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CHALLENGES IN DEVELOPMENTOF INDICATORS ON HAZARDOUS WASTE

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Introduction and summary

The content of this paper is to present some of the considerations in Topic Centre (WMF) concerning development of indicators on waste and material flows with a specific attention to hazardous waste. Topic centres are working under the umbrella of EEA so the considerations on specific indicators in this paper shall be evaluated within the frame work of indicators presented in the paper from Peter Bosch: "The European Environment Agency focuses on EU-policy in its approach to Sustainable Development Indicators"

The context for development of indicators on hazardous waste is a reformulation of indicators on waste and material flows. This process is initiated to focus the indicator-based reports of the European Environment Agency towards policy and environment core issues. Therefore this paper will try to formulate indicators relevant for evaluation of performance in relation to the EU environment policy on waste and resource management.

In this paper I will specify our general considerations regarding issues related to indicators on hazardous waste.

The main findings and issues for statistics on hazardous waste in this paper is based on "Hazardous waste generation in EEA countries" report from EEA:

- Problems of availability are mainly related to larger EU-countries, while minor countries have annual statistics.
- Statistics on total waste generation is based on a mixture of national and international classifications with no common denominator.
- The basic environmental problem of not collected hazardous waste is not monitored in waste statistics. In most cases generation is used in the heading of tables while the statistics is actually based on collection figures and not on waste generation.
- Waste generation (collection) is dominated by few categories, which differs from country to country. This result might be influenced by the fact that larger countries have no information available at detailed level.
- Because of the great differences between countries (according to statistics) further analysis must be related to specific sectors and specific categories of hazardous waste, this is at the moment only feasible for few EEA countries.

Some of the general prerequisite (e.g. non ambiguity) for indicators will tumble over problems related to hazardous waste: An increase in the part of hazardous waste under separate collection is a step towards a sustainable development. While a decrease in hazardous waste generation as a result of waste prevention or cleaner technology will have direction of sustainable development. Neither of the two indicators can be produced from available statistics because of confusion between collection and generation. Further more variations in degree and character of hazards in aggregated figures will make the correct assessment difficult.

Indicators on Eco-efficiency of waste management and policy effectiveness have its own difficulties on top of the prior mentioned problems. One crucial issue is that different treatment options have no common accepted standard for measure of degree in environment protection because of a large number of incomparable environment parameters e.g. from CO_2 emissions to heavy metals in ground water.

Problems related to indicators on hazardous waste.

Policy and environmental relevance

Hazardous waste is a highly regulated area of waste management and the consequences of contaminated sites for nature and human health is not doubtful. Directives on incineration, shipment of waste and on specific waste streams causes the need for specific monitoring and indicators .
Surprisingly the realising and the regulation at political level of the environmental relevance of problems related to hazardous waste did not lead to development of unambiguous, reliable, comparable time series for generation, collection and treatment of hazardous waste.

- **Unambiguous.** For generation of hazardous waste it is obvious that increase is bad. On the other hand statistics waste **collection** of hazardous waste is often the measured and it is presented as **generation** For hazardous waste this causes ambiguity because the target for waste management is to collect all meaning that the collection rate have to increase, but in most cases nobody knows the generation. An increase might be positive and a decline might be adverse to the environment. The best situation would be to have knowledge on the generation (based on estimates) and to know the collection rate and the treatment of collected hazardous waste.
- **Reliable;** Data is not reliable as long as there is no differentiation between generation and collection.
- **Repeatable**
- **Time series** needed to explain the actual tendency for hazardous waste is limited to a few countries. Because of change and variation in classification systems and change in respect to what is considered as hazardous.
- **Comparable statistics** between **Countries** is needed. The need for common classification is obvious but there is also a need for common way to use the classification and a need for splitting up the hazardous waste stream. This should be done to avoid having to compare pears and apples?

Policy request for Indicators on Hazardous waste.

Introduction

The European Commission in 1989 initially adopted a Community Strategy for Waste Management. The strategy sets out four strategic guidelines: Prevention, re-use and recovery, optimisation of final disposal and regulation of transport, together with a number of recommended actions.
The main strategic guidelines were maintained in the 1996 Review of the Community Strategy for Waste Management, adding that preference should in general be given to the recovery of material over energy recovery.

In the proposed 6th Environment action programme the need for indicators on waste is underlined:

by the realising that

> "A lack of aggregate data at the EU level makes it difficult to assess whether the environmental impacts associated with management of wastes are improving or deteriorating"

and

> "Environmental policy-making, given the complexities of the issues, needs to be based on sound scientific and economic assessment, based on a knowledge of the state and trends of the environment, in line with Article 174 of the Treaty.
>
> · Information to policy makers and the general public has to be relevant, up to date and easily understandable.

- Progress towards meeting environmental objectives needs to be measured and evaluated."

So there is a clear need formulated in the 6th Environment Action Programme (6th EAP) to develop the framework for relevant sound assessment in a clear and understandable information for the policy makers – the development of the core set of indicators.

EU-policies raises questions relevant for the development of indicators in the next pages the strategic targets and measures of the EU is summarised.

6th EAP priorities:

The sustainable use of natural resources and management of waste. One of the most commonly used definitions of sustainability is 'to meet the needs of the present without compromising the ability of future generations to meet their own needs'. In waste management terms, this means that we must manage unavoidable wastes in ways that minimise the impact on our environment and to conserve the resources on which our future depends (including materials, energy and land). We need to do this at an affordable cost.

The Programme aims at better resource efficiency and resource and waste management, with the following objectives:

- *- Ensuring that the consumption of renewable and non-renewable resources and their associated impacts does not exceed the carrying capacity of the environment;*
- *- A significant reduction in the quantity of waste going to final disposal and the volumes of hazardous waste produced, in the lifetime of the programme*

For waste management the priority is given as in the waste hierarchy: to waste prevention, followed by recycling, waste recovery and incineration, and finally to land filling. The programme sets out following targets:

- Reduce the quantity of waste going to final disposal by around 20% on 2000 levels by 2010 and in the order of 50% by 2020
- Reduce the quantity of hazardous waste generated by around 20% on 2000 levels by 2010 and in the order of 50% by 2020.

So the ambitions concerning Hazardous Waste is quite demanding.

Basic EU-directive on hazardous waste.

The EU's waste policy has always been focussed on an ecologically sound waste management pursue throughout a number of steps. In general they have as core policy objectives peculiar aspects such as prevention, re-use and recovery, optimisation of final disposal and regulation of transport. Amongst the most important directives are:

- *Hazardous waste Directive (91/689/EEC on hazardous waste)*
  - Protect the environment from the adverse effects of waste, through either primary, secondary or tertiary treatment and collection systems by provisions of
    - Definition of hazardous waste
    - Prohibition to mix with other waste
    - Specific permit requirement for dealing with hazardous waste

- Periodic inspection and requirement for producer to keep records of hazardous waste.
- Packaging and labelling requirement
- Waste management planning

Deriving indicators from Waste Management Policy of EU.

At the thematic policy level of waste and resource management there are many specified policy objectives and hence potentially many indicators needed to assess progress against these objectives. There are however, grounds for optimism here to streamline our approach.

- Firstly there is substantial commonality between objectives at the higher and thematic policy levels e.g. sustainable resource use (SDS, 6TH EAP, Waste Framework Directive).
- Secondly, at the thematic policy level, there are some key parameters to be measured, which are relevant to more than one Directive or other piece of legislation, e.g., hazardous waste (LCP Directive, HW Directive, and Framework Directive).
- Thirdly we also know that it is not possible to measure many dangerous substances in waste because of the high monitoring costs involved.

This means we have to think hard about indicators derived from data on driving forces (chemical production as approximations for those on state and impact. Using driving forces as approximations, also allows us to make links to material flows, an important consideration for closing the Circle of material throughput from extraction to waste generation.

Taking the wide ranging policy objectives and the commonalties between objectives at different levels - how can we best address these objectives in an integrated way to deliver assessments and to help organise our indicator thinking?

The proposed "vehicle" is to start from the most aggregated policy objectives and use those as criteria for selection of policy questions, which can be answered by indicators.
The proposed approach starts from the analysis of the 6th EAP, which is considered as the main policy framework. The priority area considered is that indicated as "*Sustainable Use of Natural Resources and Management of Waste*". The program presents this area subdivided in:

- Resource Efficiency and management
- Waste prevention and management

These areas are then analysed within certain criteria. A "criterion" is intended to represent a very general objective of EU policy strategy against which policy performance can be evaluated in terms of evolution of the problem, policy actions and achievements as represented/measured through indicators.

The three criteria proposed by the ETC/WMF are:

- Conserving our Natural Resources,
- Prevention of Waste Generation, and
- Sustainable Waste Management.

All three criteria are strictly connected with the objectives identified by the 6th EAP.

In table 1 the framework for indicators on hazardous waste is drafted in schematic form to indicate the policy questions at different levels and to indicate the proposed indicators. This framework is developed to reflect the policy questions derived from EU-strategies and policy on waste and material flows as proposed in the previous section.

Table 1

	(1) Main policy questions	(2) indicator, proposed	(3) comments on indicator
Criterion 1: Conserving Natural Resources			
1.	**Are we getting better with respect to the use of natural resources?**	**Total Material Requirement; TMR** (in tonnes, or tonnes per capita)	TMR is a highly aggregated proxy indicator indicating the overall (life-cycle -wide) resource use (without water and air) associated with a national economy
1.a	Are we reducing the consumption of the natural resources that are of most concern?		
1.b	Are we reducing the environmental damages associated with the use of particular resources?		
1.c	How are the main socio-economic driving forces affecting the use of natural resources?		
1.d	How effective are the various instruments to reduce the consumption of natural resources that are of most concern?		
Criterion 2: Prevention of Waste Generation			
2.	**Are we improving prevention of non-hazardous and hazardous wastes?**	Total waste generation (tonnes) Total generation of hazardous waste (tonnes)	
2.a	Is the quantity of priority waste streams (under legislation so far and/or beyond?) decreasing?	Total generation of waste by main waste categories e.g. - end-of-life vehicles - healthcare waste, - waste from electrical and electronic equipment (incl. batteries and accumulators), (tonnes or tonnes/capita)	
2.b	Is the content of dangerous substances in priority waste streams decreasing?	Content of dangerous substances in priority waste streams e.g.: - hazardous waste, - municipal waste, - packaging, - end-of-life vehicles (used tyres), - healthcare waste, - sewage sludge, - waste oil. (share %)	Should link to the several Directives which address or set targets for dangerous substances respectively. *The indicators for different waste streams (requirements of different directives) can be different, not only share or percentage of dang. substances in waste, but also for example: Share of batteries on the market (in the waste) containing Cd, Hg and Pb (under regulation of `batteries` directive)*
2.c	Has economic growth (driving forces) occurred without increase of waste generation (de-coupling)?	Total waste generation (tonnes) and gross value added (household income) by economic sectors and households (Euro)	For a selection of economic sectors and private households, both figures should be shown in terms of indexed time series graphs illustrating "de-coupling"
2.d	How much of the total waste generated has been addressed by specific policy measures (Which should be future priority waste streams and why?)	Share of total waste generation addressed by policy measures (share of priority streams, i.e. hazardous waste etc.) (%)	
2.e	How effective are the various policy instruments for waste prevention?		
Criterion 3: Sustainable Management of Waste			
3.	**Are we moving towards a sustainable management of waste through a maximum use of recovery whilst minimising environmental burden?**	Total waste generation by treatment categories: - recycled material - incinerated with energy recovery - incinerated without energy recovery - landfilled - others (tonnes) Optional: Share of 'recycled material' to total amount of waste generated (%)	Due to the law of conservation of matter total waste generated has to remain somewhere. This indicator should show the treatment of total waste generated in terms of a "mountain"-chart indicating whether the different treatment possibilities are increasing according to the waste hierarchy (re-use and recycling before waste incineration before landfilling). The alternative indicator, i.e. share of 'recycled material', would illustrate the rate of recycled materials entering again the economic system and by this constituting a substitute for virgin raw materials. 'Recycled material' would also include biologically recovered material by aerobic and anaerobic treatment.

3.a	Are we moving towards the targets set for sustainable recovery of waste?	Amount (or share) of waste recovered according to requirements of Directive... (tonnes or %) • Air emissions by recovery plants (incineration) • Outputs of hazardous substances (dioxins,ashes,..)	In principle, those indicators should show the state of implementation of technical standards for recovery as defined in several Directives. Should also show the impact due to incineration and/or landfilling *For waste management facilities (installations), described in Annex I of the IPPC Directive BAT reference documents have to be elaborated (pertaining to every R and D code). Waste management according BAT is clearly sustainable management, it is the postulate of the IPPC Directive. In this case indicator can describe amount (or share) of waste recovered (disposed) in facilities in accordance with BAT or in installations having IPPC permit. Thus the sustainable recovery/disposal of waste can be characterized with one summarizing indicator.*
3.b	Are we avoiding the disposal of waste which could be recovered in a sustainable way?	Amount (or share) of waste disposal which could be recovered (tonnes or %) • Land use by landfills • Soil contamination	
3.c	Has the transportation of waste been minimised?		
3.d	Are the present and future waste management capacities sufficient?	*Proposed presentation:* A mountain of actual and planed treatments capacities for the specific waste stream summing up to the total capacity in tonnes per year (for the next twenty years). The scenario will be presented as a red curve through or over the mountain.	*data needs will be:* – Statistics as in annex 2 of waste statistics regulation (waste type by treatment and disposal methods) – Scenarios for waste generation by type of waste – Plans for treatment capacity by options and by type of waste to be treated
3.e	How expensive are our waste management systems?	At system level: total capacity of wm sector as statistics and planned capacity related to some denominators: – as GDP or turnover of wm sector and – number of employees – Capital invested in wm, For specific waste stream e.g. Biodegradable I propose a trend: Cost of preventing one tonnes of GHG in bio gas plant. Based on estimate of emissions of GHG from land filling minus emissions from biogas producing plant divided by (costs of biogas extraction from BMW) minus (costs of a system based on landfiling of BMW minus income from sold products from the biogas extraction)	At level three we need information from national account, employment, market prices for extraction of a number of secondary raw materials and on emissions from different processes by type of waste
3.f	How effective are the various instrument on waste management?	Policy instruments in use are e.g. tax on waste going to landfill, ban on landfilling of certain waste types and other fiscal instruments. The conclusions must be verbal.	The efficiency of certain policy instruments is difficult to measure but some kind of evaluation will take place and should be available at a detailed level three.

Availability and Comparability in statistics on hazardous waste.

The findings of this section is based on the report on "Hazardous waste generation in EEA member countries", which will be published as a technical report from EEA.

Trends in hazardous waste generation

Information which related to more than one year was available from all countries/regions except Brussels and Sweden. The amounts of hazardous waste collected are increasing in most countries/regions.

The data shows increasing quantities of hazardous waste during the 1990s for Austria, Belgium, Denmark, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway and Spain, with a decrease in quantities in Finland, Germany, Greece, Portugal and United Kingdom. However, the trend is not very clear due to the fact that the amounts of hazardous waste in some countries fluctuates from year to year.

Furthermore, some countries can not provide new data, this makes it difficult to establish reliable trends in relation to the generation of hazardous waste.
Increasing quantities of hazardous waste can be the result of positive developments such as better collection of waste and improvements in the registration of waste, and not necessarily as a result of a real increase in waste generation. Improvement in separate collection of hazardous waste and in registration of waste is positive developments while increasing generation is a pressure on the environment.

Table 2. Hazardous waste generation in Europe (thousand tonnes)

Country	1990		1991		1992		1993		1994		1995		1996		1997		1998	
Austria	317	4	364	4	398	4	499		513		577		606		626	4	868	4
Belgium, Brussels																		
Belgium, Flanders									1,033	1	1,079	1	1,410	1	1,625	1		
Belgium, Wallonia											419		427		470		475	
Denmark									194	1	247		264		249		281	
Finland					559	1									481			
France	7,000	1											9,000	3				
Germany	13,079	1					9,091	1					17,421	4				
Greece	450	1			450	1					350	1					287	
Iceland					4		4,9		5,7		4,3		5,7		5,8		6,8	
Ireland	66				99						248		230					
Italy	3,246	2	3,387	2							2,708	2			3,401			
Luxembourg	116	1					861		811		197	1	157	1	142	1		
Netherlands	1,040	1			1,430	1	836		890		868		959		1,271		1,448	4
Norway	60						98		92		102		119		128		141	
Portugal											668	1			595	1		
Spain	1,700	1									3,394	1						
Sweden							394											
United Kingdom					2,452	1	2,077	1										

Sources: 1) Eurostat, 2000, Waste generated in Europe. Data 1985-1997, European Commission.
2) OECD, 1997, OECD Environmental Data. Compendium 1997.
3) Institut Francais de l'environnement, 'The environment in France' Orléans 1999
4) Eurostat/OECD Joint Questionnaire 2000
Otherwise: ETC/W questionnaires 1998+1999.

Classification of Hazardous Waste.

Valuable information can be achieved from both a source/process oriented as well as a substance oriented classification. The source/process based classification system is useful for waste minimisation and cleaner technology purposes as well as comparability of waste from specific branches. A substance-oriented classification will provide information on overall amounts, how to treat the waste once it is produced and the need for treatment capacity.

It has been concluded that setting up a main structure for listing existing information on hazardous waste will require that each country/region's existing classification is related, in the first instance, to HWL.

A general problem was that HWL consisted of too few codes to cover what has been regarded as hazardous waste in each country or region. Therefore, when comparing the total *quantities* of hazardous waste between countries and regions, the variations can partly be explained by the fact that the hazardous waste list does not cover all waste types that are regarded as hazardous at national or regional level.

Amendment to Hazardous Waste List improves comparability.
The EWC/HWL list has recently been amended and more waste types are today considered as hazardous. In table 2 of annex1 an in table 3 and 4 it has been indicated for each waste type whether it is according to the previous and current list:

- H-codes; included in the HWL
- E-codes; included in EWC, but not HWL or
- A-codes; not included in EWC.

From table 3 it appears that due to the amendments a larger part of the waste types applied in the countries are included in the HWL. In the top 5 only 51 % of the waste types were part of the previous HWL, while the other 49 % were E-codes and A-codes. Considering the top 10 and the top 20, 60 % of the waste types that were classified as hazardous according to the previous HWL rose to about 75 % using the current HWL (Have to be looked up).

Table 3. The distribution of H, E and A-codes in percentage of the number of waste types used in top 5, 10, and 20 respectively

	Top 5			Top 10			Top 20		
	H	E	A	H	E	A	H	E	A
Previous EWC	51 %	37 %	11 %	63 %	27 %	10 %	60 %	27 %	13 %
Amended EWC	69 %	23 %	9 %	75 %	19 %	6 %	74 %	18 %	8 %

Comparability in quantities of waste
Although a large *number* of waste codes are defined as E-codes or A-codes, this does not necessarily mean that large *quantities* of waste are registered according to these codes

According to table 4 the percentage of waste quantities related to HWL is greater than the percentage of waste types. 64-72 % of the waste quantities could be related to the HWL before the amendment and 80-84 % after. Thus, it appears that the amendment of EWC has led to a greater comparability of the total hazardous waste quantity-the further amendments to the list will probably lead to further comparability.

Table 4. The distribution of H, E and A-codes in percentage of the waste quantities in top 5, 10, and 20 respectively

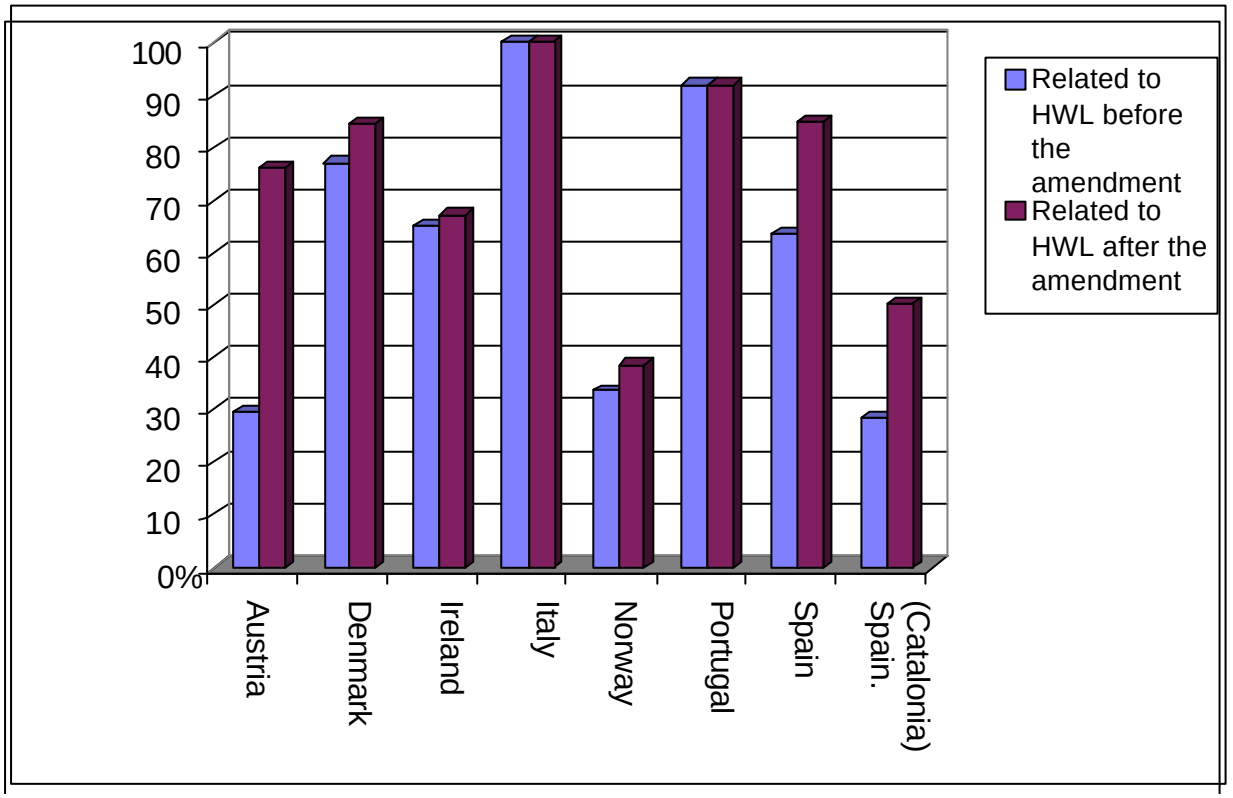
	Top 5			Top 10			Top 20		
	H	E	A	H	E	A	H	E	A
Previous EWC	64 %	28 %	8 %	72 %	21 %	7 %	71 %	23 %	6 %
Amended EWC	80 %	15 %	6 %	84 %	12 %	5 %	81 %	15 %	4 %

Even though 80 % of the hazardous waste quantities can be related to HWL, there are major variations between countries. This is evident in figure 1 showing the percentage of the hazardous waste production in countries related to HWL before and after the amendment.

The variations in generation.
These great variations can to some extent be explained by the fact that some countries have special waste streams, which according to their physical characteristics can be defined as hazardous, but have not yet been introduced in HWL. Yet another explanation is that the same waste types are considered as hazardous in one country but not in another. Due to these variations it is very difficult to compare the total hazardous waste generation between countries. At the level of specific fractions (detailed code) it may be easier to compare information between countries using HWL and European Waste Catalogue.

For the majority of countries neither the HWL nor the European Waste Catalogue is used for classification. Therefore it is difficult to compare the total generation of hazardous waste between member countries.

Figure 1. Percentage of the waste quantities from the 20 largest waste types that can be related to the HWL before and after the amendment



Conclusion on comparability of the present classification systems for hazardous waste

It is evident that HWL consists of insufficient codes to cover what has been regarded or reported as hazardous waste in each country or region. The amendment of EWC has improved the comparability, as more waste types are now regarded as hazardous, which has increased the amounts of hazardous waste in countries and regions that can be related to HWL. However, large quantities of waste are still not covered by the list and the majority of countries have no data on hazardous waste generation

classified according to EWC/HWL. However total waste generation is only the starting point for comparability between countries and regions, the further analysis of hazardous waste generation must concentrate on specific industries or specific environment problems as heavy metals or POP's.

Quantities of hazardous waste related to EWC at 6-digit level

To assess whether the same waste types dominate in the participating countries and regions hazardous waste generation, countries were asked for information on the 20 largest hazardous waste types classified according to EWC at 6-digit level.

Table 2 in annex shows the number of waste types represented in more than one country is four of a total of 35 waste types (out of 40 possible) among the top 5 in the eight countries or regions surveyed. This emphasises the fact that the hazardous waste generation is not homogeneous, as different types of hazardous waste dominate in different countries.

Tables similar to table 2 in annex have been made for 'top 10' and 'top 20'and an overview of the number of present waste types in 'top 5', 'top 10' and 'top 20' is given in table 5 below.

110 different waste types are needed to define the top 20 wastes of the eight countries/regions. In that light it seems reasonable to conclude that the hazardous waste generation is either very different or the waste classification is used in different ways in the countries and regions.

Table 5. The number of waste types and the number of countries 'sharing' the waste types

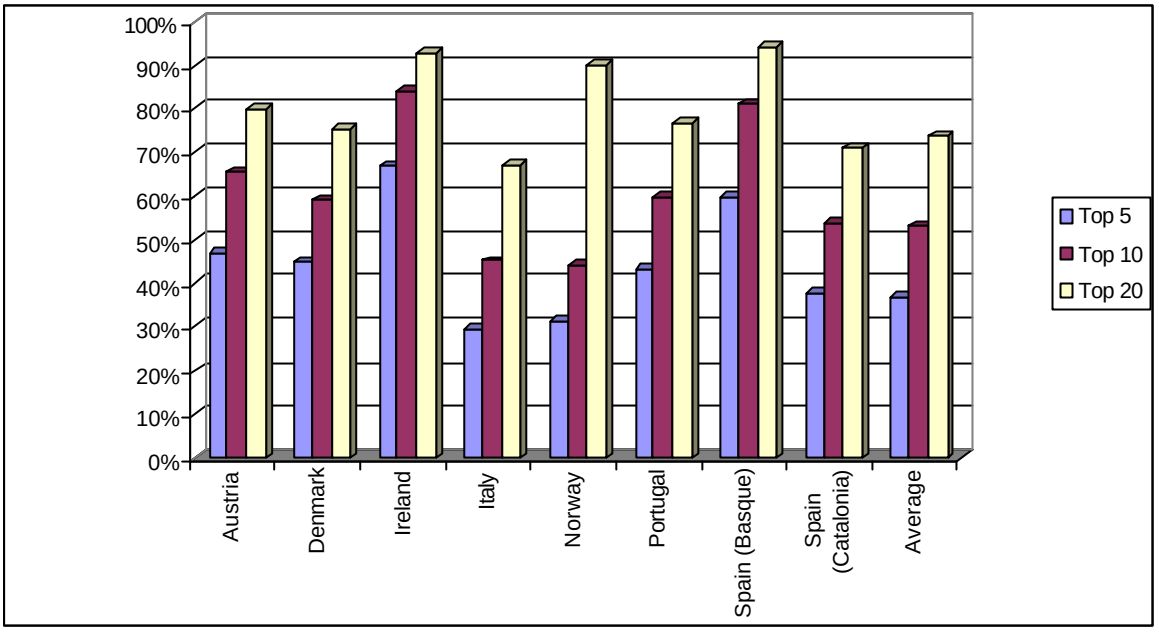
	Possible no. of waste types	**Actual no. of waste types**	**1 country**	**2 countries**	**3 countries**	**4 countries**	**5 countries**
Top 5	40	35	31	3	1	-	-
Top 10	80	63	51	9	1	2	-
Top 20	160	110	75	25	6	3	1

Domination of the major waste types

The 'Top 20' waste types account for between 70 % and 90 % of the hazardous waste generated in most countries.

On average 74 % of the hazardous waste generated are accounted for by the Top 20 waste types in the top 20 in the eight countries and regions.

Figure 2. Percentage of the total hazardous waste quantities in the countries and regions surveyed by top 5, 10, and 20 by country



Hazardous waste generation according to NACE activities

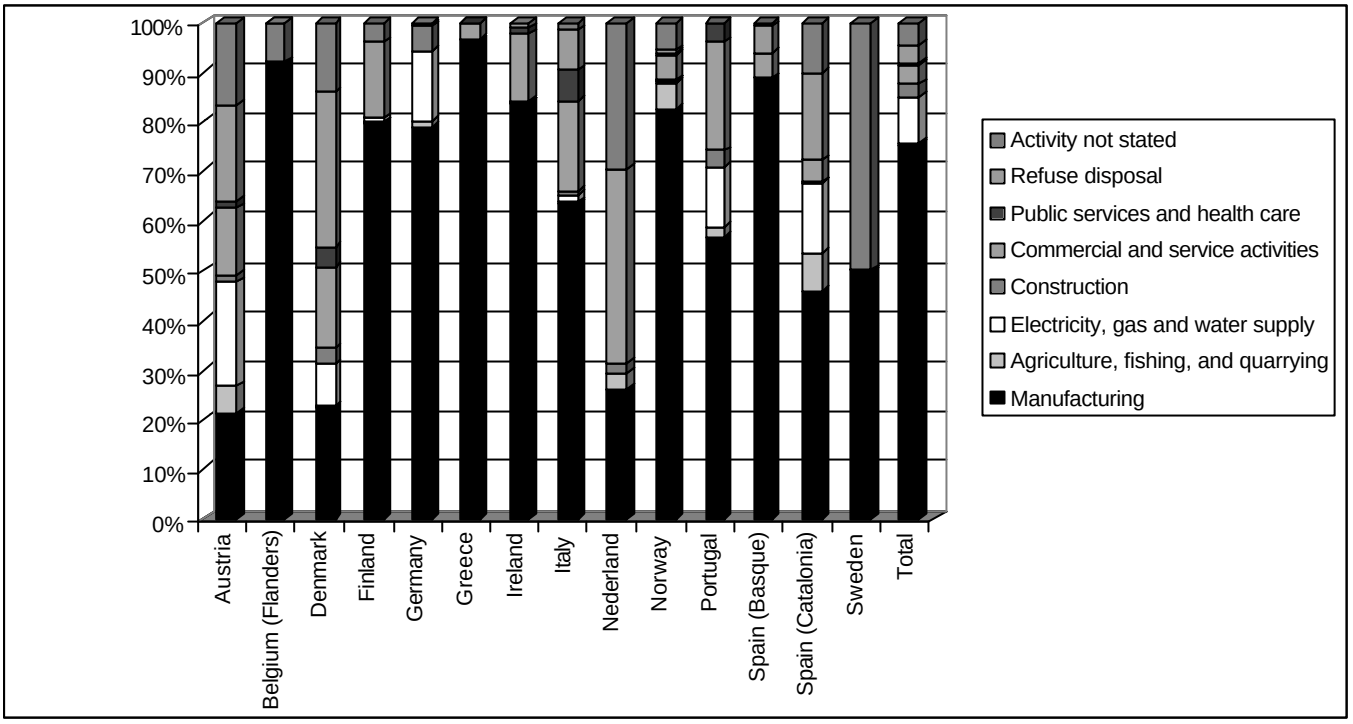
Figures 3 and table 3 in annex 1 show the quantities and percentage of hazardous waste generation classified according to NACE activity. It has to be noted that for some countries a significant proportion of the NACE activities is not stated. This is especially the case for Sweden (50 %), the Netherlands (29 %), Austria (17 %) and Denmark (14 %).

In most countries and regions, manufacturing industry produces a significant proportion of the reported hazardous waste quantities. This is especially the case for Finland, Germany, Greece, Ireland, Norway and the Basque Country, where manufacturing industry is responsible for more than 75 % of the total hazardous waste production. At the other end of the scale Austria, Denmark and the Netherlands have less than 30 % of their hazardous waste production coming from the manufacturing industry. The term 'manufacturing industry' covers several industrial sectors and the waste production from these industries varies, which can be seen in figure 3.

Apart from the fact that the majority of the hazardous waste originates from the manufacturing sector, there are not many similarities between countries when comparing hazardous waste quantities classified according to NACE-activities. Wastes from refuse disposal are important in countries with incineration (Austria and Denmark), while waste from commercial and service activities (e.g. shipping and repair of motor vehicles) are large contributors to hazardous waste generation in the Netherlands and Portugal.

The first and most obvious reason for these variations is differences in the industrial activity of the various countries. Thus, a country with a large steel industry will, naturally, have a large amount of waste from this sector.

Figure 3. Hazardous waste gene rated according to NACE and stated in % of the total quantities



For further details see annex 1 table 3

Hazardous waste generation per employee

The breakdown of industrial activity (or industrial structure) varies within each country and region. By relat ing the waste quantities to the number of employees in the countries it should be possible to attain a comparable dataset for the generation of hazardous waste from the industries. In table 6 the calculation of hazardous waste generation per employee in the manufacturing and other sectors are shown for the 5 ETC/W partner countries.

The relative size of manufacturing industries is approximately the same in Denmark and Austria, while its importance in the Basque Country and Germany is greater when measured by the number of full-time employees.

Table 6. Hazardous waste generated per employee in Austria, Denmark, Germany, Ireland and Spain (the Basque Country and Catalonia) according to NACE code

NACE-code		Austria (1996) Kg per employee	Denmark (1996) Kg per employee	Germany (1993) Kg per employee	Ireland (1996) excluding recovery on site Kg per employee	Spain/ Basque Country (1994) Kg per employee	Spain/ Catalonia (1996) Kg per employee
	Total	**199**	**132**	**188**		**301**	**304**
D	Manufacture total	210	144	372	436	888	156
E - X	Total of trade, service, transport and infrastructure	223	135	129	628	49	1348

The table is calculated with available data on the total amount of Hazardous Waste, that is divided by the number of full time occupied persons related to the same NACE classes. Source: Information from FEA-Austria, ETC/W-DK, Ministry of Environment in Germany, EPA-Ireland, Juntas de Residus-Catalonia, IHOBE-the Basque Country and the statistical offices in Austria, Denmark, Germany, Ireland, the Basque Country and Catalonia.

The difference in quantities of hazardous waste generated can be explained only partly by the number of employees in different industrial sectors.

Table 7. Hazardous waste generation per employee in manufacturing industries in selected member countries and regions in 1996

NACE	kg/employee	Austria	Catalonia	Denmark	Ireland
D	Total	210	156	144	436
DA	Food, beverages and tobacco	69	87	4	2
DB	Textiles, wearing, apparel	173	5	7	0
DC	Leather	28	189	131	14
DD	wood products	51	0	31	5
DE	Printing and publishing	83	30	35	6
DF	Refined petroleum products	*1084	329	343	787
DG	Chemicals	191	469	682	*6073
DH	Rubber and plastics products	14	6	45	84
DI	Other non-metallic mineral	57	2	28	17
DJ	Basic metals	187	509	360	248
DK	machinery and equipment	88	0	58	
DL	Electrical and optical equipment	107	78	29	46
DM	Transport equipment	275	0	87	415
DN	Furniture, manufacturing n.e.c.	*1211	0	46	35

Looking at the examples in table 7 the high level of generation of hazardous waste from Ireland can be explained by the generation from chemical industries and to some extent from the manufacturing of transport equipment. Two arguments have to be considered before making any conclusions: what kind of chemical industry is dominating in the respective countries and what kind of waste will be classified as hazardous waste in the respective countries. These two aspects might be quite different from one country to another. The only information we have at this level is that waste generation per employee in Ireland from chemical industries is ten times higher than the generation from chemical industries in Denmark, which generate three times as much as in Austria and approximately 50 % more than in Catalonia. The explanation for this difference might be found in the classification of hazardous waste, the specific kind of chemical industries and the kind of technology used in the respective countries.

A few dramatic differences in waste per employee may, for certain industries, be explained by the presence of waste types considered as hazardous in only one country.

Looking at the most detailed level of NACE available, a few sectors appear to be comparable. For instance, the manufacturing of refined petroleum products is mainly one type of production. The variation in this case is one to three from the least to the most waste producing country. In this case the explanations for different levels of hazardous waste generation is not the difference in industrial structures in member countries. Apart from a real difference in hazardous waste generation per employee, the explanations have to consider the kind of waste classified as hazardous.

For a more detailed analysis, it may be appropriate to examine the common classifications of hazardous waste against a more detailed breakdown of industrial structure. This was not possible due to the absence of data combining waste sources and waste fractions.

Conclusions according to NACE activities
Hazardous waste generation related to NACE activities shows that, first of all, knowledge of the industrial structure in a particular country or region is important in explaining differences in hazardous waste quantities, especially in the manufacturing industries. Secondly, a significant consideration is how energy is produced in each country and region. Thirdly, refuse disposal activities give rise to significant hazardous waste generation, especially flue gas cleaning residues from waste incineration. In fact, the quantities of hazardous waste from waste incineration appear to be increasing due to higher environmental standards.

General conclusions on comparability of hazardous waste generation
Key findings

- Information has been obtained for nearly all EEA member countries. Further improvement is needed to increase the comparability of data between the EEA countries.
- An objective of this report was to produce a comparable dataset for the majority of EEA member countries to provide comparable information on hazardous waste generation. This is presently possible only for one large country, five small countries and two regions.
- It has proven difficult to relate hazardous waste classified according to national or regional substance oriented classifications to HWL and the European Waste Catalogue. Only countries already registering hazardous waste according to HWL have given information for this survey at the six-digit level. The reason for this is that it is difficult to obtain the required information for reclassification following the original data collection exercise. The implementation of HWL currently taking place in several countries will improve the availability of comparable data.
- In each of the countries and regions examined a relatively small number of waste types represent a large proportion of the total hazardous waste generation. On average, the 20 largest generated waste types represent between 67% and 93% of the total hazardous waste generated with an average of 75% of hazardous waste being attributable to these top 20 waste types in each country or region.
- Industrial structure is considered an important factor in explaining the difference between hazardous waste types and quantities arising in the different countries and regions. Significant differences exist between the respective manufacturing industries, energy production sectors and waste incineration activities. According to the NACE codes less than 30 % of the hazardous waste production in some countries are related to manufacturing industries, while in other countries more than 80 % of their hazardous waste comes from these sources. More detailed data relating the sources with the kind of hazardous waste are needed in order to facilitate analysis of different hazardous waste generation paths in EEA member countries.

– Questions and topics for discussion:

– Waste prevention how to achieve and how to interpret. Avoidable waste generation and in avoidable?

– Comparability
– Differences in waste generation: sector correlation with which basic parameter?
– Eco-efficiency waste/GDP waste/employment

– Covering Europe or another geographical level?

- As the sum of individual countries?
- As one unit?
- Or both?
- At regional level or local level the adverse exposition will be present
- Shipment of waste is one of the aspects! (principle of self-sufficiency for waste management)

Annex 1 Table 1. Quantities of hazardous waste classified according to the European waste catalogue at 2-digit level (thousand tonnes)

Code	Description	A	B (Wall.)	DK	Fin	Gr.	Is	Ire	I	N	P	E (Basque.)	E (Catal.)	Total	
		1996	1998	1996	1997	1998	1998	1996	1997	1998	1998	1994	1996	1000 t.	%
1	Waste resulting from exploration, mining, dressing and further treatment of minerals and quarry	7	0	0	0			21					28	56	1%
02	Waste from agricultural, horticultural, hunting, fishing and aqua-culture primary production, food preparation and processing	22	92	0	2				0	0		0	60	176	2%
03	Wastes from wood processing and the production of paper, cardboard, pulp, panels and furniture		1	0	0			0	0	0	1		0	3	0%
04	Wastes from the leather and textile industries	0	0	1	0			0	1	0	0	1	6	10	0%
05	Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal	38	3	9	6	15		6	29	10	20	55	6	197	2%
06	Wastes from inorganic chemical processes	11	13	5	122			3	261	266	10	54	56	801	10%
07	Wastes from organic chemical processes	1	29	11	16	1		146	842	2	20	17	198	1,282	16%
08	Wastes from the manufacture, formulation, supply and use (MSFU) of coating (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks	15	8	15	8		0	2	37	3	4	1	20	113	1%
09	Wastes from the photographic industry	5	2	10	5		0	0	164	1		4	0	190	2%
10	Inorganic wastes from thermal processes	64	90	34	27	109		1	367	51	4	104	186	1,037	13%
11	Inorganic waste with metals from metal treatment and the coating of metals; non-ferrous hydro-metallurgy	5	57	7	125			0	298	82	72	93	39	778	10%
12	Wastes from shaping and surface treatment of metals and plastics	41	12	2	17	1		0	233	4	24	69	5	408	5%
13	Oil wastes and other liquids (except edible oils 05 00 00 and 12 00 00)	33	33	35	66		5	28	392	50	83	17	25	767	10%
14	Wastes from organic substances employed as solvents and coolants (except 07 00 00 and 08 00 00)	0	8	4	11		0	4	137	2	11	1	98	276	3%
15	Packaging, absorbents, wiping cloths, filter materials and protective clothing not otherwise specified	32	7	1	4			0		0		1	47	92	1%
16	Waste not otherwise specified in the catalogue	67	57	11	27	4	1	6	318	117	20	1	21	650	8%
17	Construction and demolition waste (including road construction)	66	18	5	9			0	21	2	0		1	123	2%
18	Wastes from human or animal health care and/or related research	3	4	10	0		0	3	133	0	13		0	167	2%
19	Wastes from waste treatment facilities, off-site waste water treatment plants and the water industry	140	40	91	28	36		4	164	11	11	40	96	660	8%
20	Municipal wastes and similar commercial, industrial and institutional wastes including separately collected fractions	26	0	12	9			0	5	2	39	10	2	105	1%
	Total amount related to HWL/EWC/add. EWC	576	475	263	481	165	7	225	3,401	602	320	469	894	7,878	98%
	Total amount not possible to relate to HWL/EWC/add. EWC	29		18		121		5		5				179	2%
	Total hazardous waste generation	606	475	281	481	287	7	230	3,401	607	320	469	893	8,057	100%

Table 2. Top 5 of each country and region's hazardous waste generation related to EWC on 6-digit level (thousand tonnes)

EWC codes	Description	Previous EWC/ HWL list	Current EWC list	A	DK	Ire	I	N	P	E (Basque Country)	E (Catalonia)
01 03 99	Wastes not otherwise specified	E	E			20.900					
02 01 02	Animal tissue waste	E	E								40.835
05 05 01	Waste containing sulphur	E	E							45.532	
05 08 99 01	Alkaline containing oil or tars	A	A	36.342							
06 01 02	Hydrochloric acid	H	H							39.260	
06 01 99	Wastes not otherwise specified	H	H					5.821			
06 02 99	Wastes not otherwise specified	H	H					25.467			
07 01 01	Aqueous washing liquids and mother liquors	H	H				242.470				
07 01 02	Sludge's from on-site effluent treatment	E	H								42.137
07 01 99	Wastes not otherwise specified	E	E								51.105
07 05 04	Other organic solvents, washing liquids and mother liquors	H	H			31.067					
07 05 99	Wastes not otherwise specified	E	E			49.244					
07 07 04	Other organic solvents, washing liquids and mother liquors	H	H			37.689					
10 01 02	Coal fly ash	E	E								125.513
10 01 08	Other sludge's from gas treatment	E	E		11.073						
10 02 03	Solid wastes from gas treatment	E	H		11.856					62.920	
10 02 04	Sludge's from gas treatment	E	H					27.696			
10 03 04	Primary smelting slag's/white dross's	H	H								
10 04 01	Slag's (1st and 2nd smelting)	H	H				241.223				
11 01 04	Cyanide-free wastes not containing chromium	E	E								
11 01 05	Acidic pickling solutions	H	H							64.200	
11 02 02	Sludge's from zinc hydrometallurgy (incl. jarosite, goethite)	H	H					70.999	52.000		
12 01 00	Wastes from shaping	E	E						20.212		
12 01 09	Waste machining emulsions free of halogens	H	H							69.425	
13 02 02	Non-chlorinated engine, gear and lubricating oils	H	H		16.099		197.156		13.538		
13 02 03	Other engine, gear and lubricating oils	H	H						19.336		
13 05 03	Interceptor sludge's	H	H			14.349					
16 01 04 01	Discarded vehicles, not de-polluted	A	A	50.372							
16 06 01	Lead batteries	H	H				186.690				
16 08 02	Oil contaminated drilling mud	A	A					59.892			
17 01 99 D1	Bricks, concrete, tiles and gypsum based or asbestos based materials…	A	A								
17 02 99 D1	Wood, glass and plastic with noxious contaminants	A	A								
17 05 01 01	Soil and stones, hazardous contaminated	A	A	60.344							
18 01 03	Other wastes whose collection and disposal is subject to special requirements…	H	H				131.181				
19 01 01	Bottom ash and slag	E	H	112.784							
19 01 03	Fly ash	H	H	25.557	9.065						
19 01 06	Aqueous liquid waste from gas treatment and other aqueous liquid waste	H	H								
19 01 07	Solid waste from gas treatment	H	H		69.801						
19 03 01	Wastes stabilised/solidified with hydraulic binders	E	H								77.964
20 01 21	Fluorescent tubes and other mercury containing waste	H	H						38.772		

H=included in the HWL, E=included in EWC, A=not included in EWC

Table 3 Hazardous waste generation according to NACE codes. Stated in % of the total generation of hazardous waste

NACE Code	Economic area	A	B Flanders	DK	Fin	G	GR	IR	I	NL	N	P	E Basque Country	E Catalonia	S	Total	
		1996	1998	1996	1997	1993	1998	1996	1997	1997	1998	1998	1994	1996	1993	1.000 t.	%
A	Agriculture	2,3 %							0,3 %		0,0 %			4,6 %		63.840	0
B	Fishing	0,0 %		0,1 %					0,0 %		0,0 %					496	0
C	Quarrying	3,4 %			0,2 %	1,2 %	0,2 %	0,0 %	0,1 %	3,1 %	5,4 %	1,9 %		3,1 %	0,4 %	261.365	1
DA	Manufacturin g (Mfr.) of food, beverages and tobacco	0,9 %	0,5 %	0,1 %	0,8 %	1,6 %		0,1 %	0,9 %	1,3 %	0,1 %	0,9 %	0,1 %	2,2 %	0,2 %	256.347	1
DB	Mfr. of textiles, wearing, apparel	1,1 %		0,0 %	0,1 %		1,8 %	0,0 %	0,5 %	0,2 %	0,0 %	0,9 %		0,1 %	0,1 %	36.512	0
DC	Mfr. of leather	0,0 %	0,1 %	0,1 %	0,0 %		1,1 %	0,0 %	0,0 %	0,2 %	0,0 %	0,1 %	0,2 %	0,6 %		18.022	0
DD	Mfr. of wood products	0,3 %	0,8 %	0,2 %	0,4 %		3,1 %	0,0 %	0,1 %	0,1 %	0,1 %	4,4 %			0,6 %	71.162	0
DE	Mfr. of printing and publishing	0,7 %		0,5 %	9,1 %			1,0 %	6,3 %	0,6 %	1,2 %	0,9 %	0,1 %	0,4 %	3,6 %	305.181	1
DF	Mfr. of refined petroleum products	0,5 %	4,5 %	0,1 %	30,6 %	1,2 %	10,1 %	2,9 %	0,8 %	3,2 %	0,4 %	1,7 %	11,7 %	0,6 %	10,7 %	696.224	3
DG	Mfr. of chemicals	1,0 %		6,8 %		25,2 %	31,5 %	75,8 %	19,3 %	11,1 %	78,4 %	10,6 %	15,2 %	28,3 %		4.289.44	18
DH	Mfr. of rubber and plastics products	0,1 %		0,3 %	0,2 %			0,7 %	0,9 %	1,3 %	0,0 %	0,3 %	0,0 %	0,1 %		60.823	0
DI	Mfr. of other non-metallic mineral products	0,3 %	0,4 %	0,2 %	0,1 %		0,3 %	0,2 %	0,4 %	0,2 %	0,1 %	1,3 %		0,0 %	0,9 %	44.791	0
DJ	Mfr. and processing of basic metals	2,9 %	0,9 %	6,6 %	35,3 %	10,0 %	47,4 %	1,5 %	25,1 %	5,1 %	0,8 %	21,1 %	56,8 %	11,8 %	16,8 %	2.758.83	12
DK	Mfr. of machinery and equipment	0,9 %	0,9 %	1,5 %	1,4 %	5,0 %			2,6 %	0,6 %	0,5 %	1,9 %			16,6 %	685.954	3
DL	Mfr. of electrical and optical equipment	1,2 %		0,4 %	0,7 %		0,2 %	0,9 %	1,9 %	1,0 %	0,1 %	3,1 %		1,8 %		124.608	1
DM	Mfr. of transport equipment	1,5 %		0,7 %	0,9 %	6,1 %	0,7 %	0,4 %	2,8 %	1,3 %	0,8 %	7,3 %				722.353	3
DN	Mfr. of furniture, manufacturing n.e.c.	9,7 %		0,5 %	0,2 %		0,1 %	0,2 %	2,1 %	0,2 %	0,1 %	2,3 %	4,9 %			169.545	1
	Mfr. which can not be related to a specific D-category		46,5 %	4,6 %	0,0 %	30,1 %									0,5 %	4.808.07	20
D Total	*Manufacturing total incl. amounts which can not be related to a*	21,2 %	54,4 %	22,6 %	79,9 %	79,2 %	96,3 %	83,7 %	63,7 %	26,5 %	82,5 %	56,9 %	89,0 %	45,9 %	50,0 %	15.047.868	*64*
E	Electricity, gas and water supply	20,7 %		8,6 %	0,8 %	13,8 %		0,3 %	1,4 %		0,3 %	11,9 %		14,2 %		1.624.82	7
F	Construction	1,4 %	4,7 %	3,2 %		5,4 %		0,1 %	0,8 %	1,8 %	0,4 %	3,5 %		0,2 %		791.838	3
G-50.2	Maintenance and repair of motor vehicles	4,2 %		13,0 %						2,2 %	0,0 %		0,2 %	2,6 %		127.616	1
G Total	Wholesale and retail trade incl. G-50.2	7,4 %		13,6 %				7,9 %	14,9 %	3,0 %	2,9 %	3,5 %	2,0 %	2,6 %		726.879	3
H	Hotel, restaurants	0,6 %		0,0 %					0,0 %		0,0 %					3.793	0
I-61	Shipping	0,0 %						3,0 %		36,1 %	0,6 %		1,8 %	0,0 %		736.176	3
I Total	Transport, storage and communication including I-61	3,7 %		0,6 %			3,5 %	5,5 %	1,0 %	36,1 %	1,5 %	2,2 %	1,8 %	1,6 %		836.566	4
K-74.81	Photographic activities										0,1 %		0,9 %	0,0 %		4.848	0
J+K Total	Financial intermediation, business activities incl. K-74.81	2,1 %		2,3 %				0,0 %	2,0 %		0,3 %	16,1 %	0,9 %	0,0 %		147.543	1
L	Public and personal services	0,3 %		0,4 %				0,0 %	2,2 %		0,4 %					81.271	0
M	Education	0,1 %		0,1 %				0,0 %	0,0 %		0,1 %					2.346	0
N	Human health activities	1,0 %		3,4 %		0,4 %		1,3 %	4,1 %		0,1 %	3,9 %		0,0 %		204.990	1
O	Refuse disposal	19,0 %	38,8 %	31,2 %	15,1 %	0,1 %		1,2 %	8,0 %		0,5 %		5,7 %	17,6 %		2.457.50	10
X	Activity not stated	16,6 %	2,1 %	14,0 %	4,0 %				1,4 %	29,5 %	5,5 %	0,0 %	0,5 %	10,1 %	49,6 %	1.204.84	5
Total (%)		**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**		**100 %**
Total (1.000 tonnes)		**605.81**	**4.418.729**	**263.98**	**480.98**	**9.091.0**	**286.85**	**229.56**	**3.401.1**	**1.988.0**	**607.48**	**333.04**	**468.806**	**886.241**	**394.30**	**23.455.9**	**100 %**