs include: As, Cd, Cu, Cr, Pb, Hg, Ni, Zn and to some extent a range of organic toxics. Eutroph subs include: tot N, Tot P, COD and BOD	Vary between MS – from 2001-2010.	The data are presented for each river basin district	No specific sectoral disaggregation. However, the source codes identify whether the source is under PRTR or not – so it is possible to quantify E-PRTR and non-E-PRTR emissions It is possible to know the total discharges per year for a pollutant to a RBD separating point and diffuse sources.				
WISE WFD database	The data are drawn from RBMPs submitted by MS								
HELCOM MDS: Municipal WWTPs	Dataset contains information on the location of municipal wastewater treatment plants in the HELCOM region as well as on emissions of nitrogen and phosphorus.	N, P	2006 (note an earlier separate data set for 2000 is available)	All MS/catchments discharge to the Baltic	Municipal WWTPs only		x		

Data source	Summary	Pollutants	Timescales	Geographical disaggregation	Sectoral disaggregation	Relevant to categories:			
						(i)	(ii)	(iii)	(iv)
HELCOM MDS: industries	Dataset contains information about the location of industries around the Baltic Sea and emission data for nitrogen and phosphorus collected in 2000.	N, P	2000	All MS/catchments discharge to the Baltic		x	x		
HELCOM MORS Discharge database	Discharges of radionuclides from nuclear power plants in the Baltic Sea region as well as Sellafield and The Hague reprocessing sites	Contains data for 111 different radionuclides	Most data 2007, with some later updates incl 2012.	All MS (and Russia) in the Baltic. Also NL and UK	Data are for 16 major nuclear sites – power stations and reprocessing. Data are presented per site and not aggregated.				x

Coverage of E-PRTR and Waterbase databases

E-PRTR and Waterbase were the most relied upon data source for this project, the table below presents the coverage of pollutant in each database. A scoring system is provided, indicating where data coverage is poor (★), average (★★) or good (★★★).

Table C.2 Water emissions coverage by E-PRTR and Waterbase

Pollutant	E-PRTR	Waterbase
1,2,3,4,5,6-hexachlorocyclohexane (HCH)	★	
1,2-dichloroethane (DCE)	★★	★★★
Alachlor	★	★
Aldrin	★	★
Ammonium		★★★
Anthracene	★	★★★
Arsenic and compounds (as As)	★★★	★★★
Asbestos	★	
Atrazine	★	★

Pollutant	E-PRTR	Waterbase
Benzene	★	★★★
Benzo(a)pyrene		★★
Benzo(b)fluoranthene		★★
Benzo(ghi)perylene	★★	★★
Benzo(k)fluoranthene		★★
BOD		★★★
Brominated diphenylethers (PBDE)	★	
Cadmium and compounds (as Cd)	★★★	★★★
Chlorfenvinphos	★	★
Chlorides (as total Cl)	★★★	
Chloro-alkanes C_{10}-C_{13}	★★	★
Chlorpyrifos		★
Chromium and compounds (as Cr)	★★★	★★★
Copper and compounds (as Cu)	★★★	★★★
Cyanides (as total CN)	★★★	★★
DDT	★	
Di-(2-ethyl hexyl) phthalate (DEHP)	★★★	★
Dichloromethane (DCM)	★★	★
Dieldrin	★	★
Diuron	★	★
Endosulphan	★	
Endrin	★	★
Ethyl benzene	★	
Ethylene oxide	★	
Fluoranthene	★★	★★
Fluorides (as total F)	★★★	
Halogenated organic compounds (as AOX)	★★★	★★★
Heptachlor	★	
Hexabromobiphenyl	★	

Pollutant	E-PRTR	Waterbase
Hexachlorobenzene (HCB)	★	★★
Hexachlorobutadiene (HCBD)	★★	★★
Indeno(1,2,3-cd)pyrene		★★
Isodrin	★	★
Isoproturon	★	★
Lead and compounds (as Pb)	★★★	★★★
Lindane	★	★
Mercury and compounds (as Hg)	★★★	★★★
Naphthalene	★★	★★
Nickel and compounds (as Ni)	★★★	★★★
Nitrate		★★
Nonylphenol and Nonylphenol ethoxylates (NP/NPEs)	★★	
Octylphenols and Octylphenol ethoxylates	★★	★
Organotin compounds (as total Sn)	★	
PCDD + PCDF (dioxins + furans) (as TEQ)	★★	
Pentachlorobenzene	★	★
Pentachlorophenol	★★	★★
Phenols (as total C)	★★★	
Polychlorinated biphenyls (PCBs)	★★	
Polycyclic aromatic hydrocarbons (PAHs)	★★	★
Simazine	★	★
Tetrachloroethylene (PER)	★★	★★
Tetrachloromethane (TCM)	★★	★★
Toluene	★	★★
Total nitrogen	★★★	★★★
Total organic carbon (TOC) (as total C or COD/3)	★★★	★★★
Total phosphorus	★★★	★★★
Total suspended solids		★★★
Toxaphene	★	

Pollutant	E-PRTR	Waterbase
Tributyltin and compounds	★	★
Trichlorobenzenes (TCBs) (all isomers)	★★	
Trichloroethylene	★★	★★★
Trichloromethane	★★	★★
Trifluralin	★	★
Triphenyltin and compounds	★	
Vinyl chloride	★★	
Xylenes	★★	
Zinc and compounds (as Zn)	★★★	★★★

Other data sources

OSPAR

OSPAR has had a particular focus on understanding the inputs and behaviour of hazardous substances in the North East Atlantic, many of which come from land-based sources. To take this forward it established the Comprehensive Study on Riverine Inputs and Direct Discharges which focuses on mandatory reporting on concentrations and loads of substances to the area. The last full OSPAR survey was published in 2008 "Towards the cessation target: Emissions, discharges and losses of OSPAR chemicals identified for priority action". This was a major evaluation of hazardous substance concentrations and sources linked to development of work on priority substances under the Water Framework Directive. The comments below are for those substances which are still produced or used in the territory of the contracting parties:

- Cadmium: detailed atmospheric deposition to water emissions under the European Monitoring and Evaluation Programme (EMEP). Water based emissions based on the European Pollutant Emission Register (EPER), total riverine inputs and initial assessment of ship-based sources;
- Lead: atmospheric and total riverine inputs included;
- Mercury: atmospheric and riverine inputs included and some consideration of waste water and diffuse sources;
- TBT: antifoulant uses are reported;
- Perfluorooctane sulphonate (PFOS): emissions not monitored;
- Tetrabromobisphenol-A (TBBP-A): no data on loads;
- Trichlorobenzenes (TCBs): some air data, but not water discharges;

- Brominated flame retardants (BFR): “very limited national quantitative information available on the levels of emissions, discharges and losses of polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCD) from point sources; no data are available on releases from products”;

- Polychlorinated biphenyls (PCBs): “Data reported by Contracting Parties on riverine inputs and direct discharges under the OSPAR RID Study are too patchy for assessment”;

- Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs): only considers emissions to air;

- Chlorinated paraffins: notes release to water from waste but data are very limited;

- 4-(dimethylbutylamino) diphenylamin (6PPD): “There is no routine monitoring or any data from national surveys of 6PPD releases”;

- Dicofol: “There are no data available on emissions, discharges or losses of dicofol in the OSPAR Convention area”;

- Endosulfan: water quality information collected – but not data on emissions to water;

- Lindane: The sum of direct and riverine discharges of lindane from was estimated to be in the range of 477 − 958 kg. “The Netherlands reported that the total figure for lindane in sewage effluents is already very low (< 0.07 kg/Yr)” “The total amount discharged to water from the basic organic chemical industry was 20 kg in 2004”. This shows that specific monitored sources are small compared to total water inputs;

- Pentachlorophenol (PCP): some monitoring of water and sediments, but no discharge data;

- 2,4,6-tri-tert-butylphenol (2,4,6-TTBP): “There are no data available on emissions, discharges and losses of 2,4,6-TTBP to the environment”;

- Nonylphenol ethoxylates (NPEs): “No data are available on riverine loads or atmospheric inputs of nonylphenol to the OSPAR maritime area.” Very limited studies on possible sources;

- Octylphenol: There is no OSPAR monitoring of releases of octylphenol to water or air. There is evidence from national monitoring that the substance has been detected in rivers.”;

- Phthalates: “There is no monitoring of discharges or emissions of phthalates.” OSPAR provides an overall estimate of inputs based on extrapolation of older data; and

- Polycyclic aromatic hydrocarbons (PAHs): data for water discharges are reported from IPPC/IED installations, with some additional data on offshore discharges and dumped dredged sediments. Riverine inputs are ‘hardly reported’.

As a result, OSPAR concluded that for heavy metals (cadmium, mercury and lead) “quantitative information on atmospheric deposition, riverine inputs, dumping and releases from industrial installations is available”. On PAHs “the type of information sources on releases is similar to those for heavy metals, except that no riverine input data are available”. “For organic tin compounds, quantification of releases is difficult as there are insufficient data”. “No or little data are available on PCB and dioxin discharges and losses to the aquatic environment”. “For the other

organohalogens (PFOS, tetrabromobisphenol-A, trichlorobenzenes, brominated flame retardants, and short chained chlorinated paraffins) as well as for 6PPD, quantitative information on releases is very scarce and distribution statements cannot be made". "Data on releases are scarce for pesticides (dicofol, endosulfan, lindane, methoxychlor, PCP and trifluralin)".

In conclusion, data on individual sources of these substances from activities as defined in this study are not yet available within OSPAR.

HELCOM

HELCOM has a major focus on the assessment of pollution in the Baltic Sea and adoption of relevant control measures to deliver the objectives of the Baltic Sea Action Plan. However, data available from HELCOM are limited. By far the largest effort has been put into assessing the atmospheric inputs of pollutants (nutrients and hazardous substances) to the Baltic Sea, with numerous repeated assessments. Where land-based sources are included, such as the Fifth Baltic Sea Pollution Load Compilation (PLC-5), this largely focuses on nutrients. The database available at HELCOM is GIS-based and allows identification of pollutant sources, but it is not a source of discharge data.

The most detailed assessment of the relative inputs of pollutants to the Baltic Sea to support the work of HELCOM has come via the EU funded COHIBA (Control of Hazardous Substances in the Baltic Sea Region) Project. In 2012 it published "Major Sources and Flows of the Baltic Sea Action Plan Hazardous Substances" with supporting country studies. This aimed, inter alia, to "identify the most important sources of 11 hazardous substances of special concern, quantify inputs of the selected substances to the Baltic Sea and analyse the pathways of the selected substances from production, processes and uses, to the marine environment". To do this it used a substance flow analysis from manufacture, use to end-of-life. Data on emissions and analysis were performed for Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany. As a result, the study is not an inventory as such and, therefore, not of immediate use to this project. However, the conclusions provide some insight into the relative importance of different sources to the Baltic, including industry and WWTPs. These conclusions are set out for each pollutant group below:

- Dioxins (PCDD), furans (PCDF) and dioxin-like polychlorinated biphenyls (PCBs): around 10% of emissions are to water, with the majority of emissions from an 'other' category, mostly from Poland;
- Tributyltin compounds (TBT), triphenyltin compounds (TPhT): "No emission data were found for TPhT and it was therefore not possible to quantify the emissions of TPhT to the Baltic environment" ;
- Pentabromodiphenyl ether (pentaBDE), octabromodiphenyl ether (octaBDE), decabromodiphenyl ether (decaBDE): Around 2-3% of emissions are to water, with the highest emissions coming from Finland, Sweden and Poland. Most emissions arise from the application of contaminated sewage sludge to land and use of flame retarded products;
- Perfluorooctane sulphonate (PFOS), Perfluorooctanoic acid (PFOA): Around 50% of emissions are to water, with most coming from Finland and Germany. The main sources are WWTPs, such as indirectly from the use of fire-fighting foam. Industrial sources include the metal plating industry and an additional source is landfill leachate. However, it should be noted that PFOS was banned for use in fire-fighting in 2011 and the data used are before this ban;

- Hexabromocyclododecane (HBCDD): Around 50% of emissions are to water and the main Member State sources are Poland, Finland and Germany. The former two had some industrial source contributions. However, the major sources of HBCDD to aquatic receptors are the construction and demolition of buildings and the manufacture of flame retarded products;

- Nonylphenols (NP), nonylphenol ethoxylates (NPE): Around 80% of emissions are to water. In Lithuania and Poland the main source is industry, but for the other countries it is WWTPs. Industrial sources include the leather processing industry, the pulp and paper industry and the use of NPE in metal extraction, refining and processing industries. Other reported sources were car washing (Finland) and use of pesticides in Sweden and Poland;

- Octylphenols (OP), octylphenol ethoxylates (OPE): Around 40% of emissions are to water. Although overall there are various emission sources, for water WWTPs are the main source and the private washing of textiles contributes 30-50% of emissions to waste water. Industrial sources include the use of OP-based resins in insulation varnishes (about 50% of industrial emissions) in Poland and Germany and the manufacture of OP-based resins (about 10% of industrial emissions) in Poland and possibly Estonia;

- Short-chain chlorinated paraffins (SCCP), medium-chain chlorinated paraffins (MCCP): Around 40% of emissions are to water. Most arise from service life sources, but industry remains an important source in some countries, often via WWTPs, such as in metal cutting/working fluids in Finland, Poland and Sweden and possibly in Estonia;

- Endosulfan: Around 35-50% of emissions are to water. However, it should be noted that endosulfan has been phased out so that there are no direct emissions. WWTPs still release the substance and there is atmospheric input;

- Mercury: Around 5-12% of emissions are to water. The main categories emitting mercury are ‘other’ and 'industry', the latter particularly around major combustion activities, such as cement production, coal industry and zinc production. Poland dominates emissions; and

- Cadmium: Around 20-30% of emissions are to water. Emissions are dominated by Poland, with some historical sources from Finland. Key sources include thermal power stations and other combustion installations (including combustion in households) as well as traffic.

International Commission for the Protection of the Danube River (ICPDR)

The ICPDR has a focus on the monitoring of heavy metals, nutrients and organic loads. Eight heavy metals (arsenic, copper, chromium, zinc, cadmium, lead, mercury and nickel) are regularly analysed within the ICPDR’s TransNational Monitoring Network (TNMN). The TNMN has an objective to understand long-term trends in loads and the first assessment was carried out in 2000. However, it should be noted that the agreed procedure for assessment of loads (“Transboundary assessment of pollution loads and trends”) is based on a sampling of levels of pollutants in the water column of the main river and tributaries. Therefore, while the TNMN Yearbook provides regular updates on water quality and loads, these are overall assessments of loading along the river length and not according to individual sources or categories of activity that could be compared to the activity categorisation within this project.

Rhine Commission

The Rhine Commission does not contain very recent data. The most recent assessment of pollution was conducted to develop the first River Basin Management Plans under the Water Framework Directive. It would be expected to take a more detailed assessment during the current development of the second River Basin Management Plan. Data are more general focused on water quality changes, for which the Rhine Commission has specific objectives.

Appendix D
Summary of air emissions data gaps by activity

Activities for which gaps were filled based on sectoral or industry reports

Gap filling for activities involving combustion installations

Emissions data were available from a recent report by AMEC (2013) covering combustion installations[15] with a total rated thermal input below 50 MW. This AMEC (2013) dataset was based on Member States' own estimates with gap filling from other studies and extrapolation of data when insufficient Member State information was available. The report includes emissions data for NO_X, SO_X and PM for three combustion classes: 1-5 MWth, 5-20 MWth and 20-50 MWth. Data from the first two size classes have been combined to fill activity 101 ('Combustion plants below 20 MWth') in category iii and data from the third size class were used to fill activity 061 ('Combustion of fuels in installations with a total rated thermal input above 20 MW and below 50MW') in category ii. Some caution needs to be exercised with regard to these data for activities 061 and 101, as a portion of these emissions from AMEC (2013) are potentially reported under LRTAP as emissions from 'domestic' or 'commercial services' and as such double-accounted in category ii, iii and iv. However, the uncertainties are too great to be able to estimate the share of these potentially double-accounted emissions. It is also possible that installations have reported emissions from those parts of the installation that would be under the IED threshold, as part of overall emissions (i.e. a single value) in E-PRTR (where a combustion plant below 50MWth is directly associated to an IED regulated facility). This could mean that some of the data understood as 'regulated' in category i may include some of the emissions from categories ii and iii.

Manipulation for emissions from livestock

Data are available in LRTAP and E-PRTR on ammonia emissions to air from livestock. However some manipulations were necessary for the following reasons:

- E-PRTR covers only poultry and swine rearing above the IED thresholds, not cattle;
- Some Member States have reported under the general 7(a) E-PRTR heading without specifying whether the emissions is from poultry or swine rearing; and
- LRTAP covers the following livestock categories: swine, poultry, cattle dairy and cattle non-dairy. However it does not make any distinctions on the size of the holding.

For the purpose of this report livestock emissions were split in different categories as follows:

1. Emissions from intensive livestock rearing as defined in the IED (category i);

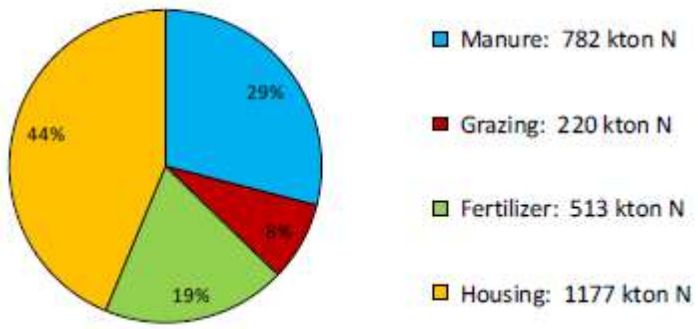
[15] AMEC, 2013, Analysis of the impacts of various options to control emissions from the combustion of fuels in installations with a total rated thermal input below 50 MWth.

2. Emissions from spreading of manure (affected by the Nitrates Directive) from cattle, poultry and swine (category ii); and

3. The remaining emissions from rearing cattle (distinguishing dairy and non-dairy), poultry and swine (category iii).

The first category was filled with emissions from E-PRTR reported under 7(a), 7(a)(i), 7(a)(ii) and 7(a)(iii). For determining the second category we relied on a study conducted by Alterra (2011)[16] on the impacts of the Nitrates Directive on emissions of gaseous N. It found that most of the emissions of ammonia in the agricultural sector are coming from housing and storage systems (44%) followed closely by manure application (29%). It also concluded that, at a Member State level, the share of ammonia emissions from these sources (i.e. housing, storage, spreading and grazing) is generally consistent although there are some variations.

Figure D.1 Sources of emissions of ammonia in agriculture for EU27 in 2008 (kton N yr-1)



Source: Alterra, 2011

These same proportions have been applied in this study but emissions from chemical fertiliser, which are presented in a separate activity in the database, were removed. As a result, it was estimated that around 36% (instead of 29%) of ammonia emissions in the agricultural sector are due to the spreading of manure. For the relevant livestock types (i.e. poultry and swine), the quantity of ammonia emissions reported in E-PRTR were subtracted from those reported under LRTAP. Subsequently the ratio determined was applied to the remaining emissions, 36% were allocated to the 'spreading of manure' activity (category ii), the remaining emissions were allocated to the 'emissions from rearing under IED threshold' (category iii). For cattle, the ratio was directly applied to the ammonia emissions reported under LRTAP in order to distinguish category ii and category iii emissions.

[16] Alterra (2011) The Impact of the Nitrates Directive on gaseous N emissions

Gap filling for organic solvents

The emissions of VOC emissions reported under the E-PRTR appeared to be under-estimated. As a result emissions of VOCs from the use of organic solvents in category i were taken from AMEC's (2013) review of the implementation of the Solvents Emissions Directive across the EU Member States[17].

Activities for which gaps were filled through combining E-PRTR and LRTAP data

Table D.1 For the following activities, the emissions data were derived by combining E-PRTR and LRTAP data.

[17] AMEC, 2013, Analysis of Member States' reports on the implementation of the Solvent Emissions Directive (1999/13/EC) and Paints Directive (2004/42/EC)

Table D.1 Activities for which air emissions were derived by combining E-PRTR and LRTAP data

Activity Code in the database	Category	Activity description	Data combined to obtain emissions
015	i	Production of cement, lime and magnesium oxide: production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other kilns with a production capacity exceeding 50 tonnes per day	Sum of emissions reported in E-PRTR under 3(c)(i) and 3(c)(iii)
021	i	Production of organic chemicals	Sum of emissions reported in E-PRTR under 4(a)(i), 4(a)(ii),4(a)(iii), 4(a)(iv),4(a)(ix),4(a)(v),4(a)(vi),4(a)(vii),4(a)(viii),4(a)(x),4(a)(xi)
022	i	Production of inorganic chemicals	Sum of emissions reported in E-PRTR under 4(b)(i), 4(b)(ii), 4(b)(iii), 4(b)(iv) and 4(b)(v)
028	i	Waste incineration	Sum of LRTAP emissions under NFR codes C A 6 , C B 6 , C C 6 , C D 6 , C E 6
060	ii	Processing of non-ferrous metals: melting, including the alloyage, of non-ferrous metals, including recovered products and operation of non-ferrous metal foundries, with a melting capacity below 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals.	Sum of E-PRTR emissions under 2(e)(i) and 2(e)(ii) subtracted from LRTAP emissions reported for the following NFR codes: 2 C 3 + 2 C 5 a + 2 C 5 b + 2 C 5 c + 2 C 5 d
062	ii	Production of cement clinker in rotary kilns with a production capacity below 500 tonnes per day or in other kilns with a production capacity below 50 tonnes per day	LRTAP emissions reported under NFR code 2 A 1- emissions in activity 015 (see above)
063	ii	Production of lime in kilns with a production capacity lower than 50 tonnes per day	LRTAP emissions reported under NFR code 2 A 2 – emissions in activity 016 (Production of cement, lime and magnesium oxide: production of lime in kilns with a production capacity exceeding 50 tonnes per day)
064	ii	Melting mineral substances including the production of mineral fibres and manufacturing of glass including glass fibre with a melting capacity below 20 tonnes per day	5% of emissions reported in the E-PRTR under activities 3 (e) + 3 (f)
071	ii	Landfills as defined in Article 2(g) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste(1) OJ L 182, 16.7.1999, p. 1., receiving less than 10 tonnes of waste per day or with a total capacity below 25 000 tonnes, excluding landfills of inert waste	LRTAP emissions reported under NFR code 6 A - activity 032 (above thresholds)

Activity Code in the database	Category	Activity description	Data combined to obtain emissions
083	ii	Activities using organic solvents listed in Part 1 of Annex VII to IED below the consumption thresholds set out in Part 2 of that Annex.	LRTAP emissions reported under NFR codes 3 A 2, 3 A 3, 3 B 2,3 B 1, 3 D 1 , 3 D 3 - category i emissions from organic solvents and VOC emissions from installations for the building of and treatment of ships and emissions reported to E-PRTR under category 9 c.
092	iii	Production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity lower than 2.5 tonnes per hour	LRTAP emissions reported under NFR code 2 C 1 - activity 007 (same activity above threshold)
094	iii	Production in industrial installations of one or more of the following wood-based panels: oriented strand board, particleboard or fibreboard with a production capacity below 600 m3 per day	LRTAP emissions reported under NFR code 2 D 3 - Activity 037 (above threshold)
095	iii	Rearing of poultry below 40 000 places for poultry, excluding manure	See agriculture gap filling
096	iii	Rearing of pigs with less than 2 000 places for production pigs (over 30 kg) and / or with less than 750 places for sows - excluding manure	See agriculture gap filling
100	iii	Storage, handling and transport of agricultural products on and off-farm	LRTAP emissions reported under NFR code 4 D 2 and 4 D 2 b
102	iii	Rearing of livestock other than poultry, pigs or cattle	LRTAP emissions reported under NFR codes 4 B 2, 4 B 13, 4 B 4, 4 B 6, 4 B 7
110	iv	Domestic emissions (all)	LRTAP emissions reported under NFR codes 1 A 4 b i + 1 A 4 b ii
111	iv	Commercial services	LRTAP emissions reported under NFR codes 1 A 4 a i + 1 A 4 a ii
107	iv	Road transport: passenger cars, light duty vehicles, heavy duty vehicles, mopeds & motorcycles, gasoline evaporation, automobile tyre and break wear, automobile road abrasion	LRTAP emissions reported under NFR codes 1 A 3 b i + 1 A 3 b ii + 1 A 3 b iii+ 1 A 3 b iv+ 1 A 3 b v+ 1 A 3 b vi+ 1 A 3 b vii
106	iv	Aviation	LRTAP emissions reported under NFR codes 1 A 3 a i (i) + 1 A 3 a ii (i)

Activities for which alternative methods for gap filling were used

Alternative methods for gap filling were investigated for a number of activities for which the three initial steps of gap filling were found to not be feasible. This section describes the approaches adopted for activities for which data were sufficient to complete the gap filling exercise.

Wood panels and paper sector

E-PRTR category 6(b) covers production of paper and board and wood-panels above 20 tonnes per day. IED separates production of paper and board above 20 tonnes as one activity (activity 036 in category i); and production of panels above 600m^3 per day as the second activity (activity 037 in category i). In addition, thresholds for wood based panels between E-PRTR and IED are different: E-PRTR uses a threshold of 20 tonnes per day, while IED uses a threshold of 600m^3. Furthermore E-PRTR does not specify the type of wood panels covered; while IED specifies three types of boards: particleboard (PB), oriented strand board (OSB) and fibreboard (FB).

The following tasks were completed for the gap filling:

- separating share of emissions for paper and cardboard, from emissions for wood based panels (to determine category i emissions) under E-PRTR category 6(b);
- estimating the difference in emissions between applying 20 tonnes and 600m^3 thresholds for wood panels (to determine category i emissions) and determining the share of emissions from particle board, OSB and fibreboard; and
- determining emissions from paper and cardboard and wood panels activities below the IED thresholds (to determine category iii emissions).

Wood-based panels

Research completed in 2007 by VITO on the wood based panels production in the EU showed that:

- 92% of EU wood panels is produced in plants with capacity greater than 500m^3/day, while 82% is in plants with capacities greater than 850m^3/day (VITO, 2007). Based on that, it was estimated that plants with production greater than 600m^3/day (the IED threshold) cover approximately 89% of total EU production;
- Capacity of wood panel production plant of 20 tonnes per day (E-PRTR threshold) is estimated to be close to 33m^3/day (VITO, 2007). It is unlikely that any wood panel production plants in the EU operate at capacities lower than 33m^3/day (VITO, 2007); therefore it is assumed that E-PRTR category 6 (b) covers all facilities producing wood based panels in the EU; and
- Production of OSB, PB and FB (regulated under the IED) covers 90% of the total wood panel production (VITO, 2007).

Emission factors for dust, CO, VOCs, NO_X and SO_X for OSB, PB and FB were based on those from a study undertaken as part of the IPPC review[18]. Production data in 2010 in each Member State were taken from the Forest Products Statistics 2007-2011 – prepared by the UNECE Trade and Sustainable Land Management Division (UNECE, 2013) (Eurostat data did not provide sufficient distinction between production of different types of wood based panels for it to be used). Production data absent for certain Member States were completed with 2005 data based on the information in VITO (2007)[19].

Emissions of PM_{10}, CO, VOCs, NO_X and SO_X were calculated by multiplying emission factors by production data for each Member State. PM_{10} emissions were calculated assuming 40% content of particulates in [total] dust.

Paper production

The following data were utilised:

- Emission factors for non-integrated paper plants were taken from EMEP/EEA (2009)[20]. Paper production (activity 036) excludes pulping as this is covered by a separate activity in the IED and E-PRTR; therefore emission factors for integrated paper plants could not be used. Emission factors were only available for NO_X and SO_X; and

- Paper production data for 2010 were taken from Eurostat.

Emissions of NO_X and SO_X were calculated by multiplying emissions factors by production data for each Member State.

Splitting category 6(b) emissions

The ratios between emissions of NO_X and SO_X from the production of paper, cardboard and wood-based panels were estimated for each Member State based on the calculations described above. Given NO_X and SO_X are both combustion related emissions, a single ratio was calculated for each Member State as an average of the NO_X and SO_X ratios. These ratios were then applied to split data in E-PRTR category 6(b) for 2010. When Member States did not report emissions, but production data suggested that there were operating installations in the Member State, emissions data were filled in from 2009. The data were split in the following activities:

- Production of wood panels above 600m^3 – activity 037 – this took into consideration that 89% of the reported emissions under E-PRTR would be from facilities regulated under the IED and therefore would fall into category i;

- Production of wood panels below 600m^3 – activity 094 – this presumed that 11% of all emissions reported in the E-PRTR fell into category ii; and

- Production of paper and board above 20 tonnes per day - activity 036 - this was calculated by subtracting the wood-panels part of the emissions from the E-PRTR category 6b. This was a category i activity.

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[18] IEEP, BIO and VITO (2006), Data gathering and impact assessment for a possible review of the IPPC Directive

[19] VITO (2007), Data gathering and impact assessment for a possible technical review of the IPPC Directive – Part 2

[20] EMEP/EEA, 2009, Emission inventory guidebook

- Production of paper and board below 20 tonnes per day – activity 074 – was calculated by subtracting the emissions calculated for activity 036 and emissions reported in the E-PRTR category 6a (pulp), from LRTAP NFR code 2D1 Pulp and paper and 1A2d - stationary combustion in manufacturing: pulp, paper and print.

Uncertainties and limitations of the methodology applied

The gap filling of emissions for wood based panels and paper production activities had a number of limitations, including:

- Information on emission factors was sparse and difficult to identify. Emission factors were not available for all pollutants examined in this study;
- Production data was available, however two different sources were used to identify the necessary data for the calculations;
- Ratios were only developed for combustion related emissions and not for process emissions; and

For activity 074 - Production of paper and board below 20 tonnes/day - the use of LRTAP emissions and apportioned emissions for category i activity meant that the results are highly uncertain and for many pollutants, the emissions obtained were a negative number.

Appendix E
Water emissions data gaps- review of additional reports

Study on three years of implementing the E-PRTR

For the Commission, UBA et al (2012)[21] undertook a comparison of data reported for water emissions in E-PRTR with those reported by MS under the UWWT Directive and the 'State of Environment' reporting. The purpose was to determine if such comparisons provided information on the completeness of the E-PRTR data.

The study found that reporting under UWWTD for large WWTPs (over 100,000 p.e.) was about 70% of that in E-PRTR (by number of facilities). They also concluded that the data provision on Total N, P and TOC is voluntary and therefore the data cannot be used to assess the completeness of E-PRTR reporting. For the purposes of this project, it is evident that these data would not address gaps in E-PRTR reporting.

Comparison between State of Environment reporting and the E-PRTR showed variable results. The hypothesis (given the thresholds for reporting for many pollutants in E-PRTR) is that E-PRTR reported numbers should be lower, but this was not always the case. The study concluded that the data could not be used to assess completeness or representativeness of E-PRTR reporting. As a consequence of the conclusions in this UBA report, it was concluded that the data are not suitable for addressing data gaps for this study.

Deltares study of E-PRTR diffuse water data

A study for the Commission by Deltares[22] examined diffuse water emissions under the E-PRTR by comparing the reported emissions to other means of calculating or estimating emissions, such as models or use of emission factors.

Deltares examined the completeness of E-PRTR data on water emissions for various sectors (e.g. agriculture, transport, urban waste water treatment plants). The report concludes that for all sectors there is a lack of transparent, consistent, comparable and actual data concerning emissions of diffuse sources, emission factors and statistical data covering all EU27 Member States. It also indicated that emissions data contained in the E-PRTR on diffuse sources are of limited use when scaling up to a European level. The report indicated that reporting under E-PRTR is likely to be more complete for point source emissions than diffuse emissions.

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[21] UBA, 2012, Three years of implementation of the E-PRTR Supporting study for the European Commission

[22] Deltares (2013). Diffuse Water Emissions in E-PRTR.

The Deltares report included case studies to illustrate this lack of reporting. One of the case studies focused on diffuse emissions of total organic carbon and for nitrogen and phosphorus from the pulp and paper industry. For this sector, the report examined the completeness of the emissions reported in E-PRTR by using emission factors in the 2001 BREF[23] for pulp and paper and comparing the expected emissions for the number of reported pulp and paper installations against total reported emissions. The data are summarised in the following table.

Pollutant	Total E-PRTR reported emissions (t/y)	Emissions calculated (t/y)		Difference between E-PRTR emissions and calculated emissions (t/y)	
TOC		Emission factor: 2 kg/ADt	Emission factor: 6 kg/ADt	Emission factor: 2 kg/ADt	Emission factor: 6 kg/ADt
	37,874	58,555	137,790	17,194	99,916
Total N		Emission factor: 5g/ADt	Emission factor: 100g/ADt	Emission factor: 5g/ADt	Emission factor: 100g/ADt
	2,036	439	8,783	-1,597	6,747
Total P		Emission factor: 1g/ADt	Emission factor: 30gAD/t	Emission factor: 1g/ADt	Emission factor: 30gAD/t
	183	88	2,635	-95	2,452

It is important to note that E-PRTR data should in practice be lower than total emissions as the TOC and N reporting threshold is 50 t/y and for P it is 5 t/y. Thus smaller emissions which would be included in calculations based on emission factors would not be in E-PRTR. Deltares refers to this as a “systematic error”. With this caveat, it can be seen that the results are different between the calculation methodology and reported data. An examination of the above table would suggest under reporting of TOC diffuse emissions, but with the situation for N and P judged to be less clear. Deltares does not go as far as this, but uses the results to consider whether the calculation methodology is potentially a reliable approach to examining emissions and concludes that it might be subject to a number of improvements.

In conclusion, the Deltares study suggests that for diffuse emissions, E-PRTR data for category i may not be complete and that further work is needed before this could be quantified.

The report is very useful as an examination of the potential accuracy or completeness of E-PRTR data. However, it does not provide new reported data. In that sense it does not fill data gaps, but rather provides a guide to issues that need to be considered in addressing data gaps in the future (at least for diffuse emissions).

[23] European Commission, 2001, Reference Document on Best Available Techniques in the Pulp and Paper Industry

Appendix F
Air emissions dataset

Scope

The dataset contains information from 104 activities in the EU27[24] (broken down by Member State) and covers the following 17 pollutants:

Ammonia	Lead	PCDD + PCDF (dioxins + furans)
Arsenic	Mercury	Polychlorinated biphenyls (PCBs)
Cadmium	Nickel	Polycyclic aromatic hydrocarbons (PAHs)
CO	NOx	Sulphur oxides (SOx/SO2)
Chromium	NMVOC	Zinc
Copper	PM10	

Each activity has been allocated a specific code, the table in Appendix A includes the list of activities and their corresponding activity code

Information has been primarily obtained from E-PRTR and LRTAP, supplemented with data from other sources (sectoral reports, gap filling).

Structure

The dataset is divided into three sections: Informative sheets (yellow tabs), main section (green tabs) and dataset input (blue tabs).

The first two [yellow] worksheets contain details about the database itself and the terms contained in it. The first tab (QAQC) is the Quality Assurance and Quality Control worksheet with details on modifications applied to the dataset, reviews and project details. The second tab (MS) explains abbreviations, colour coding and the way pollutants and activities have been grouped for the purpose of the analysis.

The second [green] section of the dataset summarises and displays information on emissions. It comprises one tab for the EU27 as a whole and an individual tab for each Member State (from “AT Main” to “UK Main”).

The third [blue] section consists of the data inputs that are collated in the main worksheets. It includes one worksheet for data extracted from sectoral reports and another worksheet for gap filling. More information on the

[24] Croatia was excluded from the scope of this study as at the time of project inception was not a full Member of the EU.

sectoral reports used as inputs can be found in the “Sectoral reports” tab itself and in Appendix B. More information on gap filling can be found in Section 3.5.3. The remaining tabs of the dataset correspond to one input worksheet for each MS, containing raw data from LRTAP and E-PRTR.

Displaying data

The study data is available to view in the main worksheets (green tabs). The main worksheet for each Member State offers data for each pollutant (in column) by activity (in rows). It also provides information on data sources, activity code, activity description, study category and comments. At the bottom of the table, underneath each pollutant data column, there is a summary of the total emissions for each pollutant by activity category.

The EU27 tab is structured in the same way. In addition, it includes a summary table at the bottom of the sheet detailing the total emissions for each pollutant by category and by country.

Filtering and sorting data

Data can be displayed by activity category (i.e. i-iv). This can be done by filtering columns D to G and selecting only those marked with the number 'one'. Member State ‘Main sheets’ can be freely sorted without losing their reference as they are based on relative functions. This can be done together with category filtering for ease of reading. However, the EU27 sheet is based on absolute references to the MS sheets. This means that sorting any MS Main sheet will distort the values in the EU27 summary. In order to restore the right values to the EU27 sheet, every MS Main sheet must be rearranged to the original order. This can be done by sorting the whole table by activity code (column B) in ascending order (A to Z).

Updating the dataset

The dataset is set up to automatically update the results displayed in the Main sheets after a change in the dataset input. New data from specific activities can be introduced into the gap filling sheet. Data should be entered in tonnes for the relevant pollutant and country, entering also the appropriate code in column B (Sector).

It is important that the code entered in column B (Sector) of the gap filling sheet matches the code detailed in column “pollutant/Sources” in the main sheets (e.g. Column I – NH3/Sources). This way the tool can recognise the activity and copy through any updates. Any updates introduced on the gap filling sheet will overwrite previous data from other sources (i.e. LRTAP / E-PRTR) in the main sheets. This can be undone just by deleting the updated data in the gap filling sheet.

Appendix G
Assessment of possible abatement options for category ii and iii activities

Screening of category ii and iii activities

The preliminary screening and final selection of category ii and iii activities was carried out using the methodology described in this section.

As a first step, a range of (agro-)industrial activities responsible for emissions to air and water were identified based on the activity groupings discussed within Section 2 of this report and linked to either category ii or iii. The activities are almost split equally; 30 related to air emissions and 31 linked to water emissions. Table G.1 presents the details of the split of the activities:

Table G.1 Screening of category ii and iii

	Category ii	Category iii	Total number of activities
Air emissions	13	17	30
Water emissions	15	16	31
Total			61

In accordance with the level of risk attached to these activities and their associated emissions of pollutants, the activities were classified into five levels of importance: High (H), High-Medium (H/M), Medium (M), Medium-Low (M/L), Low (L), according to the following criteria:

Table G.2 Level of risk related to the activities

Relevance	Criteria	Example
H	3 (or more) different pollutants including carcinogenic metals	Carcinogenic Metals, GHGs, Particulate Matter
H/M	3 different pollutants excluding carcinogenic metals	Heavy Metals, Particulate Matter, GHGs
M	2 different pollutants including heavy metals	Heavy metals, GHGs,
M/L	2 different pollutants excluding heavy metals	GHGs, Particulate Matter
L	Low risk pollutants excluding carcinogenic and excluding heavy metals	VOC, Odours

Following a preliminary screening analysis, 17 (10 for air and 7 for water) out of 61 total activities screened were identified for further analysis of abatement options that were applied or could be applied in the future to reduce pollutant emission loads. Table G.3 presents the partition of the activities selected for further analysis.

Table G.3 Preliminary screening selection: activities for further analysis

	Category ii	Category iii	Total number of activities
Air emissions	6	4	10
Water emissions	4	3	7
Total			17

Given the relatively tight scope of this task (indicatively 10% of the overall effort), a tiered approach to the literature review was taken to obtain comprehensive information about the measures and approaches being applied by (agro-)industrial activities in respect of emissions reduction. In particular this required a review of best available techniques for the 17 activities identified. Table G.4 presents the three tiers of literature that were defined for this purpose. The approach adopted consisted of exploring the sources listed in the first tier and, if no relevant information was identified for a particular activity, then following up with the sources listed in the second and third tiers.

Table G.4 Literature review methodology

Literature source Tier	Authors / Associations	Example
T1	Environmental agencies and governmental bodies	BREFs (Best Available Techniques Reference Document)
		DEFRA (Department for Environment, Food and Rural Affairs), UK
		EGTEI (Expert Group on Techno-Economic Issues)
		CITEPA (Interprofessional Technical Centre for Studies on Air Pollution)
		DFIU/IFARE (French-German Institute for Environmental Research)
		EPA (United States Environmental Protection Agency)
		Clean Air for Europe (CAFE) Programme.
T2	Selected industry associations	Food and Drink association - Europe
T3	Scientific articles database	Science Direct
		Springerlink

Table G.5 summarises the level of information available for the 17 selected activities. It is important to note that out of these 17 activities, no information could be identified for 4 activities (highlighted with "-" in the table below). Therefore, only the remaining 13 activities were chosen for further examination of the relevant best available techniques.

Table G.5 Air and water tiers and categorisation

SECTION	ACTIVITY	T1	T2	T3
WATER	**Category ii**			
	Spreading of manure - poultry, pigs and cattle	x		x
	Disposal or recovery of hazardous waste (capacity >10 tpd)			x
	Activities using organic solvents listed in Part 1 of Annex VII to IED below the consumption thresholds set out in Part 2 of that Annex	x		x
	Use of fertilisers other than manure (synthetic N-fertilizers)	-	-	-
	Category iii			
	Food and drink processing	x	x	x
	Installations for the building of, and Painting of, or removal of Paint from ships	x		x
	Rearing of poultry, pigs under the IED threshold	-	-	-
	Rearing of cattle	-	-	-
AIR	**Category ii**			
	Processing of non-ferrous metals: melting, including the alloyage, of non-ferrous metals, including recovered products and operation of non-ferrous metal foundries, with a melting capacity below 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals	x		
	Combustion of fuels in installations with a total rated thermal input above 20 MW and below 50MW (except in installations for the incineration of hazardous or municipal waste)	x		
	Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain with a production capacity below 75 tonnes per day and/or with a kiln capacity below 4 m3 and with a setting density per kiln below 300 kg/m3	x		
	Disposal, recovery or a mix of both with a capacity <75 tonnes/day	-	-	-
	Activities using organic solvents listed in Part 1 of Annex VII to IED below the consumption thresholds set out in Part 2 of that Annex	x		
	Preservation of wood and wood products with chemicals with a production capacity equal to or lower than 75 m3 per day other than exclusively treating against sapstain	x		
	Category iii			
	Combustion of fuels in installations with a total rated thermal input lower than 20 MW	x		x
	Gasification or liquefaction of other fuels in installations with a total rated thermal input lower than 20 MW	-	-	-
	Production of magnesium oxide in kilns with a production capacity below 50 tonnes per day	x		
	Installations for the building of, and painting of or removal of paint from ships	x		x

Abatement options

Based on the literature review, 104 possible abatement options (which include a range of Best Available Techniques (BATs)) were identified for the eight activities concerning air emissions, and further a 53 abatement options for the five activities concerning water emissions. These techniques and technologies have been used to build a profile of the possible abatement options for pollutant emissions that currently exist and either are being applied or may potentially be applied in the future (both to other installations within the same activity classification and across different activities).

Selection of most appropriate abatement options

Out of the already identified options (104 for air emissions and 53 for water emissions), the most relevant ones were selected using the following criteria:

1. Number of activities covered;
2. Type of pollutants covered; and
3. Number of categories covered.

Table G.6 presents the classification of the abatement options according to the above 3 criteria:

Table G.6 Abatement option classifications

Abatement option	Number of activities covered out of the (13) final screened activities	Type of Pollutants - Air/Water	Number of categories covered for Air/Water
Filters	10	Both	2/2
Centrifugal separator (Cyclone separator/ Rotary drum)	8	Both	2/2
Crystallisation / Ion exchange / Nano-filtration or Reverse osmosis	9	Both	1/2
UV –A curing technology	6	Both	2/1
Absorption (Carbon absorption System, Cascade type bed absorber)	8	Air	2/0
Scrubbers	8	Air	2/0
Proper Fuel Selection	7	Air	2/0
Abrasive blasting / Vacuum blasting	7	Air	2/0
Electrostatic precipitator	6	Air	2/0
Thermal and catalytic incinerators	5	Air	2/0
Low VOC Content Products and water based solvents	5	Air	2/0
Low NO_x burner	5	Air	2/0
SCR (Selective Catalytic Reduction) and EGR (Exhaust Gas recirculation)	5	Air	2/0
Activated Sludge/Wet Land	4	Water	0/2
$DeSo_x$ Semi dry and $DeSo_x$ Wet	5	Air	1/0
Slurry pig manure/Grassland: Use shallow injection - open slot/close slot	1	Water	0/1
In situ thermal treatment	1	Water	0/1

Conclusions

From the analysis that has been conducted above it is possible to summarise the current use of pollutant abatement options (including best available techniques) and present those which seem the best-adapted for the efficient reduction of emissions to air and water.

Abatement options already extensively used across the 13 priority activities

The four options presented in the table below are already widely being used in the 13 priority activities. They are prioritised based on their frequency of use in both air and water emission treatment in the 13 priority activities. Electrostatic precipitator has also been included to the list as it is highly effective and a widely used technique.

Table G.7 Abatement options most frequently applied in priority activities

Option Name	Number of activities where the option is already being used for both air and water emissions treatment	Type of Pollutants Abated	Achievable Emission Level or Level (%) of pollutant reduction
Proper Fuel Selection	4	NO_x	**Solid fuels** 1. Low [25]- 90 mg/Nm^3 2. High - 450 mg/Nm^3 **Liquid Fuels** 1. Low - 150 mg/Nm^3 2. High - 450 mg/Nm^3 **Gaseous Fuels** 1. Low - 50 mg/Nm^3 2. High - 100 mg/Nm^3 **Low nitrogen content fuel**[26] < 500 – 1 500 mg/Nm^3
		SO_x	**Solid Fuels** 1. Low - 150 mg/Nm^3 2. High - 400 mg/Nm^3 **Liquid Fuels** 1. Low - 100 mg/Nm^3 2. High - 350 mg/Nm^3 **Gaseous Fuels** 1. Low - 10 mg/Nm^3 **Very Low sulphur content fuel** Annual operating hrs: 1000hrs, 75% reduction in emission Annual operating hrs: 3000hrs, 73% reduction in emission

[25] Low & High: Range of pollutant (NO_x, SO_x and PM) ELVs (Emission Limit Values) for Solid/Liquid/Gaseous fuels. Emission concentration, mg/m3 , dry, 0ºC, 101.3 kPa at reference O_2 6% v/v dry as per BREF

[26] The BAT-AEL(Associated Emission Levels) for the emissions of NO_X from the flue-gases of kiln firing processes is < 500 – 1 500 mg/Nm3 , as the daily average value or average over the sampling period (spot measurements for at least half an hour) stated as NO_2. The higher values are related to the high temperature DBM (Dead burned magnesia) process.

Option Name	Number of activities where the option is already being used for both air and water emissions treatment	Type of Pollutants Abated	Achievable Emission Level or Level (%) of pollutant reduction
		PM/Dust[27]	**Solid Fuels** 1. Low - 5 mg/Nm^3 2. High capacity plants - 30 mg/Nm^3 **Liquid Fuels** 1. Low - 5 mg/Nm^3 2. High - 30 mg/Nm^3 **Gaseous Fuels** 1. Low - 5 mg/Nm^3 **Low ash fuel** 1-20 mg/m^3
Crystallisation / Ion exchange / Nano-filtration or Reverse osmosis	4	Oils, Organics	Oils: 40 - 90% removal efficiency
		Heavy Metal	90% removal efficiency
		PM/Dust	80 - 99% removal efficiency
		VOC	99% reduction
Filters	4	Phosphorous, Nitrogen	**Trickling filter (Water)** Phosphorous - Removal efficiency from 8 to 12%
		PM/Dust	**Fabric Filter** PM/Dust < 20 mg/Nm^3 (99% reduction) **Bag Filter** Annual operating hrs: 1000hrs, 86% reduction in emission Annual operating hrs: 3000hrs 87% reduction in emission
		SO_x	**Dry flue gas cleaning with filter with absorbent** Absorbent - Calcium hydroxide ($Ca(OH)_2$) – 7 - 90% Absorbent - Sodium carbonate ($NaHCO_3$) – 98-99%
		HF	**Dry flue gas cleaning with filter with absorbent** Absorbent - Calcium hydroxide ($Ca(OH)_2$) – 80 – 96% Absorbent - Sodium carbonate ($NaHCO_3$) – >95%
		HCl	**Dry flue gas cleaning with filter with absorbent** Absorbent - Calcium hydroxide ($Ca(OH)_2$) – 10 - 85% Absorbent - Sodium carbonate ($NaHCO_3$) – 89%
		VOC	**Activated Carbon filter:** 95 -99%
Electrostatic precipitator	1	PM/Dust	Daily average value: 5 – 50 mg/m3 Production of magnesium oxide in kilns with a production capacity below 50 tonnes per day: < 35 mg/Nm3 (75-99%)

It appears that the selection of the appropriate fuel can allow an efficient reduction in the quantity of pollutant emitted (such as PM, SOx, NOx and CO for processes involving combustion activities).

[27] This BAT reduces CO emissions as well. To avoid creating a blank row because of the data unavailability for CO ELVs (Emission Limit values) it is grouped with PM/Dust.

Abatement options with limited current applications across the 13 priority activities

The six options presented in the following table are highly dependent on the capacity, quantity and specificities of the pollutant or activity, therefore their current use can be rather limited for both air and water treatments. The same approach as in the section above has been applied to select the options from the 17 identified BATs which are quite useful but not widely applicable to the activities as part of the scope of the study.

Table G.8 Abatement options with limited current application in priority activities

Option Name	Number of activities where the option is already being used for either air and/or water emissions treatment	Type of Pollutants	Achievable Emission Level or Level (%) of pollutant reduction
In situ thermal treatment	1	Chlorine	Reduction in the range 30-80%
Slurry pig manure/Grassland: Use shallow injection - open slot/close slot	1	Nitrogen	Reduction in the range 30-80%
DeSox Semi dry and DeSox Wet	1	SO_x	Annual operating hrs:1000hrs, 75% reduction in emission Annual operating hrs:3000hrs, 73% reduction in emission
Activated Sludge/Wet Land	1	P, N, SS, Organics	Removal efficiency (P): 10 to 25%

Abatement options with potential to provide relatively larger benefits

Table G.9 presents 10 'candidate' options that have the potential to offer larger benefits mainly on the basis of the frequency of their possible application to the 61 activities (for both air and water emissions). The classification has been conducted on the basis of the count of the total number of activities out of the 61 where the options can be implemented. For example, the option which is being used for most activities is ranked one etc… The table below also presents the type of pollutants that are affected by the abatement option and an indication of the removal efficiency achieved by that option.

Table G.9 BAT with potential application in priority activities

Rank	Option name	Number of activities where the option can be used for both air and water emissions treatment	Type of pollutants	Achievable Emission Level or Level (%) of pollutant reduction
1	Crystallisation / Ion exchange / Nano-filtration or Reverse osmosis	39	Oils, Organics	Oils: 40 - 90% removal efficiency
			Heavy Metal	90% removal efficiency
			PM/Dust	80 - 99% removal efficiency
			VOC	99% reduction

Rank	Option name	Number of activities where the option can be used for both air and water emissions treatment	Type of pollutants	Achievable Emission Level or Level (%) of pollutant reduction
2	Centrifugal separator (Cyclone separator/ Rotary drum)[28]	39	PM/Dust	99% (<35 mg/Nm3)
			SS	(Herring industry): 80% reduction (Fish Production):10 to 40% reduction
3	Scrubbers	32	VOC	75% reduction efficiency
			CO	**Wet scrubber + ESP:** 5.15 kg/t MgO (76%) **Wet Scrubber + Fabric Filter:** 5.62 kg/t MgO (92%)
			SO_x	**Wet scrubber + ESP:** 0.40 – 3.20 kg/t MgO (33%) **Wet Scrubber + Fabric Filter:** 0.40 – 3.20 kg/t MgO (67%) **Venturi scrubber:** <200 mg/Nm^3
			PM/Dust	**Wet scrubber + ESP:** < 35 mg/Nm3 (+ 75% of Base reduction) **Wet Scrubber + Fabric Filter:** < 20 mg/Nm3 (Base)
4	Filters	28	Phosphorous, Nitrogen	**Trickling filter (Water)** Phosphorous - Removal efficiency from 8 to 12%
			PM/Dust	**Fabric Filter** PM/Dust < 20 mg/Nm^3 (99% reduction) **Bag Filter** Annual operating hrs: 1000hrs, 86% reduction in emission Annual operating hrs: 3000hrs 87% reduction in emission
			SO_x	**Dry flue gas cleaning with filter with absorbent** Absorbent - Calcium hydroxide ($Ca(OH)_2$) – 7 - 90% Absorbent - Sodium carbonate ($NaHCO_3$) – 98-99%
			HF	**Dry flue gas cleaning with filter with absorbent** Absorbent - Calcium hydroxide ($Ca(OH)_2$) – 80 – 96% Absorbent - Sodium carbonate ($NaHCO_3$) – >95%

[28] Physical separation techniques (filters, cyclone separators and scrubbers) can effectively treat water and air emissions for a variety of activities, since the pollutants are captured, separated and isolated. Equipment design may need to be specific to a particular activity based on the characteristics of its emission streams.

Rank	Option name	Number of activities where the option can be used for both air and water emissions treatment	Type of pollutants	Achievable Emission Level or Level (%) of pollutant reduction
			HCl	**Dry flue gas cleaning with filter with absorbent** Absorbent - Calcium hydroxide ($Ca(OH)_2$) – 10 - 85% Absorbent - Sodium carbonate ($NaHCO_3$) – 89%
			VOC	**Activated Carbon filter:** 95 -99%
5	Absorption (Carbon absorption System, Cascade type bed absorber)[29]	27	SO_x	**Absorbent** 1.$Ca(OH)_2$ – 7 - 90% 2.$NaHCO_3$ – 98-99%(1 - 10 mg/m^3) 3. $CaCO_3$ – 80-85% 4.Lime – 92 – 98% 5. Soda Lye (caustic) – 90 – 98%
			PM/Dust, CO	**Absorbent** 1.$Ca(OH)_2$ – 90 – 99% 2.$NaHCO_3$ – 99% 3. $CaCO_3$ – 99-100% 4. Soda Lye (caustic) – 100 %
			HCl	**Absorbent** 1.$Ca(OH)_2$ – 10-85% 2.$NaHCO_3$ – 89 % 3. $CaCO_3$ – >50% 4.Lime – 50 - 95 % 5. Soda Lye (caustic) – 90 – 98 %
			HF	**Absorbent** 1.$Ca(OH)_2$ – 80-96% 2.$NaHCO_3$ – > 95 % 3. $CaCO_3$ – 90-99 % 4.Lime – 92–99 % 5. Caustic Soda (or Lye) – 98 %

[29] Chemical treatments are able to transform or capture pollutants by degradation and chemical bonding, making it possible to treat a variety of pollutants, providing a set of diverse and useful techniques. Carbon absorption is the most widely used and an effective BAT to treat both air and water emissions cost-effectively.

Rank	Option name	Number of activities where the option can be used for both air and water emissions treatment	Type of pollutants	Achievable Emission Level or Level (%) of pollutant reduction
6	Proper Fuel Selection	25	NO_x,	**Solid fuels** 1. Low - 90 mg/Nm^3 2. High - 450 mg/Nm^3 **Liquid Fuels** 1. Low - 150 mg/Nm^3 2. High - 450 mg/Nm^3 **Gaseous Fuels** 1. Low - 50 mg/Nm^3 2. High - 100 mg/Nm^3 **SO_x (low sulphur content fuel)** Annual operating hrs: 1000hrs, 75% reduction in emission Annual operating hrs: 3000hrs, 73% reduction in emission **Limited nitrogen content** < 500 – 1 500 mg/Nm3
			SO_x	**Solid Fuels** 1. Low - 150 mg/Nm^3 2. High - 400 mg/Nm^3 **Liquid Fuels** 1. Low - 100 mg/Nm^3 2. High - 350 mg/Nm^3 **Gaseous Fuels** 1. Low - 10 mg/Nm^3
			PM/Dust, CO	**PM/Dust** **Solid Fuels** 1. Low - 5 mg/Nm^3 2. High - 30 mg/Nm^3 **Liquid Fuels** 1. Low - 5 mg/Nm^3 2. High - 30 mg/Nm^3 **Gaseous Fuels** 1. Low - 5 mg/Nm^3 **Low ash fuel** 1-20 mg/m3
7	Electrostatic precipitator	23	PM/Dust	Daily average value: 5 -50 mg/m3 Production of magnesium oxide in kilns with a production capacity below 50 tonnes per day: < 35 mg/Nm3 (75-99%)
8	UV –A curing technology	22	VOC	Reduces solvent emissions to air
			Heavy Metals	93% reduction
9	Thermal and catalytic incinerators	15	VOC	99% reduction efficiency

Rank	Option name	Number of activities where the option can be used for both air and water emissions treatment	Type of pollutants	Achievable Emission Level or Level (%) of pollutant reduction
10	Low VOC Content Products and water based solvents	12	VOC	Reducing the share of solvent based adhesive from 90% to 60% (the remain is water based adhesive):18-30% reduction efficiency Use solvent free adhesive: 100% reduction efficiency Change of solvents or processes to VOC free processes: 100% reduction efficiency

Further classification of the most promising options

The classification applied to the most promising options (as shown in the table above) has been based on the following two criteria:

1. The type of pollutants treated by a specific abatement option; and

2. The achieved level of emission reduction or emission removal efficiency.

Therefore, five options with the maximum number of likely applicable activities, number of pollutants covered and reduction in emission level have been identified as the most versatile and efficient in terms of their implementation. These options, in order of their classification, are listed below with further commentary:

- Filters;
- Crystallisation / Ion exchange / Nano-filtration or Reverse osmosis;
- Absorption (Carbon absorption System, Cascade type bed absorber);
- Proper Fuel Selection; and
- Scrubbers

Description of selected options

A standard template was designed to provide the relevant information for all of the 13 priority activities. The description of the terminology used in the template is provided below:

- Activity Groups: it indicates the group of the activities for which the option is recommended. The Group Numbers (i.e. G1, G2, etc.) are given to the Activity Groups;
- Activities for which the option is already being used: those activities out of the 13 prioritised activities, for which the option is currently being used;
- Target Activities: those activities out of the total 61 activities identified in this chapter for which the concerned option can additionally be used; and

- Barriers and constraining factors: cost effectiveness, technical feasibility and ability to reduce the pollutants; and
- Sources: reference sources are contained within a separate table following the description of the options.

The tables with the above mentioned details for each option are included at the end of this section.

ABATEMENT DESCRIPTIONS

Option 1 (Use of different kinds of filter)

Items	Description
Name	Filters
Category	Air – ii and iii Water – ii and iii
Activity Groups	Air G6 – Combustion Process G8 – Cement and Lime (or Non-metal, non-ferrous production) G4 – Paint application (or Coating) G5 – Alloys (non-ferrous) (manufacture) Water G3 – Drinks and Beverages G1 – Agro
Activities already applying the option	Air G6 – Activity 061 G8 – Activity 090 Water G3 – Activities 086, 087, 088 G1 – Activities 079, 080, 081
Target Activities	Air emissions for the 13 selected activities G6 – Activity 101 (CO, NO_x, SO_x) G5 – Activity 060 (CO, SO_x, PM/Dust) G6 – Activity 065 (SO_x, PM/Dust, HF, HCl) G7 – Activities 078, 083 (VOC) G4 – Activity 084 (CO, PM/Dust, VOC) Air emissions for the remaining non selected 48 activities which can also be treated: PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 069, 070, 082, 095, 096, 097, 075, 094, 074, 091, 092, 093 SO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094 VOC – 064, 066, 082, 074, 094, 075 CO – 056, 057, 058, 059, 098, 093 Water emissions for the remaining non selected 48 activities which can also be treated: Nitrogen, Phosphorous - 095, 096, 097, 082
Pollutants treated	Air emissions - SO_x, PM/Dust, HF, HCl, VOC, CO Water emissions – Nitrogen, Phosphorous

<table>
<tr><th>Items</th><th>Description</th></tr>
<tr><td>Level of reduction in Pollutants</td><td>
Bag Filter
Annual operating hrs: 1000hrs, 86% reduction in emission
Annual operating hrs: 3000hrs 87% reduction in emission
Dry flue gas cleaning with filter with absorbent
Absorbent - Calcium hydroxide (Ca(OH)2)
Absorbent - Sodium carbonate (NaHCO3)
<table>
<tr><th>SO2</th><th>SO3</th><th>PM/Dust</th><th>HF</th><th>HCl</th></tr>
<tr><td>1. 7 - 80%
2. 98 - 99 %</td><td>1. up to 90%
2. 98 – 99 %</td><td>1. 90 - 99%
2. 99% (1 - 10 mg/m3)</td><td>1. 80 up to 96%
2. > 95 %</td><td>1. 10 up to 85%
2. 89 %</td></tr>
</table>
Activated Carbon filter: VOC reduction from 95 to99%
Fabric Filter : PM/Dust < 20 mg/Nm^3 (99% reduction)
Trickling filter (Water)
Phosphorous: Removal efficiency from 8 to 12%
Nitrogen: reduction
</td></tr>
<tr><td>Cost effectiveness/Cost of implementation</td><td>
The cost benefit analysis indicates that despite low load factors, substantial numbers of smaller combustion units and lower emission estimates than previous studies, the potential emission reductions from inclusion of 20-50 MWth combustion installations in IPPC - under a variety of emission reduction scenarios - would result in a net benefit.
The activated carbon costs about: 1 to 1.50 €/kg.
The cost for external recovery of the solvent is about 0.60 €/kg.
Ca(OH)2 Investment costs(in million €): 0,76 to 1,08
It is a proven technology that is simple to install and easy to operate and maintain. Capital costs are among the least expensive for most alternative treatment technologies.
</td></tr>
<tr><td>Operational conditions/ Tools</td><td>
For Ca(OH)2 absorbent
1. Excess dosing of absorbent (the ratio between the quantity of adsorbent required in practice to achieve the stated cleaning efficiency to the quantity of adsorbent that would be required in theory (based on the stoichiometry of the adsorption reaction):1.35 – 2.00
2. Water consumption (m3/day): 0
3. Electricity consumption (kWh/day): 1200 – 2880
4. Costs of absorbent(EUR/tonne): 104
Bag filter material can operate at temperatures of up to 140 °C.
</td></tr>
<tr><td>Barriers and constraining factors</td><td>
The costs associated with the achievement of the emission levels associated with the BAT disproportionately outweigh the environmental benefits due to the geographical location, the local environmental conditions or the technical characteristics of the installation concerned.
Filters if used with Wet scrubbers emit CO2.
</td></tr>
<tr><td>Sources</td><td>S7, S8, S9, S10, S11, S20, S21, S22, S23</td></tr>
</table>

Option 2 (Centrifugal Separator)

Items	Description
Name	Centrifugal separator (Cyclone separator/ Rotary drum)
Category	Air – ii and iii Water – ii and iii
Activity Groups	Air G8 – Cement and Lime (or Non-metal, non-ferrous production) G7 – Chemical treatment of material G6 – Combustion Process G5 – Alloys (non-ferrous) (manufacture) Water G3 – Drinks and beverages G1 – Agro
Activities already applying the option	Air G8 – Activity 090 Water G3 – Activities 086, 087, 088 G1 – Activities 079, 080, 081
Target Activities	Air emissions for the 13 selected activities G6 – Activities 065, 061, 101 (PM/Dust) G7 – Activity 078 (PM/Dust) G5 – Activity 060 (PM/Dust) Air emissions for the remaining non selected 48 activities which can also be treated: PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 069, 070, 082, 095, 096, 097, 075, 094, 074, 091, 092, 093, 098 Water emissions for the remaining non selected 48 activities which can also be treated: SS – 076, 054, 055, 056, 057, 058, 059, 066, 069, 070, 083, 082, 092, 101, 074, 094, 093, 089, 095, 096, 097
Pollutants treated	Air emission – PM/Dust Water emission – SS
Level of reduction in Pollutants	Air emissions PM / Dust:99% (<35 mg/Nm3) Water emissions **SS (Herring industry):** 80% reduction **SS (Fish Production):**10 to 40% reduction

Items	Description
Cost effectiveness/Cost of implementation	Water High cost for low flow installations Air Low capital investment
Operational conditions/ Tools	Water – Starch recovery for potato process[30]
Sources	S23, S22, S9, S10, S11

Option 3 (Water usage techniques)

Items	Description
Name	Crystallisation / Ion exchange / Nano-filtration or Reverse osmosis
Category	Water – ii Air – ii and iii
Activity Groups	Water G7– Chemical treatment of material G2 – Disposal or recovery of hazardous waste (capacity >10 tpd) G4 – Paint application (or Coating) Air G8 – Cement and Lime (or Non-metal, non-ferrous production) G4 – Paint application (or Coating) G7 – Chemical treatment of material G6 – Combustion Process G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	Water G7 – Activity 083 G2– Activity 066 Air G7 – Activity 090 G4 – Activity 084

[30] Potato sludge applications need centrifuge separation technology for an effective, low-maintenance solution to continuous liquid clarification solids dewatering.

Items	Description
Target Activities	Air emissions for the 13 selected activities G7 – Activity 078 (VOC) G6 – Activities 061, 065, 101 (PM/Dust) G5 – Activity 060 (PM/Dust, VOC) Air emissions for the remaining non selected 48 activities which can also be treated: PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 069, 070, 082, 095, 096, 097, 075, 094, 074, 092, 091, 093, 098, 086, 087, 088 VOC – 064, 082, 074, 094, 075 Water emissions for the remaining non selected 48 activities which can also be treated: Heavy Metals – 056, 057, 058, 059, 060, 061, 069, 070, 083, 092, 101, 093 Oil – 054, 055, 069, 070, 075 Organics – 056, 057, 058, 059, 060, 062, 083, 078, 092, 101, 074, 075, 093, 085
Pollutants treated	Water emissions – Heavy Metal, Oil, Organics Air emissions – PM/Dust, VOC
Level of reduction in Pollutants	Oils:40 - 90% removal efficiency (Crystallisation / Ion exchange) PM/Dust: 80 - 99% removal (Ion Exchange, Nano-filtration) Removal: Hg > 90%, Cd > 90% (Ion exchange) VOCs : 99% reduction (Crystallisation)
Operational conditions/ Tools	Growth of heavy metal compounds on granular seed. Ion exchange – Typical influent concentrations are between 10 and1000 mg/l. Suspended particles in the feed should be less than 50 mg/l to prevent plugging, thus gravity or membrane filtration are appropriate pre-treatments.
Barriers and constraining factors	Limits / restrictions of Ion exchange - High ionic strength to be avoided - Temperature limit about 60 °C - Corrosive agents can damage resin - Pre-filtration is required. Limits / restrictions of Reverse Osmosis (or Nano-filtration) - Concentrations too high result in osmotic pressure too high to operate -Low thermal and chemical resistance Could be less cost effective as implementation of the recommended BAT is currently being done for higher capacity plants. The costs associated with the achievement of the emission levels associated with the BAT disproportionately outweigh the environmental benefits due to the geographical location, the local environmental conditions or the technical characteristics (lower capacity plant) of the installation concerned.
Sources	S1, S2, S3, S4, S5, S6, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19

Option 4 (UV technology)

Items	Description
Name	UV – A curing technology
Category	Air – ii and iii Water – iii
Activity Groups	Air G7 – Chemical treatment of material G5 – Alloys (non-ferrous) (manufacture) Water G4 – Paint application (or Coating)
Activities already applying the option	Air G7 – Activities 083 G4 – Activity 084 Water G4 – Activity 084
Target Activities	Air emissions for the 13 selected activities G7 – Activities 078, 065 (VOC) G5 – Activity 060 (VOC) Air emissions for the remaining non selected 48 activities which can also be treated: VOC – 064, 066, 082, 078, 074, 094, 075 Water emissions for the remaining non selected 48 activities which can also be treated: Heavy Metals – 056, 057, 058, 059, 060, 061, 066, 069, 070, 083, 092, 101, 093
Pollutants treated	Air emission – VOC Water emission – Heavy Metals
Level of reduction in Pollutants	Air emissions VOC – Reduces solvent emissions to air Water emissions Heavy metals COD: 93% reduction
Cost effectiveness/Cost of implementation	Expensive
Operational conditions/ Tools	Install UV Lights
Barriers and constraining factors	Raw material prices for cationic inks and varnishes are much higher than those of common radical systems. Insufficient power for larger spot sizes. Insufficient intensity (over entire spot) leading to surface tackiness. Insufficient spectrum for effective curing and/or depth of cure.
Sources	S1, S2, S3, S4, S5, S17, S18

Option 5 (Use of absorbent and adsorbent)

Items	Description
Name	Adsorption, Absorption (Carbon absorption System, Cascade type bed absorber)
Category	Air – ii and iii
Activity Groups	G6 – Combustion Process G7 – Chemical treatment of material G3 – Paint application (or coating) G8 – Cement and Lime (or Non-metal, non-ferrous production) G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	G7 – Activity 083 G4 – Activity 084
Target Activities	Air emissions for the 13 selected activities G6 – Activity 065(SO_x, PM/Dust, HF, HCl) G6 – Activities 061, 101 (CO, SO_x) G5 – Activity 060 (CO, VOC, PM/Dust) G8 – Activity 090 (CO, PM/Dust, SO_x) G7 – Activity 078 (VOC) Air emissions for the remaining non selected 48 activities which can also be treated: CO – 056, 057, 058, 059, 098, 093, 086, 087, 088 SO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094 PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 069, 070, 082, 095, 096, 097, 075, 094, 074, 091, 092, 093, 098 , 086, 087, 088 VOC – 064, 066, 082, 074, 094, 075
Pollutants treated	CO_2, SO_x, PM/Dust, HF, HCL
Level of reduction in Pollutants	

Absorbent/ Pollutant	SO_2	SO_3	PM/Dust	HF	HCl
1.$Ca(OH)_2$ 2.$NaHCO_3$	1.7-80% 2.98-99%	1.upto 90% 2.98–99 %	1. 90 - 99% 2. 99%(1 - 10 mg/m^3)	1. 80-96% 2. > 95 %	1. 10-85% 2. 89 %
$CaCO_3$	8-43%	80–85%	99-100%	90-99 %	>50%
1.Lime 2. Caustic Soda (Lye)	1.20-98% 2.90-98%	1. 92 – 95 % 2. 94 – 96 %	2. 100 %	1. 92–99 % 2. 98 %	1. 50 - 95 % 2. 90 – 98 %

Cost effectiveness/Cost of implementation	Replace the steam jet ejectors with a vacuum pump and duct the exhaust vapours to an activated carbon adsorption system or to an afterburner: £2100/installation A simple100 cubic foot per minute adsorption system consisting of two 200 pound canisters and a blower would require about 20 sq ft of area and cost about $2,000-$3,000. A 5000 cfm[31] system with two adsorbers and an exhaust blower would have a capital cost in the range of $30,000 to $40,000 and if skid mounted would take up an area of about 100sq ft.

[31] cfm – cubic feet per minute

Items	Description
Operational conditions/ Tools	1. For $Ca(OH)_2$ - Excess dosing of absorbent (the ratio between the quantity of adsorbent required in practice to achieve the stated cleaning efficiency to the quantity of adsorbent that would be required in theory (based on the stoichiometry of the adsorption reaction): 1.35 – 2.00 - Water consumption(m3/day): 0 - Electricity consumption(kWh/day): 1200 – 2880 - Costs of absorbent(EUR/tonne):104 - Investment costs: €0,76-1,08 million 2. For $CaCO_3$ - Excess dosing of absorbent (the ratio between the quantity of adsorbent required in practice to achieve the stated cleaning efficiency to the quantity of adsorbent that would be required in theory (based on the stoichiometry of the adsorption reaction): 2.5 - Water consumption(m3/day): 0 - Electricity consumption(kWh/day): 641 - 864 - Costs of absorbent(EUR/tonne): 59 - Investment costs: €0,23-0,27 million 3. For Modified $CaCO_3$ (SO_2 < 1500 mg/Nm3) - Excess dosing of absorbent (the ratio between the quantity of adsorbent required in practice to achieve the stated cleaning efficiency to the quantity of adsorbent that would be required in theory (based on the stoichiometry of the adsorption reaction): 2.5 - Water consumption(m3/day): 0 - Electricity consumption(kWh/day): 864 - Costs of absorbent(EUR/tonne): 99 - Investment costs: €0,69 million 4. For Modified $CaCO_3$ (SO_2 >=2500 mg/Nm3) - Excess dosing of absorbent (the ratio between the quantity of adsorbent required in practice to achieve the stated cleaning efficiency to the quantity of adsorbent that would be required in theory (based on the stoichiometry of the adsorption reaction): 2.5 - Water consumption(m3/day): 0 - Electricity consumption(kWh/day): 864 - Costs of absorbent(EUR/tonne): 99 - Investment costs:€ 0,69 million 5. For Lime (Water/$Ca(OH)_2$ or $CaCO_3$) - Excess dosing of absorbent (the ratio between the quantity of adsorbent required in practice to achieve the stated cleaning efficiency to the quantity of adsorbent that would be required in theory (based on the stoichiometry of the adsorption reaction): 1.01-2.0 - Water consumption(m3/day): 86-240 - Electricity consumption(kWh/day): 2352 – 4824 - Costs of absorbent(EUR/tonne) :30 - 100 - Investment costs:€ 0,51 – 0,6 million
Barriers and constraining factors	Adsorption system capital and operating costs can vary widely but depend primarily on the gas volume to be treated and the amount of carbon consumed.
Sources	S22, S1, S2, S3, S4, S5, S6, S7, S8

Option 6 (Scrubber)

<table>
<tr><th>Items</th><th>Description</th></tr>
<tr><td>Name</td><td>Use of different Scrubbers</td></tr>
<tr><td>Category</td><td>Air – ii and iii</td></tr>
<tr><td>Activity Groups</td><td>G7 – Chemical Treatment of material
G8 – Cement and Lime (or Non-metal, non-ferrous production)
G4 – Paint application (or Coating)
G5 – Alloys (non-ferrous) (manufacture)
G6 – Combustion Process</td></tr>
<tr><td>Activities already applying the option</td><td>G8 – Activity 090
G4 – Activity 084</td></tr>
<tr><td>Target Activities</td><td>Air emissions for the 13 selected activities
G6 – Activities 065 ,101, 061(CO, SO_x, PM/Dust)
G5 – Activity 060 (CO, SO_x, PM/Dust)
G7 – Activity 078, 083 (VOC)

Air emissions for the remaining non selected 48 activities which can also be treated:
VOC – 064, 066, 082, 074, 094, 075
CO – 056, 057, 058, 059, 098, 093, 086, 087, 088, 083
SO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094
PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 069, 070, 082, 095, 096, 097, 075, 094, 074, 091, 092, 093, 098 , 086, 087, 088</td></tr>
<tr><td>Pollutants treated</td><td>VOC, CO, SO_x, PM/Dust</td></tr>
<tr><td>Level of reduction in Pollutants</td><td>VOC: 75% reduction
Wet scrubber + ESP:
<table>
<tr><td>CO</td><td>SO_2</td><td>PM/Dust</td></tr>
<tr><td>5.15 kg/t MgO (76%)</td><td>0.40 – 3.20 kg/t MgO (33%)</td><td>< 35 mg/Nm3 (+ 75% of Base)</td></tr>
</table>
Wet Scrubber + Fabric Filter:
<table>
<tr><td>CO</td><td>SO_2</td><td>PM/Dust</td></tr>
<tr><td>5.62 kg/t MgO (92%)</td><td>0.40 – 3.20 kg/t MgO (67%)</td><td>< 20 mg/Nm3 (Base)</td></tr>
</table>
Venturi scrubber:SO_2 – <200 mg/Nm^3</td></tr>
</table>

Items	Description
Operational conditions/ Tools	

Consumptions		ESP+WS	FF + WSa	FF + WSb
Electricity	**kWh/t MgO**	12.33	13.42	13.42
Water	**l/t MgO**	1950 to 3540	1950 to 3540	1950 to 2880

Technology	Consumption (kWh/t MgO)
ESP	4.15
FF	5.24
WS	8.18

Barriers and constraining factors

Greater efficacy in one or several environmental aspects, and less efficacy in other or several other environmental aspects.

Greater or lesser water availability, deep local, air quality, fuels available, etc.

For the combination FF + WSa, the use of fuel to heat gases between FF and WS would involve a new emission of SO_2 leading to more CO_2 in the purification to reach levels indicated.

Pollutant		ESP + WS	FF+WS(+additional heat)	FF + WSb
CO2 Kg/t MgO	**WS**	8.97–16.28	8.97 – 16.28	8.97– 11.87
	Additional Heat	0	112.20 – 195.00	0
	Total	**8.97–16.28**	**121.17 – 211.28**	**8.97– 11.87**

Sources	S9, S10, S11

Option 7 (Proper Fuel Selection)

Items	Description
Name	Proper Fuel Selection
Category	Air – ii and iii
Activity Groups	G6 – Combustion process G8 – Cement and Lime (or Non-metal, non-ferrous production) G7 – Chemical treatment of material G4 – Paint application (or Coating) G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	G6 – Activities 061, 101 G5 – Activity 060 G8 – Activity 090
Target Activities	Air emissions for the 13 selected activities G6 – Activity 065 (SO_x, PM/Dust) G7 – Activity 078 (PM/Dust) G4 – Activity 084 (CO, PM/Dust) Air emissions for the remaining non selected 48 activities which can also be treated: PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 069, 070, 082, 095, 096, 097, 075, 094, 074,

Items	Description
	091, 092, 093, 098, 086, 087, 088 NO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094, 093, 086, 087, 088 SO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094 CO – 056, 057, 058, 059, 098, 093, 086, 087, 088, 083
Pollutants treated	CO, NO_x, SO_x, PM/Dust
Level of reduction in Pollutants	NO_x / **SO_x** / **PM/Dust** **Solid fuels** 1. Low [32]- 90 mg/Nm^3 2. High - 450 mg/Nm^3 **Liquid Fuels** 1. Low - 150 mg/Nm^3 2. High - 450 mg/Nm^3 **Gaseous Fuels** 1. Low - 50 mg/Nm^3 2. High - 100 mg/Nm^3 **Solid Fuels** 1. Low - 150 mg/Nm^3 2. High - 400 mg/Nm^3 **Liquid Fuels** 1. Low - 100 mg/Nm^3 2. High - 350 mg/Nm^3 **Gaseous Fuels** 1. Low - 10 mg/Nm^3 **Solid Fuels** 1. Low - 5 mg/Nm^3 2. High - 30 mg/Nm^3 **Liquid Fuels** 1. Low - 5 mg/Nm^3 2. High - 30 mg/Nm^3 **Gaseous Fuels** 1. Low - 5 mg/Nm^3 **SO_x (low sulphur content fuel)** Annual operating hrs: 1000hrs, 75% reduction in emission Annual operating hrs: 3000hrs, 73% reduction in emission **Low ash fuel** 1-20 mg/m3 **Limited nitrogen content** < 500 – 1 500 mg/Nm3
Cost effectiveness/Cost of implementation	1-5 MW a) Low capacity Costs (million €/yr): 1,600 Benefits (million €/yr): 1,950 b) High capacity Costs (million €/yr): 2,200 Benefits(million €/yr): 5,200 5-20 MW a) Low capacity Costs(million €/yr): 1,700 Benefits(million €/yr): 3,200 b) High capacity Costs(million €/yr): 2,800 Benefits(million €/yr): 8,800
Barriers and constraining factors	1. Although the potential reduction differs from fuel to fuel, the reduction cost is mainly determined by load hours and required reduction. 2. Depending on the fuel type used, direct CO_2 emissions associated with the magnesium oxide production will range between 1.49 – 2.39 tCO_2/t MgO (1490 – 2390 kgCO2/t MgO).
Sources	S24, S20, S9, S10, S11

[32] Low & High: Range of pollutant (NOx, SO2 and PM) ELVs (Emission Limit Values) for Solid/Liquid/Gaseous fuels. Emission concentration, mg/m3 , dry, 0ºC, 101.3 kPa at reference O2 6% v/v dry as per BREF

Option 8 (Blasting)

Items	Description
Name	Abrasive blasting / Vacuum blasting
Category	Air – iii
Activity Groups	G4 – Paint application (or coating) G8 – Cement and Lime (or Non-metal, non-ferrous production) G5 – Alloys (non-ferrous) (manufacture) G6 – Combustion process G7 – Chemical treatment of material
Activities already applying the option	G4 – Activity 084
Target Activities	Air emissions for the 13 selected activities G6 – Activities 061, 065,101(PM/Dust) G5 – Activity 060 (PM/Dust) G8 – Activity 090 (PM/Dust) G7 – Activity 078 (PM/Dust) Air emissions for the remaining non selected 48 activities which can also be treated: PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 067, 069, 070, 082, 095, 096, 097, 075, 094, 074, 091, 092, 093, 098 , 086, 087, 088
Pollutants treated	PM/Dust
Sources	S1, S2, S3, S4, S5

Option 9 (Electrostatic Precipitator)

Items	Description
Name	Electrostatic Separator/Precipitator
Category	Air – ii and iii
Activity Groups	G6 – Combustion Process G8 – Cement and Lime (or Non-metal, non-ferrous production) G7 – Chemical treatment of material G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	G8 – Activity 090
Target Activities	Air emissions for the 13 selected activities G6 – Activities 065, 101, 061 (PM/Dust) G8 – Activity 090 (PM/Dust) G7 – Activity 078 (PM/Dust) Air emissions for the remaining non selected 48 activities which can also be treated: PM/Dust – 054, 055, 056, 057, 058, 059, 062, 063, 064, 066, 069, 070, 082, 095, 096, 097, 075, 094, 074, 091, 092, 093, 098 , 086, 087, 088
Pollutants treated	PM/Dust

Items	Description
Level of reduction in Pollutants	Daily average value: 5 – 50 mg/m3 Production of magnesium oxide in kilns with a production capacity below 50 tonnes per day: < 35 mg/Nm3 (75-99%)
Cost effectiveness/Cost of implementation	Investment (approx.. million €): 1 to3
Operational conditions/ Tools	Operation Cost (million €): 0.1 to 0.2
Barriers and constraining factors	Activity 090: greater efficacy in one or several environmental aspects, and less efficacy in other or several other environmental aspects
Sources	S20, S22, S9, S10, S11

Option 10 (Incinerators)

Items	Description
Name	Thermal and catalytic incinerators
Category	Air – ii and iii
Activity Groups	G7 – Chemical treatment of material G4 – Paint application (or Coating) G5 – Alloys (non-ferrous) (manufacture) G8 – Cement and Lime (or Non-metal, non-ferrous production)
Activities already applying the option	G7 – Activity 083 G4 – Activity 084
Target Activities	Air emissions for the 13 selected activities G7 – Activity 078 (VOC) G5 – Activity 060 (CO) G8 – Activity 090 (CO) Air emissions for the remaining non selected 48 activities which can also be treated: CO – 056, 057, 058, 059, 098, 093, 086, 087, 088 VOC – 064, 066, 082, 074, 094, 075
Pollutants treated	VOC, CO
Level of reduction in Pollutants	VOC – 99% reduction
Cost effectiveness/Cost of implementation	£2100/installation for production (wood) capacity > 75 m^3 per day
Operational conditions/ Tools	Thermal Incinerators – Auto-ignition temperature – 800 – 1400°F. Catalytic Incinerators – 700 – 800°F
Barriers and constraining factors	**Thermal incinerators** 1.Varying VOC concentrations and gas flow rates can cause problems with incinerators performance 2.Most operations and maintenance problems are associated with the burner system **Catalytic Incinerators** 1. Ultimate functioning of incineration is to achieve complete combustion .Incomplete combustion can form new, potentially more toxic compounds 2.Catalytic incinerators can experience problems with catalyst aging, volatilization, attrition, masking, and poisoning. They need to be replaced every 3 to 5 years

Items	Description
Sources	S1, S2, S3, S4, S5, S6, S7, S8

Option 11 (Low VOC Content Products)

Items	Description
Name	Low VOC Content Products and Use of water based Solvents
Category	Air – ii and iii
Activity Groups	G7 – Chemical treatment of Material G5 – Alloys (non-ferrous) (manufacture) G4 – Paint application (or Coating) G6 – Combustion Process
Activities already applying the option	G7 – Activity 083 G4 – Activity 084
Target Activities	Air emissions for the 13 selected activities G7 – Activity 078 (VOC) G6 –Activity 065 (VOC) G5 – Activity 060 (VOC) Air emissions for the remaining non selected 48 activities which can also be treated: VOC – 064, 066, 082, 078, 074, 094, 075
Pollutants treated	VOC
Level of reduction in Pollutants	Reducing the share of solvent based adhesive from 90% to 60% (the remain is water based adhesive):18-30% Use solvent free adhesive: 100% Change of solvents or processes to VOC free processes: 100%
Cost effectiveness/Cost of implementation	Use water-based preservatives or by using a creosote formulation with a low VOC content - the impregnation costs can vary between 20 and 40 €/m^3 Reducing the share of solvent based adhesive from 90% to 60% (the remain is water based adhesive)-13500 €/year
Operational conditions/ Tools	Change of solvents or processes to VOC free processes: use supercritical CO_2 for extraction of non-polar substances. Highly restricted by pharmaceutical approval. Use of solvent less film coating of tablets: powder coating, hot-melt coating, supercritical fluid spray coating (CO_2)
Sources	S19, S1, S2, S3, S4, S5, S7, S8

Option 12 (Low NOx Burner)

Items	Description
Name	Low NO_x burner
Category	Air – ii and iii
Activity Groups	G8 – Cement and Lime (or Non-metal, non-ferrous production) G6 – combustion process G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	G8 – Activity 090 G6 – Activity 061
Target Activities	Air emissions for the 13 selected activities G6 – Activities 065, 101 (NO_x) G5 – Activity 060 (NO_x) Air emissions for the remaining non selected 48 activities which can also be treated: NO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094, 093, 086, 087, 088
Pollutants treated	NO_x
Level of reduction in Pollutants	Annual operating hrs:1000hrs,12% reduction in emission Annual operating hrs:3000hrs, 27% reduction in emission
Cost effectiveness/Cost of implementation	Combustion plant: the cost benefit analysis indicates that despite low load factors, substantial numbers of smaller combustion units and lower emission estimates than previous studies, the potential emission reductions from inclusion of 20-50 MWth combustion installations in IPPC: under a variety of emission reduction scenarios would result in a net benefit.
Sources	S9, S10, S11

Option 13 (NO_x reducing technique)

Items	Description
Name	SCR (Selective Catalytic Reduction) and EGR (Exhaust Gas recirculation)
Category	Air – ii and iii
Activity Groups	G6 – Combustion Process G8 – Cement and Lime (or Non-metal, non-ferrous production) G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	G6 – Activities 061, 101
Target Activities	Air emissions for the 13 selected activities G6 – Activity 065 (NO_x) G5 – Activity 060 (NO_x) G8 – Activity 090 (NO_x) Air emissions for the remaining non selected 48 activities which can also be treated: NO_x – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094, 093, 086, 087, 088

Items	Description
Pollutants treated	NO_x
Level of reduction in Pollutants	Annual operating hrs :1000hrs, 12% reduction in emission Annual operating hrs: 3000hrs, 27% reduction in emission
Cost effectiveness/Cost of implementation	The cost benefit analysis indicates that despite low load factors, substantial numbers of smaller combustion units and lower emission estimates than previous studies, the potential emission reductions from inclusion of 20-50 MWth combustion installations in IPPC - under a variety of emission reduction scenarios - would result in a net benefit. Expensive: Exhaust gas recirculation on existing oil boilers
Barriers and constraining factors	Capacity is also a factor determining the costs, but the effect of load hours is bigger because the scenarios assume low load levels. For installations smaller than 3 MWth (on average 0,5MWth), abatement equipment can be relatively more expensive. Although most combustion units in 20-50 MWth are smaller than 3 MWth, less than 10% of the emissions are from this category. The overall conclusion on the cost benefit is not greatly influenced by those small combustion units because the average cost for reducing emissions does not increase significantly. However, it is worth noting that the marginal net-benefit per tonne emission reduction for a combustion unit < 3 MWth (marginal benefit minus marginal cost) is much lower because the marginal costs per tonne emission reduction are higher and thus much closer to benefits of an avoided tonne. The abatement measures are for boilers/steam turbines. It is assumed that for engines, the reduction cost is in the same range. Some techniques are ignored in determining the reduction cost because they are too expensive, e.g. exhaust gas recirculation on existing oil boilers.
Sources	S20

Option 14 (Activated Sludge)

Items	Description
Name	Activated Sludge/Wet Land
Category	Water – ii and iii
Activity Groups	G3 – Drinks and Beverages G2 – Disposal or recovery of hazardous waste (capacity >10 tpd) G1 – Agro G7 – Chemical treatment of material
Activities already applying the option	G3 – Activities 086, 087, 088
Target Activities	Water emissions for the 13 selected activities G1 – Activities 079, 080, 081 (P, N, SS) G2 – Activity 066 (SS) G7 – Activity 083 (SS, Organics) Water emissions for the remaining non selected 48 activities which can also be treated: P – 082, , 095, 096, 097 Organic – 056, 057, 058, 059, 060, 078, 092, 101, 074, 075, 093, 085 SS – 076, 054, 055, 056, 057, 058, 059, 060, 065, 069, 070, 092, 101, 074, 094, 093, 089, 082, , 095, 096, 097 N – 082, 095, 096, 097

Items	Description
Pollutants treated	P, N, SS, Organics
Level of reduction in Pollutants	Removal efficiency (P): 10 to 25%
Cost effectiveness/Cost of implementation	High energy consumption
Operational conditions/ Tools	Chlorinated chemicals to prevent bulking. Separate compartment has to treat bulking
Sources	S23

Option 15 (SO_x reducing technique)

Items	Description
Name	DeSox Semi dry and DeSox Wet
Category	Air – ii and iii
Activity Groups	G6 – Combustion Process G8 – Cement and Lime (or Non-metal, non-ferrous production) G5 – Alloys (non-ferrous) (manufacture)
Activities already applying the option	G6 – Activity 061
Target Activities	Air emissions for the 13 selected activities G6 – Activities 065, 101 (SO_x) G5 – Activity 060 (SO_x) G8 – Activity 090 (NO_x) Air emissions for the remaining non selected 48 activities which can also be treated: SOx – 056, 057, 058, 059, 062, 063, 064, 092, 091, 074, 094
Pollutants treated	SO_x
Level of reduction in Pollutants	Annual operating hrs:1000hrs, 75% reduction in emission Annual operating hrs: 3000hrs, 73% reduction in emission
Cost effectiveness/Cost of implementation	The cost benefit analysis indicates that despite low load factors, substantial numbers of smaller combustion units and lower emission estimates than previous studies, the potential emission reductions from inclusion of 20-50 MWth combustion installations in IPPC under a variety of emission reduction scenarios would result in a net benefit.
Sources	S20

Option 16 (Shallow injection of slurry or sludge)

Items	Description
Name	Slurry pig manure/Grassland: Use shallow injection - open slot/close slot
Category	Water – ii
Activity Groups	G1 – Agro
Activities already applying the option	G1 – Activities 079, 080, 081
Target Activities	Water emissions for the remaining non selected 48 activities which can also be treated: Nitrogen – 082, 095, 096, 097
Pollutants treated	Nitrogen
Level of reduction in Pollutants	Reduce N from 30-80%
Operational conditions/ Tools	Open: 50 mm deep, space between injectors <300 mm Closed/ Shallow: 50 - 100 mm or deep: 150 - 200mm
Sources	S25

Option 17 (Thermal treatment)

Items	Description
Name	In situ thermal treatment
Category	Water – ii
Activity Groups	G7 – Chemical treatment of material
Activities already applying the option	G7 – Activity 083
Target Activities	Water emissions for the remaining non selected 48 activities which can also be treated: Chlorine – 062, 063, 074
Pollutants treated	Chlorine
Level of reduction in Pollutants	Reduce from 30-80%
Cost effectiveness/Cost of implementation	15 to 30 USD/cubic yard
Operational conditions/ Tools	Steam injection Hot water or air injection Conditions: pump/compressor energy
Sources	S15

PRIORITY ABATEMENT DESCRIPTION OPTIONS

A short description of the five best selected options is provided below.

BAT 1: Filters

This helps reduce pollutants for both air and water and it is highly efficient in reducing the emissions of pollutants such as PM/Dust as well as pollutants bound to particulates within the gas stream or microscopic particles in an aqueous stream[33]. Pollutant removal efficiency is in the range of 90-99% for air (e.g. bag filters) and the technology can achieve significant water pollutant emission reductions (e.g. phosphorous up to 12% reduction). It is a proven technology that is easy to operate and maintain and capital costs are among the least expensive for most alternative treatment technologies.

BAT 2: Crystallisation / Ion exchange / Nano-filtration or Reverse osmosis

This helps reduce several different groups of pollutants (i.e. water emissions – Heavy Metal, Oil, Organics and for air emissions – PM/Dust, VOC) for both air and water in a highly efficient way. For example, oils can be reduced up to 90% while heavy metals, PM/Dust, VOC can all be reduced in the range of 80-99%. The technologies have been tested and are simple to implement, operate and maintain. Capital costs are among the least expensive for higher capacity plants.

BAT 3: Absorption

This option contains a number of different techniques from solid carbon absorption beds to aqueous scrubber-type absorption units of the cascade type. These options can reduce pollutant emissions from five main types in a highly efficient way. By using different absorbents like $Ca(OH)_2$, $NaHCO_3$, $CaCO_3$, lime and caustic, which are easily available, the emissions of pollutants such as SO_x, PM/Dust, CO, HCl and HF can be reduced up to 99%. Costs of absorbents are highly justifiable in terms of cost effectiveness of its implementation. It is a proven technology that is simple to implement and easy to operate and maintain.

BAT 4: Proper Fuel Selection

This option helps reduce several different groups of air pollutants (i.e. CO, NO_x, SO_x, PM/Dust) in a highly efficient way. By using different types of fuels such as solid, liquid, gaseous, low ash, low sulphur and low nitrogen content, which are easily available, the emissions of metals, organic pollutants, SO_x and PM/Dust can be reduced up to 73-75%. The cost of different types of fuel is justified in terms of cost effectiveness by its usage in different kind of activities. It is a proven technique that, in some scenarios, is simple to implement and easy to operate and maintain.

[33] It is noted that the actual filter technologies for different media (air and water) and different substances are very different and that to draw conclusions across such a broad category may not fully reflect the individual costs and benefits of specific applications in (agro-)industrial activities. The grouping of these into a single abatement option category has been for the purposes of a simplified presentation and to limit the number of options considered.

BAT 5: Scrubbers

Different types of scrubbers (e.g. wet scrubber, venturi scrubber) can reduce emissions of SO_x, CO, VOC and PM/dust. The removal efficiency range is 33-92%. It is cost effective and recommended to be implemented with other technologies to reach better reduction levels. However scale is an important factor as in the largest applications, substantial space, engineering and power requirements mean these abatement options become significant components of the overall installation requiring high technical levels of maintenance and operational control, often with dedicated support systems (e.g. recirculation and cooling). The context of the application is therefore an important consideration for this option.

REFERENCE SOURCES

Sources	Source Code
Investigation of VOC emissions from indoor and outdoor painting processes in shipyards Ugur Bugra Celebi, Nurten Vardar (http://www.sciencedirect.com/science/article/pii/S1352231008002471)	S1
Modern approaches to marine antifouling coatings - L.D. Chambers, □, K.R. Stokes, F.C. Walsh, R.J.K. Wood (http://eprints.soton.ac.uk/43767/1/our_anti-fouling.pdf)	S2
Alternative Control Techniques Document: Surface Coating Operations at Shipbuilding and Ship Repair Operations(http://www.dep.state.pa.us/dep/deputate/airwaste/aq/attain/ctgs/final_ACT_shipbuilding_repair_1994.pdf)	S3
Air pollutants, hazardous; national emission standards: Surface coating operations from new or existing shipbuilding and ship repair facilities, 44050 (http://www.epa.gov/ttnatw01/shipb/fr27au96.pdf)	S4
BREF - BEST AVAILABLE TECHNIQUES (BAT) FOR THE PAINT AND ADHESIVE APPLICATION IN GERMANY	S5
GUIDANCE ON VOC SUBSTITUTION AND REDUCTION FOR ACTIVITIES COVERED BY THE VOC SOLVENTS EMISSIONS DIRECTIVE (DIRECTIVE 1999/13/EC)	S6
Wood Products Industry-Emission factors (http://www.epa.gov/ttnchie1/ap42/ch10/final/c10s08.pdf)	S7
Updated Impact Assessment of the Industrial Emissions Directive (IED), DEFRA, 27 January 2012	S8
COMPARATIVE STUDY OF DIFFERENT ENVIRONMENTAL TECHNIQUES IN THE SECTOR PRODUCING MAGNESIUM OXIDE FROM MAGNESIUM VIA DRY PROCESS (http://eippcb.jrc.ec.europa.eu/reference/BREF/comparative_study_on%20environmental_%20technologies.pdf)	S9
COMMISSION IMPLEMENTING DECISION of 26 March 2013 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the production of cement, lime and magnesium (http://eippcb.jrc.ec.europa.eu/reference/BREF/CLM_BATC_Published.pdf)	S10
Large Volume Inorganic Chemicals - Solids and Others industry August 2007 (http://eippcb.jrc.ec.europa.eu/reference/BREF/lvic-s_bref_0907.pdf)	S11
Reference Document on Best Available Techniques in Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector February 2003	S12
IPPC - GUIDANCE FOR THE RECOVERY AND DISPOSAL OF HAZARDOUS AND NON HAZARDOUS WASTE	S13
Science Direct - Landfill leachate treatment: Review and opportunity	S14
SD_Solvents	S15
Science Direct - Removal of greases and lubricating oils from metal parts of machinery processes by subcritical water treatment	S16
Reference Document on Best Available Techniques on Surface Treatment using Organic Solvents, Aug 2007	S17
Science direct - Naval derusting wastewater containing high concentration of iron, treated in UV photo-Fenton-like oxidation	S18
BAT Reference document, July 2004	S19
Assessment of the benefits and costs of the potential application of the IPPC Directive (EC/96/61) to industrial combustion installations (http://www.cafe-cba.org/assets/ippc_ec_thernal_input.pdf)	S20
20-50 MW rated thermal input http://www.cafe-cba.org/assets/ippc_ec_thernal_input.pdf	S21
Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry, August 2007 (http://eippcb.jrc.ec.europa.eu/reference/BREF/cer_bref_0807.pdf)	S22
BREF FD	S23
AMEC - European Commission Final Report (http://www.endseurope.com/docs/120723a.pdf)	S24
IIASA - Emissions from agriculture and their control potentials	S25

Appendix H
Impact of air emissions

A total of 23% of emissions air to air for various pollutants from industrial activities are regulated under the IED (category i); the impacts from these emissions are undoubted. However given the controls exerted by the IED it could be concluded that these emissions are not only being controlled but also progressively reduced through the application of BAT and the progressive tightening of emission limits within the overall permitting frameworks of the Member States.

The same cannot however be said for pollutant emissions from categories ii and iii. Emissions from category ii activities, whilst regulated by EU legislation, are in most cases unlikely to have the same level of direct control exerted over them as for category i. This may be because the control instrument covering the activity may not necessarily target emissions, or it may be because the effect of the legislation is somewhat indistinct (i.e. there may be control but the mechanisms at the installation level are not clear). This can be seen, for example, in those facilities affected by the EU Emissions Trading Scheme, which seeks to cap carbon emissions and encourage a transition to lower carbon industrial sectors. Whilst the focus is on carbon dioxide emissions, the indirect effect (for example by increasing efficiency within the process) is to create a reduction in other pollutant emissions, the impact of which may not necessarily have been quantified or directly regulated.

A further consideration is the relative impact of the pollutant emissions on human health and the environment, in absolute terms as well as a proportion of the emissions when taken as a whole from all (agro-)industrial activities. This report does not seek to offer a prioritised ranking of those pollutants considered to require further regulation because of their mass or the impact that emission has on human health or the receiving environment. Damage cost functions do exist for the main combustion pollutants (NO_x, SO_2, CO and PM_{10}) as well as for ammonia and VOCs, but there are no similar functions for the other pollutants examined in this report, meaning the calculation of avoided damages from further pollutant reductions could only ever be established for a limited proportion of the total emission loading.

To arrive at robust and useful conclusions that tie the mass emission of pollutants from category ii and ii activities to the damage caused in the receiving environment would require further research outside the scope of this report. Such conclusions would be powerful evidence in helping policy makers to understand if, and where, further resources may be needed to control and reduce pollutant emissions from categories ii and iii.

Impact of air emissions not regulated under the IED

The analysis is centred on presentation of the **splits of pollutant by category**, which provides an indication as to what extent pollutant emissions could be deemed ‘unregulated’ or indirectly regulated, and on **presentation of the mass of pollutant emissions by category**. Commentaries in the form of bullet points are made for each of the three groupings. The pollutants have been gathered in three different groups based on the percentage (mass terms) of emissions within categories ii and iii measured against total emissions in all categories. These groups are low, medium and high:

- **Low:** Pollutants for which category ii and iii emissions are up to 10% of the total mass emissions for all categories (i.e. the majority of emissions from (agro-)industrial activities are regulated);
- **Medium:** Pollutants for which category ii and iii emissions are between 10% and 25% of the total mass emissions for all categories (i.e. most of the emissions from (agro-)industrial activities are regulated); and
- **High:** Pollutants for which category ii and iii emissions are more than 25% of the total mass emissions for all categories (i.e. the majority of emissions from (agro-)industrial activities are 'unregulated').

Although the aim is not to provide a justification or case for further regulation of these activities, it may form part of the evidence for the Commission to consider when evaluating any possible new policy measures to limit, reduce or further control emissions of key pollutants from (agro-)industrial activities or to judge how effective controls that may be introduced as a result of existing industrial regulation might be.

G.1 Low (<10%) mass emission pollutants

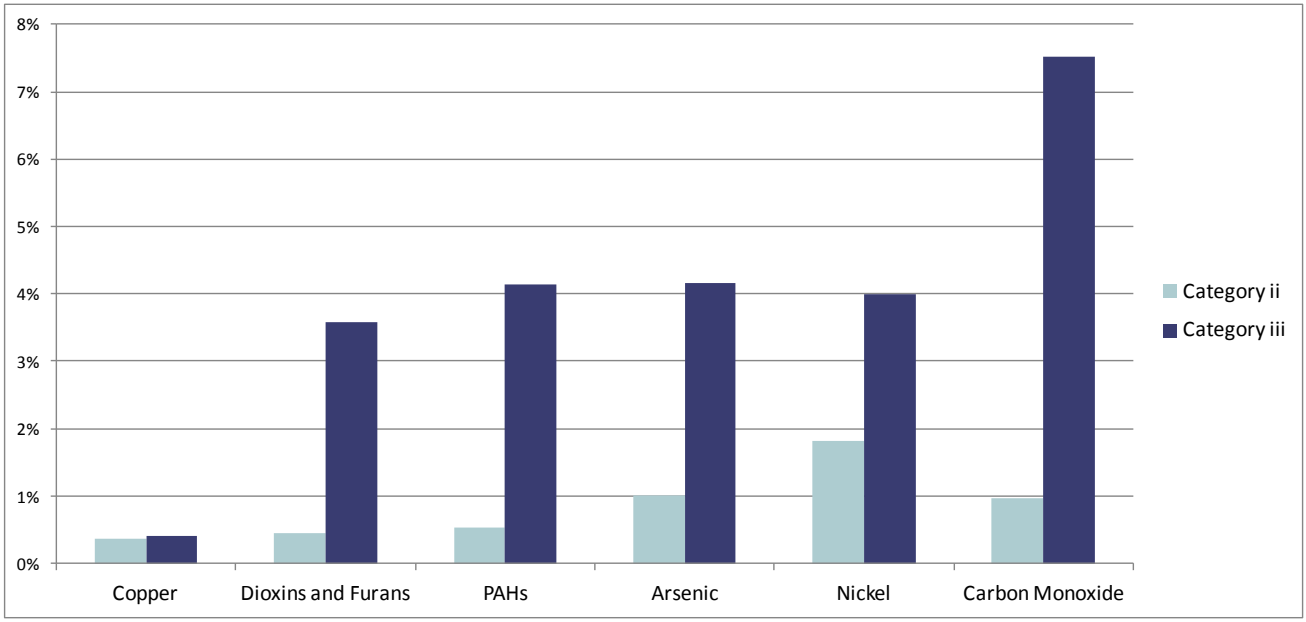
This section includes pollutants whose air emissions are distinctive due to the fact that up to 10% of all pollutant emissions come from activities within category ii and iii, which includes:

- Copper;
- Dioxins and furans;
- PAHs;
- Arsenic;
- Nickel; and
- Carbon monoxide.

Split of pollutants by category

Figure H.1presents for each of the pollutants included in the low mass emission group the importance of category ii and category iii emissions in percentage of the total quantity of emissions.

Figure H.1 Partition of emissions in percentage of the total quantity of emissions



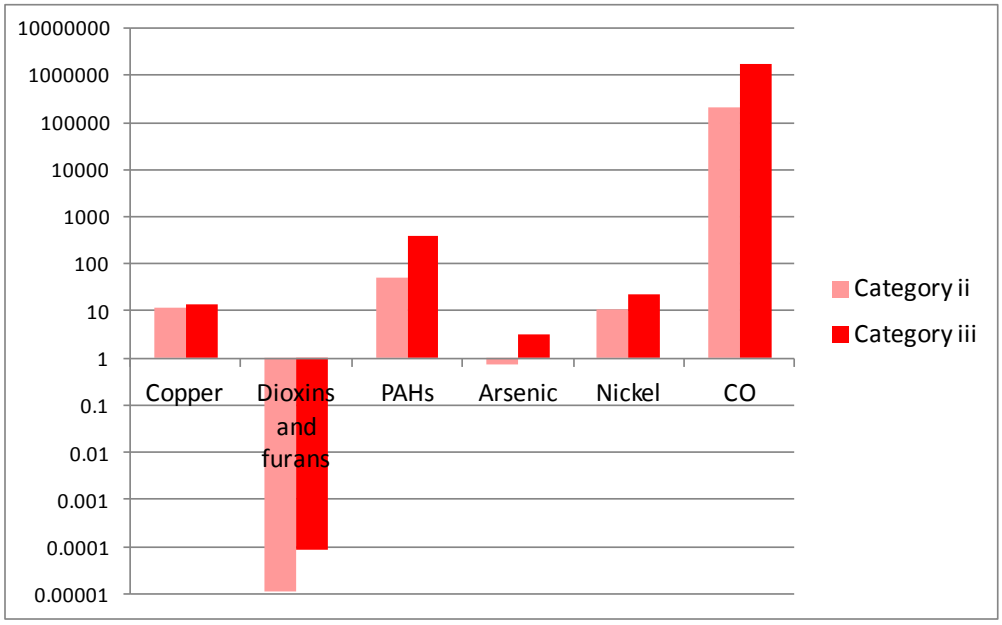
The following comments can be made:

- For all pollutants, there are more emissions originating from category iii activities than category ii, whilst they represent a small fraction of the total quantity of emissions for these pollutants, these emissions are currently 'unregulated'.
- Category iii emissions of **dioxins and furans** and **CO**, arise mainly from industrial activities under IED threshold which has already been identified as a significant source of 'unregulated' emissions; and
- Category iii emissions of **PAHs** are due to field burning of agricultural waste. The pollutant is released to air during the combustion of biomass (agricultural wastes). A very small proportion of PAH is emitted by industrial activities conducted under IED threshold (category ii);

Impact of low mass emission pollutants on health and environment

Figure H.2 presents the partition of emissions between category ii/iii in terms of mass. This gives an indication on the range of quantity of emissions that are estimated to be included in these categories; and from this understand their possible impact on environment and health.

Figure H.2 Quantity of emissions in category ii/iii per pollutant in tonnes (per annum)



Note: A logarithmic scale has been applied to present all the pollutants on the same chart

The following comments can be made in relation to possible impacts of low mass emission pollutants;

- **Copper** is mainly emitted during the grinding of mineral-rich rock containing copper. It is estimated that some rocks can contain from 0.5% to 5% of copper[34]. An estimate of 3% of copper emitted ends in water bodies and 0.04% remains in suspension in air. Exposure to small amounts of copper in drinking water and food is common and small levels are unlikely to have adverse effects on health or on the environment. In the environment, copper sulphate can form, which has other impacts, particularly toxic effects on some species of aquatic life and certain soil micro-organisms;

- The impact of **dioxins** is a persistent pollutant that can be deposited on soil and plants. The Australian environment agency estimated that over 96% of the dioxins present in the environment originate from air emissions[35], where upon their deposition they are then be ingested by fish and livestock. Some of the dioxins substances may be carcinogenic even in low concentrations. Figure H.2 shows that the quantities of dioxins and furans are very small in mass terms. However, even small quantities should not be discounted due to the potential health impacts and their persistence in the environment.;

- **PAHs** are a group of different compounds, some of which have been proven to be carcinogenic. Emissions of category ii/iii PAHs amount to roughly 100 tonnes. Exposure to PAHs may be harmful to human health, in particular for the eyes, liver, skin and immune system. High localised concentrations of PAHs may pose particular health issues. PAHs can associate themselves with other particulate matter (e.g. soot particles) and travel long distances in the atmosphere, creating potential transboundary impacts far from the point of release;

[34] INERIS,2005, Fiche de données toxicologiques et environnementales des substances chimiques: Cuivre
[35] Australian government, Factsheet on dioxins and PCB, accessed on 18 September 2013 http://www.environment.gov.au/settlements/chemicals/dioxins/factsheet2.html

- **Arsenic** is a heavy metal that is released to the atmosphere through the combustion of fossil fuels. The inhalation of arsenic is dangerous for human health and is one of the first chemical components recognised as carcinogenic by the European Union. Arsenic is a persistent pollutant, and once released it accumulates in the environment, eventually reaching concentrations that become toxic for flora and fauna. However, arsenic is naturally occurring in the environment and at low concentrations, its impact is limited. More research is necessary to understand the specific impacts of 'unregulated' arsenic emissions;

- **Nickel** is emitted in the air in an aerosol form with a range of particle sizes, the average size being 5.4 micrometres.[36] Based on the evidence, nickel is not judged to be a particularly toxic pollutant and emissions from activities in categories ii and iii are likely to have only a limited impact, particularly when considered against the other pollutants discussed here. Nickel can accumulate in soils and sediments, where it can affect water quality, however it does not bioaccumulate in the food chain and therefore further regulation of the pollutant would appear to be less of a priority at this time; and

- **CO** is an indirect greenhouse gas and as such has an important effect on air quality and atmospheric warming. It also produces, when combined with other pollutants, ground level ozone, which consequentially affects air quality. However, CO is targeted by other regulatory instruments; it is one of the pollutants included in the UN Framework Convention on Climate Change. The Convention requires that Annex I parties report their annual emissions of CO with the aim of gradually reducing emission levels. As such, it is indirectly regulated and it is reasonable to expected atmospheric CO emissions to reduce over time as emission prevention and reduction measures are implemented. Around 1 million tonnes of CO are currently 'unregulated'. This quantity is half the size of the emissions that are regulated by the IED.

G.2 Medium mass emission pollutants

This section focuses on those pollutants for which 10% to 20% of all emissions come from activities within category ii and iii, which includes:

- Sulphur oxides;
- Nitrogen oxides
- Cadmium
- PM10;
- Lead;
- Chromium;
- Zinc;
- Mercury; and

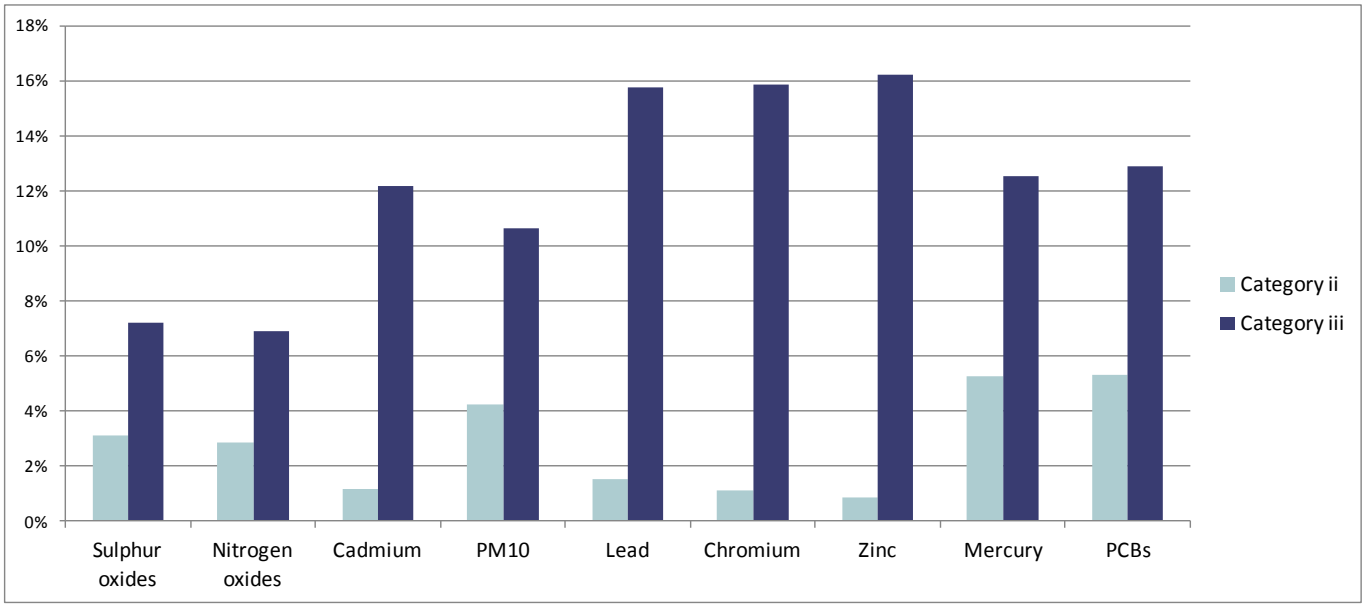
[36] INERIS, 2006, Fiche de données toxicologiques et environnementales des substances chimiques: Nickel

- PCBs.

Split of pollutants by category

Figure H.3 presents the split of 'unregulated' emissions between category ii and category iii for the relevant pollutants.

Figure H.3 Partition of emissions in percentage of the total quantity of emissions (per annum)



The following observations are highlighted from analysis of the data:

- The 'unregulated' emissions (category ii/iii) of **NO_x** and **SO_x** represents a third of the total of the emissions regulated by IED (category i). This is a significant quantity of emissions that could be targeted by extending the scope of regulation to include combustion plants below 50 MW^{th};

- Most of the emissions of **PM10** are emitted by non-industrial activities (transport, domestic emissions). Emissions from category ii and iii are mainly due to the activity of combustion plants 20-50 MWth (category ii) and below 20 MWth (category iii) and the transport and storage of agricultural products;

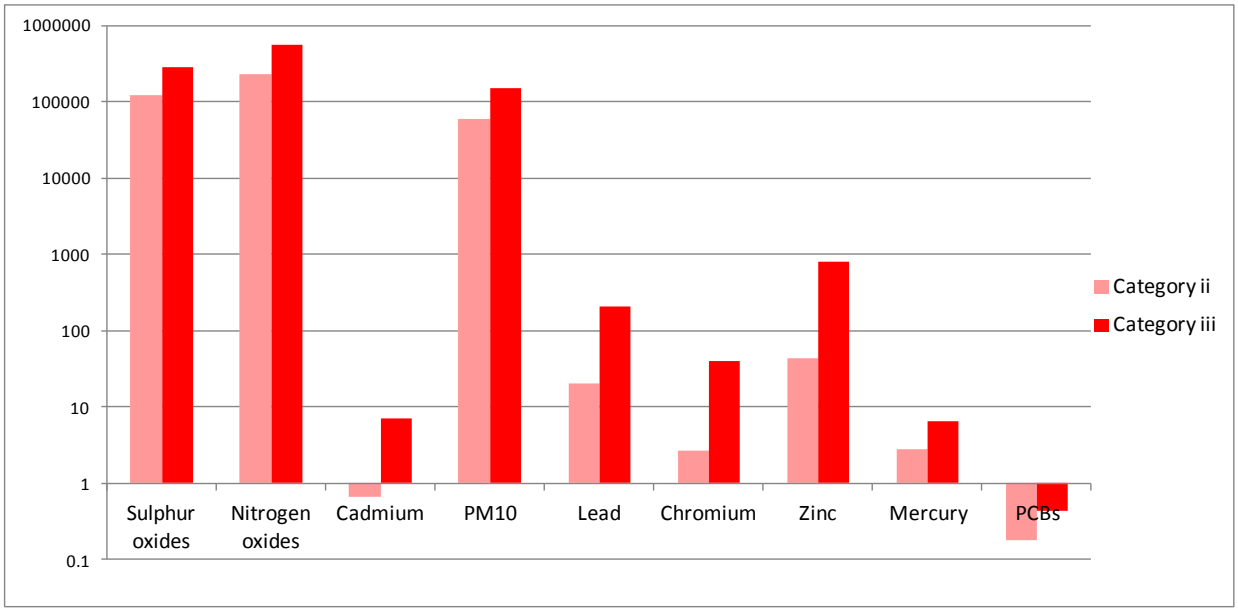
- The repartition of emissions of **lead**, **chromium**, **zinc, mercury and PCBs** indicates that the majority of these pollutant emissions are from category i activities and category iv. Category ii and iii emissions represent 15 to 17% of the total emissions, mainly originating from industrial activities under IED threshold; and

- **Cadmium** emissions are mainly due to emissions from category iv activities. Cadmium emissions from categories ii and iii combined are approximately the same as those from category i. Most of the emissions within category iii are due to industrial activities below the defined IED thresholds.

Impact of medium mass emission pollutants

Figure H.4 presents the quantity of pollutants emitted by category ii and category iii activities. This presents an indication on the range and quantity of emissions that are included in the 10% to 20% medium mass emission pollutants group.

Figure H.4 Quantity of emissions in category ii/iii per pollutant in tonnes (per annum)



Note: A logarithmic scale has been applied to present all the pollutants on the same chart

The following comments can be made:

- **SO_x and NO_x** are key air pollutants for which a lot of information on impacts on environment and human health are available. The average marginal cost per tonne of emissions of NO_x in 2010 for EU25 ranged from €8,200 to €12,000 depending on the sensitivity applied. NO_x reacts with various pollutants to create ground level (tropospheric) ozone, which can affect photosynthesis and reduce crop productivity. The average marginal cost per tonne of emissions of SO_2 for the EU25 ranged from €11,000 to €16,000. The emissions can have a severe effect on human health and the environment. SO_2 has a half-life of 3 to 5 hours during which it combines with other atmospheric molecules to create SO_3 which is the primary agent of acid rain. The 1994 Protocol on Further Reduction of Sulphur Emissions adopted under the Convention for Long Range Transboundary Air Pollution is dedicated to reducing SO_x emissions. The possible options to further control and reduce emissions of SO_x/SO_2 and NO_x/NO_2 from combustion plants below 50 MW^{th} have recently been presented in report published by AMEC for the European Commission[37]. The report concludes that various options are available to reduce in a cost-efficient ways emissions of NO_x and SO_x from this specific category of combustion installations;

[37] AMEC, 2013, Analysis of the impacts of various options to control emissions from the combustion of fuels in installations with a total rated thermal input below 50 MW. A report for DG Environment, European Commission.

- **Cadmium** is a by-product of zinc production. It is used for the manufacture of batteries and in industrial processes. Cadmium exhibits a strong bioaccumulating effect and is readily absorbed by many organisms, in particular in micro-organisms, with some incidence of bio-magnification in the food chain. Chronic impacts are believed to be more of an issue than acute effects with long-term exposure leading to kidney diseases. There are no major environmental impacts resulting from the emissions of cadmium. Consequently, it is not estimated that there is an urgent need to tighten the current regulation of cadmium;

- **PM_{10}** emissions are composed of various solid and/or liquid elements. They consist of both primary components, which are released directly from the source, and secondary components, which are formed in the atmosphere by chemical reactions. Pollutants such as SO_2, NOx, ammonia and NMVOCs are all precursors of secondary components. In the UK alone, it was estimated that exposure to PM10 in 2002 led to 6,500 deaths and 6,400 hospital admissions. The main impacts of PM10 are on human health, but they also have impact on the environment. Particulate matter contributes to climate change through its ability to alter the radiative forcing of the atmosphere. They also alter general visibility by creating 'smog'. PM10 emissions pose a threat to human health, air quality and the global environment; as such it is thought that the impact of 'unregulated' emission is important enough to justify exploring the possibility of further regulation. As a by-product from combustion of fuels, tightening emissions limits for smaller combustion installations would contribute to reduce PM10 emissions significantly;

- **Lead** is also a neuro-toxin that once ingested accumulates and affects the brain and the nervous system. Long-term exposure to high concentrations of lead has serious impacts on human health and can lead to poisoning. Atmospheric releases are deposited relatively close to the emission source where adverse effects can include loss of biodiversity, decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates.[38] It is estimated that whilst most of the lead falls in a close proximity of the emission source, 20% of the emissions are more widely dispersed, so the potential range of affected environment is wider than the proximity of the source. However, the quantities of emissions 'unregulated' (category ii/iii) are still inferior to those emitted by sectoral activities, and lead emissions does not appear to be urgently requiring further regulation. Further research will be necessary to understand the impact of these 'unregulated' lead emissions;

- **Chromium** emissions are mainly due to industrial activities and pure chromium metal and alloys are not hazardous to health although hexavalent chromium is particularly toxic and linked to serious health effects. However, there is limited evidence to suggest there are significant effects on the global environment expected from chromium emissions made from activities within categories ii and iii. As such it is not considered that chromium's 'unregulated' emissions present an important impact.[39] More research is necessary to understand the specific impacts of 'unregulated' chromium emissions;

- **Zinc** is produced mainly by the metal working industry and in its elemental form is an essential nutrient in the human diet. It is also added to the feed of some livestock to accelerate growth. As a result, the accumulation of zinc within the organism is regulated to maintain a constant level. The recommended amount of intake of zinc by the EU is for adult males and females of 9.5 mg/day and

[38] US EPA, Lead in air: health, accessed 20 September 2013 http://www.epa.gov/oaqps001/lead/health.html

[39] Scottish Environment Protection Agency, Scottish pollutant emissions inventory: Chromium . Accessed 20/09/2013 http://apps.sepa.org.uk/spripa/Pages/SubstanceInformation.aspx?pid=103

7.0 mg/day, respectively[40]. There are negative health effects reported following the inhalation of zinc emissions (e.g. zinc chloride). Exposure to the concentrations required to cause major health and environmental effects are restricted to a worker's industrial exposure (e.g. workplace controls apply) and to major contamination events. As a result, despite the fact that a large amount of zinc emissions are currently 'unregulated', it is not believed to be causing major impacts to the environment and human health and is therefore not judged to be a priority for additional controls;

- **Mercury** is a toxic heavy metal that affects brain function and the nervous system in humans and animals leading to severe health impacts. Exposure is most commonly observed through consumption of contaminated fish or grain. However, additional international regulation should soon be adopted. A draft text entitled 'Minamata Convention on Mercury' has been adopted in January 2013 under the auspices of the UNEP. The Convention, finalised and adopted in October 2013, has a formal objective to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds (Article 1). Article 8 on control of emissions states that "*A Party with relevant sources shall take measures to control emissions and may prepare a national plan setting out the measures to be taken to control emissions and its expected targets, goals and outcomes. Any plan shall be submitted to the Conference of the Parties within four years of the date of entry into force of the Convention for that Party*"[41];

- **PCBs** is a persistent pollutant which has impacts on human health and the environment. Similarly to the emissions of dioxins, the Australian environment agency estimated that over 96% of the dioxins and PCBs present in the environment originate from air emissions[42], where upon their deposition they are then be ingested by fish and livestock. Figure H.4 shows that the quantities of dioxins and furans and to a lesser extent PCBs are very small in mass terms. However, even small quantities should not be discounted due to the potential health impacts and their persistence in the environment; and

- There is already international legislation affecting PCB emissions, which are one of the pollutants included in the Stockholm Convention on Persistent Organic Pollutants. The Convention, adopted in 2001, aims to protect human health and the environment from highly dangerous and long-lasting chemicals and requires parties to develop an action plan to identify, characterise and address the release of the chemicals. Parties are also requested to provide information on steps taken to eliminate the production and use of PCBs. These requirements are implemented through the Persistent Organic Pollutants Regulation.

G.3 High (above 25%) mass emissions pollutants

This section gathers pollutants for which more than 25% of emissions are 'unregulated'. Only two pollutants in this category are:

- NMVOCs; and

[40] European Commission, DG SANCO, 2003, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Zinc (expressed on 5 March 2003) http://ec.europa.eu/food/fs/sc/scf/out177_en.pdf

[41] UNEP, 2013, UNEP(DTIE)/Hg/INC.5/7* - Report of the intergovernmental negotiating committee to prepare a global legally binding instrument on mercury on the work of its fifth session http://www.unep.org/hazardoussubstances/Mercury/Negotiations/INC5/INC5Report/tabid/3496/Default.aspx

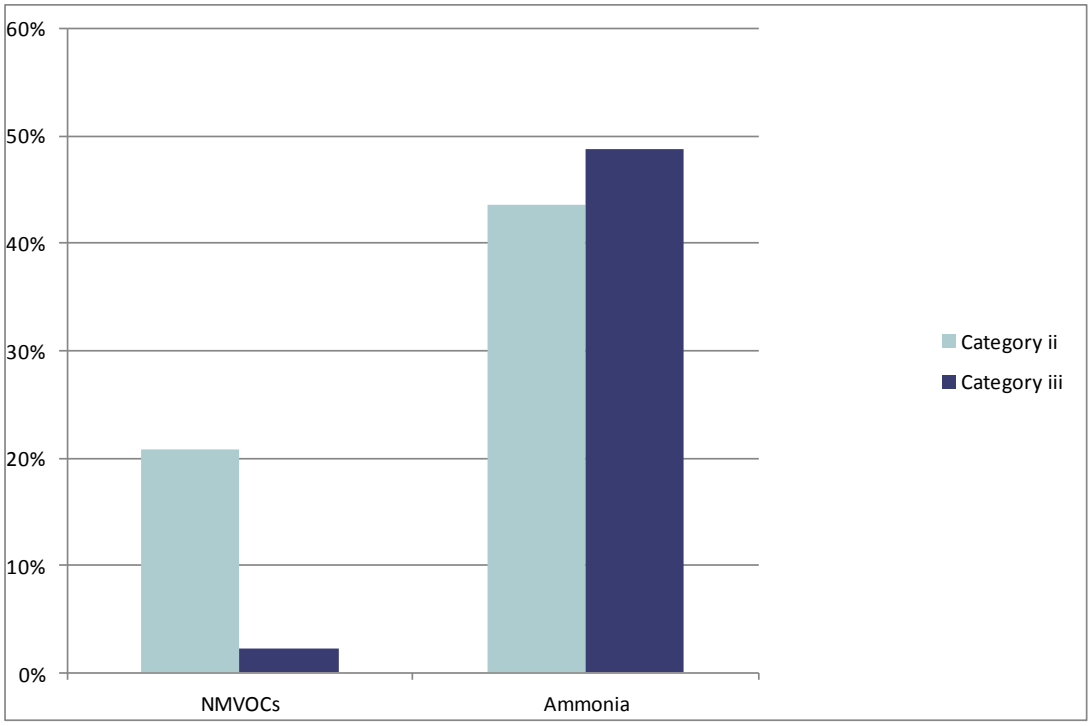
[42] Australian government, Factsheet on dioxins and PCB, accessed on 18 September 2013 http://www.environment.gov.au/settlements/chemicals/dioxins/factsheet2.html

- Ammonia.

Split of pollutants by category

Figure H.5 presents the partition of 'unregulated' emissions between category ii and category iii.

Figure H.5 Partition of emissions in percentage of the total quantity of emissions



The following observations are made:

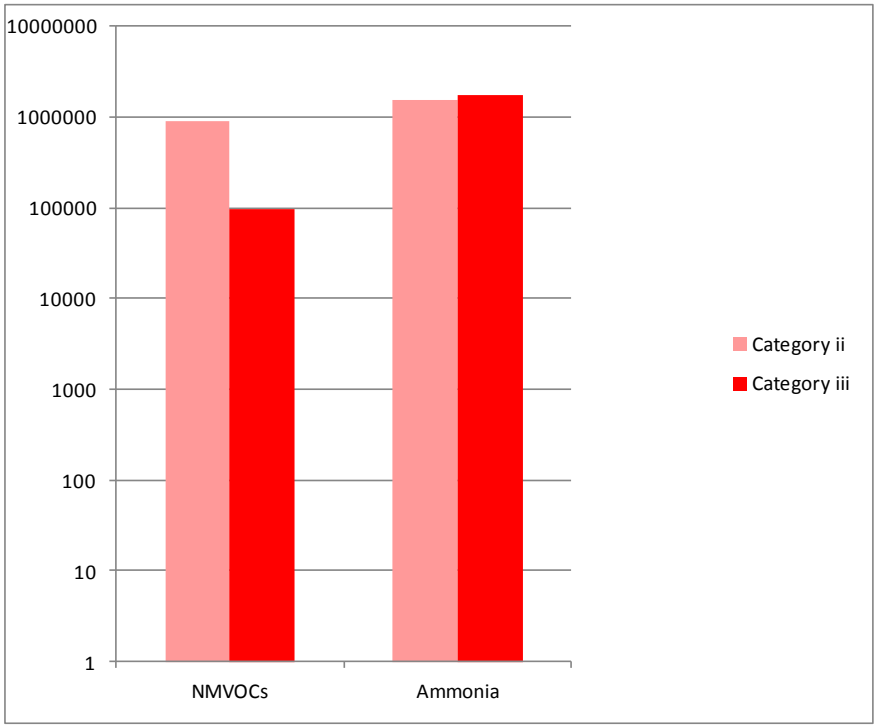
- Category iv has the largest share of emissions of **NMVOCs**. The rest of the emissions are split almost equally between category i activities and category ii/iii activities. The sources of emissions in category ii are activities using organic solvents below the IED threshold and the use of fertilisers other than manure. Category iii emissions represent a smaller share of emissions (5%) and are due to field burning of agricultural wastes; and

- 92% of emissions of **ammonia** are currently not directly regulated. They are split almost half and half between category ii activities (spreading of manure from livestock) and category iii activities (rearing livestock below the IED thresholds).

Impact of high mass emissions

Figure H.6 presents the quantity of pollutants emitted by category ii and category iii activities.

Figure H.6 Quantity of emissions in category ii/iii per pollutant in tonnes



Note: A logarithmic scale has been applied to present both pollutants on the same chart

The following comments can be made:

- **NMVOCs** represent a number of different organic chemical compounds such as benzene, ethanol, formaldehyde, cyclohexane or acetone. They all share some common properties such as a high vapour pressure at ambient temperature. Some NMVOCs are carcinogenic. The effect on health depends on the concentration and the duration of exposure. Some of the volatile organic compounds are already strongly regulated, for example those included in paints and solvents and those used in the refrigeration industry. The impacts of NMVOCs on the environment and air quality in particular can be quite severe. NMVOCs play an important part in the formation of photochemical smog and may react with other air pollutants to form ground-level ozone. High levels of ozone can cause damage to plants, reduce agricultural crop yields and decrease forest growth. It is interesting to note that the amount of 'unregulated' emissions (category ii/iii) is roughly equal to those of regulated emissions (i) and considering the range of impacts on health and the environment, a tighter regulation of NMVOCs may be justified; and

- Exposure to **ammonia** at normal emissions level is not likely to trigger any adverse effect to health. However, ammonia is a secondary particle emissions precursor and once emitted to air can combine with PM to create ozone and other air quality pollutants. These would have consequences on human health (respiratory systems primarily). The main impact of ammonia is on the environment, as once emitted, ammonia combines with other substances to create nitrogen. Ammonia is also harmful to ecosystems through acidification and eutrophication caused by excess nutrients leaching into

freshwaters and disrupting plant communities, leading to a loss of biodiversity. A recent report[43] conducted by AMEC on the impacts of emissions from spreading of manure found that since 1990 the emissions of ammonia from cattle (dairy and non-dairy) and swine have decreased due to a combination of factors including changes in overall livestock numbers (increases and decreases) as well as the uptake and application of more efficient feeding, housing, manure storage and application strategies and techniques. AMEC's report details several policy options and their associated costs and emissions reduction potential.

[43] AMEC, 2013, Collection and analysis of data for the control of emissions from the spreading of manure

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