

DASTA

Dipartimento delle Scienze Aziendali, Statistiche, Tecnologiche e Ambientali

DASTA Working Paper Series

Paper no. 22

Developing a Life Cycle Inventory data set for cattle slaughtering

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March, 2010



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Abstract

The food and drink sector is responsible for 20% to 30% of the overall environmental impact of private consumption in the EU, with meat and dairy products contributing most.

The “IMPRO-meat and dairy” project have investigated these products in order to identify potential environmental improvements according to a life cycle perspective.

Unfortunately, some issues related to the chosen methodology (i.e. IO-LCA) and reference legislation background seem to have affected result robustness.

To overcome these limitations, the authors briefly present in this paper a Life Cycle Inventory (LCI) data set for cattle slaughtering. This LCI data set could be instrumental in conducting more accurate environmental assessments of the beef life cycle in the next future.

Keywords: Slaughtering • Cattle • Beef • Life Cycle Assessment • Industrial Ecology

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Developing a Life Cycle Inventory data set for cattle slaughtering

Camillo De Camillis, Andrea Raggi, Luigia Petti

1. Introduction

The Environmental Impact of Products (EIPRO) study, entrusted by DG Environment-European Commission, pointed out the food and drink sector as responsible for 20% to 30% of the overall environmental impact of private consumption in the EU, with meat and dairy products contributing most (Tukker et al., 2006).

Based on these outcomes, in 2006 the European Commission launched the “IMPRO-meat and dairy” project to identify possible environmental improvements of the meat and dairy life cycles (Weidema et al., 2008). Although the major findings of this project might be found valuable by several stakeholders, it should be noted that some methodology limitations might have strongly affected and even deviated results. For instance, IO-LCA was used by Weidema et al. (2008) as baseline methodology and, given its low level of detail, as well as other major weaknesses of IO-LCA (Suh and Nakamura, 2007), more accurate instruments (e.g. process LCA) could be used in its place. Moreover, the current EU legislative background on the animal by-product management seems to have been neglected by Weidema et al. (2008). This lack may have caused relevant implications on study results.

Given the abovementioned weaknesses of the IMPRO project, considered also the deficiency of other Life Cycle Inventory (LCI) studies in defining an accurate, European geo-referenced and average LCI dataset of the bovine slaughtering process (Nielsen et al., 2003; Cederberg and Darelius, 2002; Cederberg and Stadig, 2003), the authors briefly present in this paper the development of a new LCI dataset of the cattle slaughtering. The key aim is to provide researchers and policy makers with robust data in order to study in detail the beef life cycle.

Thanks to the experience gained in the LCA of this sector from the research project “Cicle Pell: Industrial ecology in the animal-to-leather chain” (Puig et al., 2007a), the authors first describe in this paper the EU legislation affecting animal waste and by-products in the background section. Then, the main characteristics and modelling issues of the LCI dataset are described. Finally, the next steps for a more detailed study on the environmental profile of the beef life cycle are briefly outlined.

2. Legislation background

The slaughtering industry was regulated in the EU with strict rules. In particular, due to the Transmissible Spongiform Encephalopathies (TSE) epidemic, the EU has adopted a series of measures to protect human and animal health. In particular, Regulation (EC) No. 1774/2002 (EC, 2002) and subsequent integrations and amendments set out the measures to be

implemented for the processing of animal by-products. This regulation classifies animal by-products in three categories according to their relative hazardousness, and sets out the compulsory options for by-product recovery and disposal.

3. LCI data set modelling

In this section the key elements which have characterised the development of the cattle slaughtering LCI data set (see *Table 1a and 1b*) are presented. These data are lacking of any review so far.

3.1 Selection of slaughterhouses

A few Italian slaughtering firms located in Abruzzo region were directly involved in data collection in the time frame 2006-2008. These organisations can be considered as being adequately representative of at least the regional slaughtering industry if the following criteria are taken into account:

- company size, expressed as annual slaughtering capacity;
- company type (low-capacity¹, EC approved²).

3.2 Reference flow

Most of slaughtering firms provide a slaughtering service activity, rather than buying live cattle and selling meat and by-products. The reference flow chosen was, therefore, the overall amount (on a mass basis, expressed as live weight) of animals slaughtered in one year.

3.3 System boundaries description

The system boundaries of the slaughtering data set include the following main processes (see *Figure 1*):

1. cattle slaughtering;
2. animal by-product rendering and disposal.

Data collection was performed through various means, such as the filling in of *ad hoc* data collection sheets, interviews, on-site visits, etc. Several people with different background were involved in this data collection process (e.g. researchers, employees of the contacted firms, veterinaries, and other technical experts).

3.3.1 Cattle slaughtering process

The slaughterhouse layout is important for operational efficiency, environmental loads and food safety aspects. Generally, there are three separate slaughtering and dressing lines for cattle, sheep and pigs respectively, whereas lairages and cold stores are normally common to all classes of livestock (Lean, 1980). A generic cattle slaughtering process is made up of several activities as precisely shown by Puig et al. (2007b).

Slaughtering LCI data reported in this paper refer to a slaughterhouse located in Avezzano whose environmental performances were checked with

¹ According to the Italian legislation (GI 1994; MS, 1995), low-capacity slaughtering plants are those which may slaughter up to 1000 large animal units (UGB) per year – in any case, not more than 20 UGBs/week. One UGB corresponds to one adult bovine animal, or two calves, or five pigs, or ten sheep, etc.

² EC approved slaughterhouses are those which have obtained an official acknowledgment (GI, 1994). For such slaughterhouses no limits are set as regards the maximum amount of animals killed weekly (yearly).

other two similar organisations located in Abruzzo. Particular attention has been drawn to the accurate quantification of slaughtering products, by-products and wastes. More specifically, as no primary data were available on the aggregate amount these output flows, a set of direct measurements was carried out on a sample of slaughtered cattle provided by a major Italian slaughtering company (IN.AL.CA. SpA, plant of Castelvetro). Average percentage ratios, on a mass basis, were calculated for specific bovine parts to the overall weight of the animal, for various age/sex categories.

Although the EU legislation framework (EC, 2002) clearly defines some slaughtering outputs as animal by-products, some of them (category 1 and 2 by-products) have been classified in the LCI data set as waste flows because they have no market value and their management is even a cost for slaughterhouses. All category 3 by-products other than hide have been also considered in this study as waste streams because slaughterhouses did not make any profit from their trade.

3.3.2 Animal by-product rendering

Firms operating the collection and recovery (hereafter called rendering) of by-products generated by the analysed slaughterhouses are located outside the Abruzzo region. To make data collection less resource intensive, as a first step, remote interviewing was attempted through specific forms sent by mail. Site visits to collect data directly on site were then necessary because no results were achieved in this way. Finally, only one firm (the one performing blood rendering) did not provide data. Unfortunately no data were also obtained by other firms running the same processes. Therefore, literature data were used for blood rendering (EC, 2005; Nordic Council of Ministers, 2001).

3.3.3 Animal by-product incineration

In accordance with EU legislation (EC, 2002), category 1 by-products are processed into animal meal and fat. These are then incinerated or co-incinerated. Data collected for this stage comes from a specific animal meal incinerator located in Italy.

3.4 Allocation

The distribution of environmental loads among co-products was a crucial issue in the setting up of this LCI data set. In particular, allocation was necessary for those rendering processes of category 3 by-products, considered in this study as waste streams because slaughterhouses did not make any profit from their trade. More specifically, allocation was performed in order to properly distribute environmental loads among category 3 by-products (i.e. outputs of the slaughtering process) and transformed products (i.e. outputs of these rendering processes). This repartition was necessary because transformed products have market value and are the raw materials of a wide range of manufacturing processes (De Camillis et al., 2007; Raggi et al., 2007). Thus, environmental loads of these recovery processes have been attributed by the 50% to the slaughtering process and the rest 50% to the downstream processes. The same problem of category 3 by-products raised for manure. As it is strewed over agricultural fields as soil remediation, only the transport to these farms has been considered as part of the slaughtering system.

The allocation issue raises also up for the environmental loads related to the co-products of the slaughtering processes. The authors suggest to adopt the economic criterion because in most of cases allocation procedure seems not to be avoidable and other criteria are inapplicable.

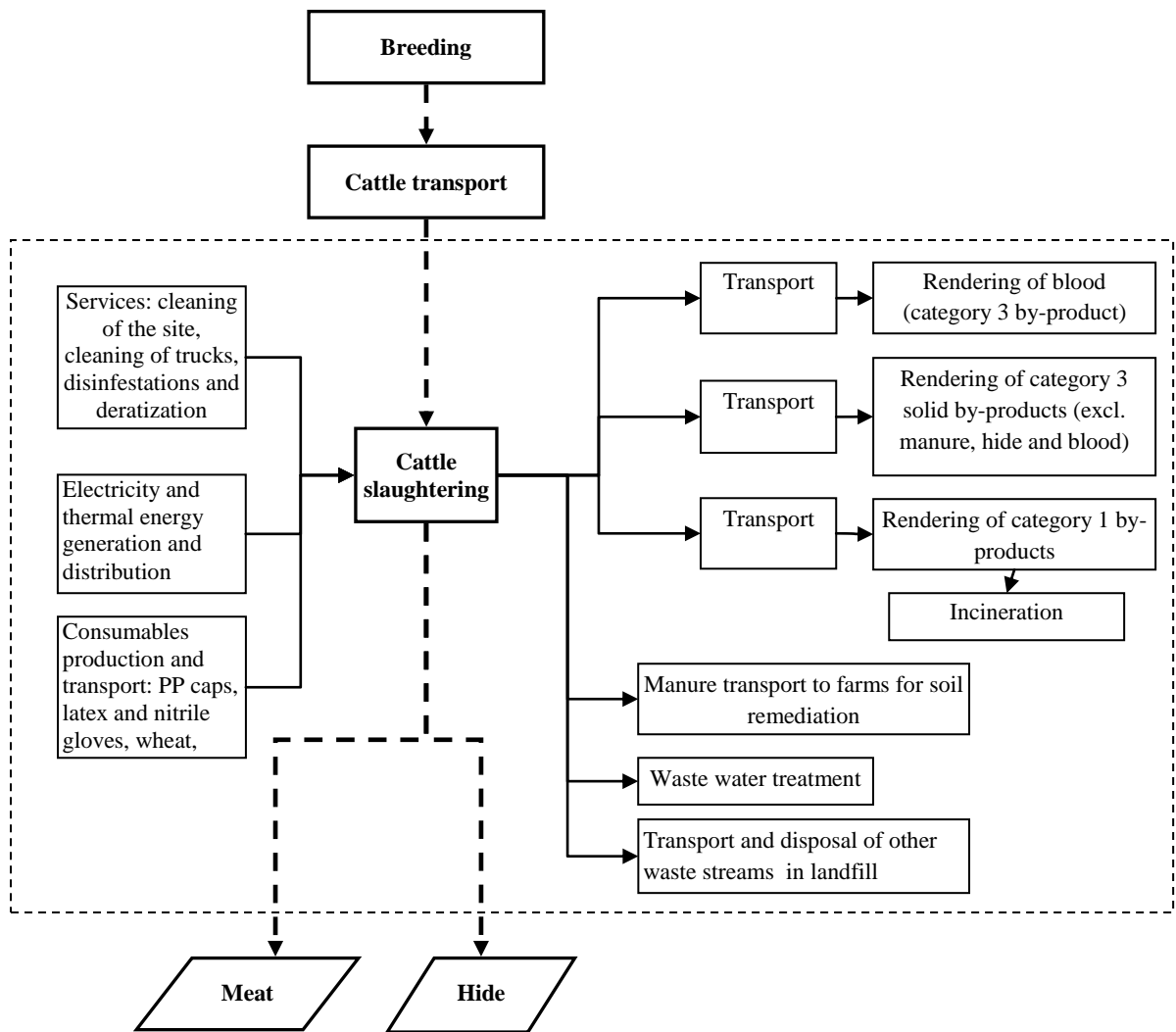


Fig. 1 System boundaries of the cattle slaughtering LCI data set

4. Conclusions

A detailed LCI dataset development for the cattle slaughtering was briefly illustrated in this paper. The European laws that lay down specific rules to categorize and manage animal wastes and by-products have strongly affected such a development process. Even if the LCI data set is representative of an Italian region, this work could be the starting point to better study in detail the beef life cycle. In fact, methodological insights illustrated in this paper could be valuable to develop an European geo-referenced average LCI dataset of the cattle slaughtering process. Associations of meat producers should be fully involved in this development process in order to provide LCA practitioners with robust and representative data sets, hopefully in line with the ILCD Handbook criteria (EC, 2010). Finally, this case study highlighted a

few elements to be carefully taken into account in the development of a reference cattle slaughtering data set. Besides different technologies and production layouts that characterise slaughterhouses according to their size, the cattle breed affect the overall amount of co-products and animal residues. Moreover, local food habits should be taken into into account. Comparing small and medium slaughterhouses with large scale slaughtering companies, it emerged that big firms use to adopt different recovery processes than those mentioned above. In fact, it was noticed that big companies tend to recover each by-product in-house, given the significant amount of residues collected every day.

Table 1a. Inputs of the cattle slaughtering data set

Alfalfa [Technical input]	78,147	kg
Cotton seed [Technical input]	753,2503	kg
Detergent (cleaning of the collection tank) [Technical input]	43	kg
Disinfestant [Technical input]	96	kg
Gluten [Technical input]	2274,946	kg
Molasses [Technical input]	479,7358	kg
Phosphate carbonate [Technical input]	99,8545	kg
Rat bait [Technical input]	10,8	kg
Reicepted cattle [Intermediate product]	2424921	kg
Cooling water [Operating materials]	58851,68	kg
Air [Renewable resources]	190698,3	kg
Barium sulphate [Non renewable resources]	7,76E-09	kg
Basalt [Non renewable resources]	2,450022	kg
Bauxite [Non renewable resources]	20,39612	kg
Bentonite [Non renewable resources]	393,3546	kg
Biomass [Renewable energy resources]	0,065512	kg
Blast furnace dust [Organic intermediate products]	1,45E-06	kg
Calcium chloride [Non renewable resources]	7,96E-07	kg
Carbamide (urea) [Organic intermediate products]	12,97952	kg
Carbon dioxide [Renewable resources]	71842,75	kg
Carcass meal [Hazardous waste for recovery]	1,96E-08	kg
CH: calcareous marl, at plant [additives]	1,004263	kg
Chalk (Calciumcarbonate) [Non renewable resources]	6,08E-33	kg
Chromium [Non renewable elements]	8,46E-12	kg
Chromium ore [Non renewable resources]	0,058774	kg
Clay [Non renewable resources]	71,1613	kg
Clay minerals (paper production) [Minerals]	3374,358	kg
Cobalt ore [Non renewable resources]	9,04E-10	kg
Colemanite ore [Non renewable resources]	0,001664	kg
Complexing agent [Operating materials]	11,93539	kg
Copper [Non renewable elements]	1,44E-07	kg
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag) [Non renewable resources]	1,70E-05	kg
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag) [Non renewable resources]	1,04E-05	kg

Table 1a. (continued)

Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag) [Non renewable resources]	5,86E-06	kg
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag) [Non renewable resources]	1,43E-05	kg
Copper ore [Non renewable resources]	0,003627	kg
Copper ore (0.14%) [Non renewable resources]	21,6744	kg
Copper ore (1.2%) [Non renewable resources]	1,77E-06	kg
Copper ore (4%) [Non renewable resources]	1,41E-10	kg
Copper ore (sulphidic) [Non renewable resources]	1,67E-07	kg
Corn (t86) [Renewable resources]	306,3165	kg
Crude oil [Crude oil (resource)]	507,7359	kg
Crude oil (APME) [Crude oil (resource)]	30808,64	kg
Crude oil Algeria [Crude oil (resource)]	2819,748	kg
Crude oil Angola [Crude oil (resource)]	1635,939	kg
Crude oil Argentina [Crude oil (resource)]	0,842324	kg
Crude oil Australia [Crude oil (resource)]	38,31346	kg
Crude oil Austria [Crude oil (resource)]	2,76268	kg
Crude oil Bolivia [Crude oil (resource)]	1,04E-05	kg
Crude oil Brazil [Crude oil (resource)]	86,22969	kg
Crude oil Brunei [Crude oil (resource)]	0,006626	kg
Crude oil Bulgaria [Crude oil (resource)]	5,77E-05	kg
Crude oil Cameroon [Crude oil (resource)]	1200,135	kg
Crude oil Canada [Crude oil (resource)]	31,62591	kg
Crude oil Central Africa [Crude oil (resource)]	3,08077	kg
Crude oil Central America [Crude oil (resource)]	2,178171	kg
Crude oil Chile [Crude oil (resource)]	0,002646	kg
Crude oil China [Crude oil (resource)]	0,793484	kg
Crude oil CIS [Crude oil (resource)]	18820,58	kg
Crude oil Colombia [Crude oil (resource)]	7,854719	kg
Crude oil Czech Republic [Crude oil (resource)]	0,186219	kg
Crude oil Denmark [Crude oil (resource)]	82,65502	kg
Crude oil Ecuador [Crude oil (resource)]	0,33493	kg
Crude oil Egypt [Crude oil (resource)]	3079,111	kg
Crude oil France [Crude oil (resource)]	3,920331	kg
Crude oil free wellhead [Crude oil (resource)]	1,3E+08	kg
Crude oil Gabon [Crude oil (resource)]	1,994328	kg
Crude oil Germany [Crude oil (resource)]	236,7911	kg
Crude oil Greece [Crude oil (resource)]	0,54318	kg
Crude oil Hungary [Crude oil (resource)]	0,000522	kg
Crude oil India [Crude oil (resource)]	1,79E-08	kg
Crude oil Indonesia [Crude oil (resource)]	19,7386	kg
Crude oil Iran [Crude oil (resource)]	8744,007	kg
Crude oil Iraq [Crude oil (resource)]	2564,106	kg
Crude oil Ireland [Crude oil (resource)]	1,26E-05	kg

Table 1a. (continued)

Crude oil Italy [Crude oil (resource)]	4770,876	kg
Crude oil Italy [Crude oil products]	11,54903	kg
Crude oil Kuwait [Crude oil (resource)]	169,0204	kg
Crude oil Libya [Crude oil (resource)]	19473,58	kg
Crude oil Malaysia [Crude oil (resource)]	3,42E-07	kg
Crude oil Mexico [Crude oil (resource)]	133,0407	kg
Crude oil Middle East [Crude oil (resource)]	8,73091	kg
Crude oil Netherlands [Crude oil (resource)]	33,50048	kg
Crude oil New Zealand [Crude oil (resource)]	2,27571	kg
Crude oil Nigeria [Crude oil (resource)]	1641,559	kg
Crude oil North Africa [Crude oil (resource)]	5,632407	kg
Crude oil Norway [Crude oil (resource)]	6907,93	kg
Crude oil Oman [Crude oil (resource)]	1,218685	kg
Crude oil Poland [Crude oil (resource)]	0,577801	kg
Crude oil Qatar [Crude oil (resource)]	1,421743	kg
Crude oil Romania [Crude oil (resource)]	1,106728	kg
Crude oil Saudi Arabia [Crude oil (resource)]	8688,46	kg
Crude oil Slovakia [Crude oil (resource)]	3,59E-06	kg
Crude oil South Africa [Crude oil (resource)]	2,48E-05	kg
Crude oil Spain [Crude oil (resource)]	0,905195	kg
Crude oil Syria [Crude oil (resource)]	0,000329	kg
Crude oil Trinidad and Tobago [Crude oil (resource)]	0,555895	kg
Crude oil Tunisia [Crude oil (resource)]	285,173	kg
Crude oil Turkey [Crude oil (resource)]	1,31E-09	kg
Crude oil United Arab Emirates [Crude oil (resource)]	5,008069	kg
Crude oil United Kingdom [Crude oil (resource)]	2174,674	kg
Crude oil USA [Crude oil (resource)]	177,8108	kg
Crude oil Venezuela [Crude oil (resource)]	402,7258	kg
Defoamer [Operating materials]	49,60969	kg
Dolomite [Non renewable resources]	0,002661	kg
Energy (recovered) [Thermal energy]	-31,5	MJ
Energy unspecified (APME) [Energy resources]	5412,791	MJ
Feldspar (aluminum silicates) [Non renewable resources]	1,06E-15	kg
Ferro manganese [Non renewable resources]	2,02E-06	kg
Fertilizer [Inorganic intermediate products]	50,50722	kg
Fluorspar (calcium fluoride; fluorite) [Non renewable resources]	1,583754	kg
Granite [Non renewable resources]	3,74E-14	kg
Gypsum (natural gypsum) [Non renewable resources]	14,35309	kg
Hard coal [Hard coal (resource)]	210,398	kg
Hard coal (APME) [Hard coal (resource)]	3896,293	kg
Hard coal Australia [Hard coal (resource)]	4094,803	kg
Hard coal Belgium [Hard coal (resource)]	0,069535	kg
Hard coal Bosnia and Herzegovina [Hard coal (resource)]	0,00501	kg

Table 1a. (continued)

Hard coal Brazil [Hard coal (resource)]	0,033051	kg
Hard coal Canada [Hard coal (resource)]	1271,878	kg
Hard coal Chile [Hard coal (resource)]	0,277167	kg
Hard coal China [Hard coal (resource)]	999,2025	kg
Hard coal CIS [Hard coal (resource)]	2475,863	kg
Hard coal Colombia [Hard coal (resource)]	3320,373	kg
Hard coal Czech Republic [Hard coal (resource)]	108,4249	kg
Hard coal France [Hard coal (resource)]	2,045957	kg
Hard coal Germany [Hard coal (resource)]	3035,624	kg
Hard coal India [Hard coal (resource)]	1,58E-07	kg
Hard coal Indonesia [Hard coal (resource)]	5579,154	kg
Hard coal Italy [Hard coal (resource)]	262,9401	kg
Hard coal Japan [Hard coal (resource)]	2,12E-05	kg
Hard coal Malaysia [Hard coal (resource)]	1,02E-08	kg
Hard coal Mexico [Hard coal (resource)]	0,06372	kg
Hard coal New Zealand [Hard coal (resource)]	0,226731	kg
Hard coal Poland [Hard coal (resource)]	1305,091	kg
Hard coal Portugal [Hard coal (resource)]	0,00027	kg
Hard coal South Africa [Hard coal (resource)]	6937,052	kg
Hard coal Spain [Hard coal (resource)]	0,523093	kg
Hard coal Turkey [Hard coal (resource)]	6,56E-06	kg
Hard coal United Kingdom [Hard coal (resource)]	13,55584	kg
Hard coal USA [Hard coal (resource)]	5362,613	kg
Hard coal Venezuela [Hard coal (resource)]	2128,175	kg
Hard coal Vietnam [Hard coal (resource)]	0,20266	kg
Heavy spar (barytes) [Non renewable resources]	1018,41	kg
Herbicide [Organic intermediate products]	0,05192	kg
Hydrogen [Inorganic intermediate products]	1,75E-05	kg
Industrial waste (incineration) [Waste for recovery]	0,221874	MJ
Inert rock [Non renewable resources]	301593,2	kg
Iron [Non renewable elements]	0,002235	kg
Iron ore [Non renewable resources]	297,4236	kg
Iron ore (65%) [Non renewable resources]	4,174407	kg
Iron ore (65%) (Copy) [Non renewable resources]	0,309648	kg
Kaolin ore [Non renewable resources]	0,002887	kg
Lead [Non renewable elements]	4,33E-06	kg
Lead - zinc ore (4.6%-0.6%) [Non renewable resources]	100,0623	kg
Lignite [Lignite (resource)]	6,500665	kg
Lignite Australia [Lignite (resource)]	40,36087	kg
Lignite Austria [Lignite (resource)]	1,866758	kg
Lignite Bosnia and Herzegovina [Lignite (resource)]	0,011376	kg
Lignite Bulgaria [Lignite (resource)]	0,007355	kg
Lignite Canada [Lignite (resource)]	2,874912	kg

Table 1a. (continued)

Lignite CIS [Lignite (resource)]	38,11156	kg
Lignite Czech Republic [Lignite (resource)]	0,489512	kg
Lignite France [Lignite (resource)]	0,534406	kg
Lignite Germany [Lignite (resource)]	381,5027	kg
Lignite Germany (Central Germany) [Lignite (resource)]	56,6049	kg
Lignite Germany (Lausitz) [Lignite (resource)]	12,83219	kg
Lignite Germany (Rheinisch) [Lignite (resource)]	158,6431	kg
Lignite Greece [Lignite (resource)]	0,526866	kg
Lignite Hungary [Lignite (resource)]	0,033355	kg
Lignite India [Lignite (resource)]	3,16E-08	kg
Lignite Macedonia [Lignite (resource)]	0,015309	kg
Lignite Poland [Lignite (resource)]	33,27881	kg
Lignite Romania [Lignite (resource)]	0,001812	kg
Lignite Serbia and Montenegro [Lignite (resource)]	0,08786	kg
Lignite Slovakia [Lignite (resource)]	0,005222	kg
Lignite Slovenia [Lignite (resource)]	108,5013	kg
Lignite Spain [Lignite (resource)]	1,06968	kg
Lignite Turkey [Lignite (resource)]	1,63E-07	kg
Lignite USA [Lignite (resource)]	1,270329	kg
Limestone (calcium carbonate) [Non renewable resources]	16008,5	kg
Magnesit (Magnesium carbonate) [Non renewable resources]	42,15296	kg
Magnesium [Non renewable elements]	6,52E-09	kg
Magnesium chloride leach (40%) [Non renewable resources]	17,10993	kg
Magnesium sulphate [Inorganic intermediate products]	89,25594	kg
Manganese ore [Non renewable resources]	0,010556	kg
Manganese ore (R.O.M.) [Non renewable resources]	3,78119	kg
Manganese ore (R.O.M.) (Copy) [Non renewable resources]	0,00034	kg
Manure [Waste for recovery]	967,0286	kg
Mercury [Non renewable elements]	9,00E-09	kg
Methane [Organic intermediate products]	0,178815	kg
Molybdenite (Mo 0,24%) [Non renewable resources]	0,003059	kg
Molybdenum ore [Non renewable resources]	3,49E-10	kg
Natural Aggregate [Non renewable resources]	204,8116	kg
Natural gas [Natural gas (resource)]	520,8827	kg
Natural gas (APME) [Natural gas (resource)]	41312,88	kg
Natural gas Algeria [Natural gas (resource)]	41751,89	kg
Natural gas Angola [Natural gas (resource)]	193,2757	kg
Natural gas Argentina [Natural gas (resource)]	1,562853	kg
Natural gas Australia [Natural gas (resource)]	6,88801	kg
Natural gas Austria [Natural gas (resource)]	0,807461	kg
Natural gas Bolivia [Natural gas (resource)]	0,020826	kg
Natural gas Brazil [Natural gas (resource)]	5,186721	kg
Natural gas Brunei [Natural gas (resource)]	0,007095	kg

Table 1a. (continued)

Natural gas Bulgaria [Natural gas (resource)]	4,96E-06	kg
Natural gas Cameroon [Natural gas (resource)]	293,2593	kg
Natural gas Canada [Natural gas (resource)]	53,48682	kg
Natural gas Chile [Natural gas (resource)]	0,629571	kg
Natural gas China [Natural gas (resource)]	0,112402	kg
Natural gas CIS [Natural gas (resource)]	35187,4	kg
Natural gas Colombia [Natural gas (resource)]	0,444764	kg
Natural gas Czech Republic [Natural gas (resource)]	0,01367	kg
Natural gas Denmark [Natural gas (resource)]	12,10946	kg
Natural gas Ecuador [Natural gas (resource)]	0,037309	kg
Natural gas Egypt [Natural gas (resource)]	139,8735	kg
Natural gas France [Natural gas (resource)]	1,36245	kg
Natural gas Gabon [Natural gas (resource)]	0,292853	kg
Natural gas Germany [Natural gas (resource)]	148,8465	kg
Natural gas Greece [Natural gas (resource)]	0,0355	kg
Natural gas Hungary [Natural gas (resource)]	0,001696	kg
Natural gas India [Natural gas (resource)]	1,37E-08	kg
Natural gas Indonesia [Natural gas (resource)]	4,745976	kg
Natural gas Iran [Natural gas (resource)]	517,624	kg
Natural gas Iraq [Natural gas (resource)]	107,5589	kg
Natural gas Ireland [Natural gas (resource)]	0,028106	kg
Natural gas Italy [Natural gas (resource)]	25159,92	kg
Natural gas Japan [Natural gas (resource)]	6,88E-06	kg
Natural gas Kuwait [Natural gas (resource)]	7,550297	kg
Natural gas Libyan [Natural gas (resource)]	1190,646	kg
Natural gas Malaysia [Natural gas (resource)]	0,007111	kg
Natural gas Mexico [Natural gas (resource)]	8,673386	kg
Natural gas Netherlands [Natural gas (resource)]	14317,22	kg
Natural gas New Zealand [Natural gas (resource)]	0,148708	kg
Natural gas Nigeria [Natural gas (resource)]	9181,462	kg
Natural gas Norway [Natural gas (resource)]	8768,302	kg
Natural gas Oman [Natural gas (resource)]	0,157614	kg
Natural gas Poland [Natural gas (resource)]	0,162054	kg
Natural gas Qatar [Natural gas (resource)]	0,278795	kg
Natural gas Romania [Natural gas (resource)]	0,070781	kg
Natural gas Saudi Arabia [Natural gas (resource)]	324,2362	kg
Natural gas Slovakia [Natural gas (resource)]	3,74E-05	kg
Natural gas South Africa [Natural gas (resource)]	0,000209	kg
Natural gas Spain [Natural gas (resource)]	0,08389	kg
Natural gas Syria [Natural gas (resource)]	3,53E-05	kg
Natural gas Trinidad and Tobago [Natural gas (resource)]	0,140734	kg
Natural gas Tunisia [Natural gas (resource)]	20,56626	kg
Natural gas Turkey [Natural gas (resource)]	1,33E-10	kg

Table 1a. (continued)

Natural gas United Arab Emirates [Natural gas (resource)]	0,545636	kg
Natural gas United Kingdom [Natural gas (resource)]	75,42401	kg
Natural gas USA [Natural gas (resource)]	121,1269	kg
Natural gas Venezuela [Natural gas (resource)]	28,34695	kg
Nickel [Non renewable elements]	1,31E-08	kg
Nickel ore [Non renewable resources]	0,001316	kg
Nickel ore (1.6%) [Non renewable resources]	12,40246	kg
Nitrogen [Renewable resources]	1,26621	kg
Nuclear energy [Uranium (resource)]	33,29621	MJ
Nuclear energy (APME) [Uranium (resource)]	59834,83	MJ
Occup. as Convent. arable land [Hemeroby]	24628,54	m2*yr
Olivine [Non renewable resources]	2,08E-05	kg
Organic substance (BUWAL MJ) [Renewable energy resources]	62993,57	MJ
Oxygen [Renewable resources]	0,726132	kg
Palladium [Non renewable elements]	1,72E-11	kg
Peat [Non renewable resources]	0,516101	kg
Peroxitan [Operating materials]	9,033755	kg
Pesticide [Organic intermediate products]	0,777819	kg
Phosphate ore [Non renewable resources]	701,4397	kg
Phosphorus [Non renewable elements]	1,27E-11	kg
Phosphorus minerals [Non renewable resources]	0,000329	kg
Pit gas [Natural gas (resource)]	52,84249	kg
Pit Methane [Natural gas (resource)]	258,8009	kg
Platinum [Non renewable elements]	3,79E-11	kg
Potassium chloride [Non renewable resources]	42,05226	kg
Potato (t100) [Renewable resources]	199,7076	kg
Precious metal ore (R.O.M) [Non renewable resources]	0,036926	kg
Primary energy from geothermics [Renewable energy resources]	3303,96	MJ
Primary energy from hydro power [Renewable energy resources]	15909,6	MJ
Primary energy from hydro power (APME) [Renewable energy resources]	17870,67	MJ
Primary energy from hydro power (BUWAL) [Renewable energy resources]	1,2E+09	MJ
Primary energy from solar energy [Renewable energy resources]	738831	MJ
Primary energy from waves [Renewable energy resources]	0,005841	MJ
Primary energy from wind power [Renewable energy resources]	671,3996	MJ
Process and cooling water [Operating materials]	2,21E-06	kg
Process water [Operating materials]	1090,797	kg
Quartz sand (silica sand; silicon dioxide) [Non renewable resources]	77,88938	kg
Raw brown coal (BUWAL) [Lignite (resource)]	10276747	kg
Raw hard coal (BUWAL) [Hard coal (resource)]	66803501	kg
Raw natural gas (BUWAL) [Natural gas (resource)]	36084269	kg
Raw pumice [Non renewable resources]	0,00028	kg
Renewable fuels [Renewable energy resources]	1,907584	kg
Resin glue [Operating materials]	0,1872	kg

Table 1a. (continued)

Rhenium [Non renewable elements]	9,12E-12	kg
Rhodium [Non renewable elements]	1,36E-11	kg
Rutile (titanium ore) [Non renewable resources]	3,56E-05	kg
Salt [Non renewable resources]	120,5116	kg
sand [Non renewable resources]	0,001155	kg
Silver [Non renewable elements]	1,82E-05	kg
Slate [Non renewable resources]	0,000148	kg
Sodium chloride (rock salt) [Non renewable resources]	31184,02	kg
Sodium dichromate [Inorganic intermediate products]	0,020758	kg
Sodium hypochlorite [Inorganic emissions to fresh water]	4,24E-07	kg
Sodium nitrate [Non renewable resources]	1,96E-08	kg
Sodium sulphate [Non renewable resources]	1,49E-06	kg
Soil [Non renewable resources]	1103,691	kg
Steam (mp) [Thermal energy]	132,7859	kg
Steel scrap (St) [Waste for recovery]	1,01E-06	kg
Sulphur [Non renewable elements]	262,8421	kg
Sulphur [Inorganic intermediate products]	25,19146	kg
Sulphur (bonded) [Non renewable resources]	8,77E-05	kg
Sulphur dioxide [Inorganic intermediate products]	851,577	kg
Talc [Non renewable resources]	0,000166	kg
Tin ore [Non renewable resources]	1,02E-05	kg
Titanium ore [Non renewable resources]	1,023248	kg
Uranium free ore (BUWAL) [Uranium (resource)]	2735,625	kg
Uranium natural [Uranium (resource)]	0,061886	kg
Water [Water]	23854522	kg
Water (feed water) [Water]	221,0172	kg
Water (ground water) [Water]	1496656	kg
Water (lake water) [Water]	0,001134	kg
Water (sea water) [Water]	1738,277	kg
Water (surface water) [Water]	230035,5	kg
Water (well water) [Water]	0,628964	kg
Water (with river silt) [Water]	6,99E-15	kg
Water for industrial use [Operating materials]	8722,306	kg
Wood [Renewable energy resources]	4,068128	kg
Wood (BUWAL) [Renewable energy resources]	786734,9	kg
Zeolite [Not classified flows]	0,000416	kg
Zinc [Non renewable elements]	0,000684	kg
Zinc [Heavy metals to industrial soil]	0,020883	kg
Zinc - copper ore (4.07%-2.59%) [Non renewable resources]	24,65364	kg
Zinc - lead - copper ore (12%-3%-2%) [Non renewable resources]	7,847066	kg
Zinc - lead ore (4.21%-4.96%) [Non renewable resources]	4,80E-11	kg
Zinc ore [Non renewable resources]	1,27E-05	kg
Zinc ore (sulphide) [Non renewable resources]	6,00E-08	kg

Table 1b. Outputs of the cattle slaughtering data set

Abomasum [Product]	3184	kg
Body skirt [Product]	2013	kg
Cheek [Product]	3558	kg
Diaphragm [Product]	4812	kg
Head skin [Product]	12750	kg
Head [Product]	2330	kg
Headmeat [Product]	11266	kg
Heart [Product]	6067	kg
Hide [Product]	149352	kg
Kidney [Product]	2033	kg
Liver [Product]	18813,9	kg
Lung [Product]	6141,1	kg
Omasum [Product]	15474	kg
Rumen and reticulum [Product]	38931	kg
Side [Product]	657278	kg
Spleen [Product]	284	kg
Tail [Product]	4539	kg
Thymus [Product]	776	kg
Tongue [Product]	3876	kg
Tall oil [Organic intermediate products]	607,1479	kg
Thermal energy (MJ) [Thermal energy]	39853,81	MJ
Turpentine [Organic intermediate products]	71,67267	kg
Aluminum scrap [Waste for recovery]	1,94E-07	kg
Ash [Waste for recovery]	23349,85	kg
Ash [Stockpile goods]	16,65945	kg
Blast furnace slag [Waste for recovery]	0,009671	kg
Boiler ash (unspecified) [Waste for recovery]	8,580775	kg
CaF2 (low radioactive) [Radioactive waste]	0,006018	kg
Chemicals (unspecified) [Waste for recovery]	0,023457	kg
Chromium containing slag [Hazardous waste for disposal]	1,63E-13	kg
Cooling water [Waste for recovery]	151983,5	kg
Demolition waste (deposited) [Stockpile goods]	46,37707	kg
Dross [Waste for recovery]	3,32E-05	kg
Filter dust (heavy fuel oil power plant) [Waste for recovery]	0,000862	kg
Fly ash (unspecified) [Waste for recovery]	28,83082	kg
Furnace clinker [Waste for recovery]	3,05E-08	kg
Gypsum [Waste for recovery]	5,864236	kg
Gypsum (FDI) [Waste for recovery]	9,838882	kg
Hazardous waste (unspec.) [Hazardous waste]	0,003593	kg
Highly radioactive waste [Radioactive waste]	0,011692	kg
Highly radioactive waste (Copy) [Radioactive waste]	0,00438	kg
Highly-active fission product solution [Radioactive waste]	0,000554	kg
Incineration good [Waste for disposal]	0,02126	kg

Table 1b. (continued)

Industrial waste for municipal disposal [Consumer waste]	89662,72	kg
Inert chemical waste [Consumer waste]	200,0875	kg
Inert chemical waste [Hazardous waste]	0,009909	kg
Jacket and body material [Radioactive waste]	0,000333	kg
Liquid hazardous waste [Hazardous waste]	0,018582	kg
Liquid waste [Consumer waste]	0,072873	kg
Manure to be spread [Waste for recovery]	1043149	kg
Medium and low radioactive liquid waste [Radioactive waste]	0,000791	kg
Medium and low radioactive wastes [Radioactive waste]	0,019234	kg
Mineral waste [Consumer waste]	0,23975	kg
Oil [Waste for disposal]	1736,6	kg
Organic waste [Consumer waste]	1,89E-05	kg
Overburden (deposited) [Stockpile goods]	298671,3	kg
Packaging waste (metal) [Consumer waste]	3,53E-07	kg
Packaging waste (plastic) [Consumer waste]	8,68E-12	kg
Plastic (unspecified) [Waste for recovery]	0,003792	kg
Plutonium as residual product [Radioactive waste]	3,54E-05	kg
Polypropylene (PP, unspecified) [Consumer waste]	10,62272	kg
Production residues (unspecified) [Waste for recovery]	0,018712	kg
Radioactive tailings [Radioactive waste]	10,62934	kg
Red mud (wet) (3% NaOH) [Hazardous waste for disposal]	0,006146	kg
Rolling gravel [Waste for recovery]	4,88E-06	kg
Rolling tinder [Waste for recovery]	1,48E-07	kg
Salt slag [Waste for recovery]	0,359868	kg
Sewage sludge (waste water processing) [Hazardous waste]	0,003157	kg
Slag [Waste for recovery]	0,636674	kg
Slag [Hazardous waste]	305,4965	kg
Slag (Iron plate production) [Waste for recovery]	0,221954	kg
Slag (Uranium conversion) [Radioactive waste]	0,025947	kg
Sludge [Hazardous waste]	385,7198	kg
Sludge (from processing) [Waste for recovery]	0,022509	kg
Slurry (in brick works used) [Waste for recovery]	1914,851	kg
Steel works slag [Waste for recovery]	7,63E-07	kg
Straw [Biomass fuels]	34275	kg
Tailings [Stockpile goods]	4136,413	kg
Toxic chemicals (unspecified) [Hazardous waste for disposal]	2,736869	kg
Treatment residue (mineral, deposited) [Stockpile goods]	1236,681	kg
Uranium depleted [Radioactive waste]	0,041629	kg
Uranium spent as residue [Radioactive waste]	0,000708	kg
Used clothing (Cotton) [Materials from renewable raw materials]	2,08	kg
Volatile fission products (inert gases;iodine;C14) [Radioactive waste]	5,70E-06	kg
Waste (unspecified) [Consumer waste]	2403,305	kg
Waste paper [Waste for recovery]	2,62E-08	kg

Table 1b. (continued)

Waste radioactive [Radioactive waste]	0,0324	kg
Waste water [Other emissions to fresh water]	2552685	kg
Waste water processing residue [Hazardous waste for recovery]	0,53502	kg
Wood [Waste for recovery]	5,61E-07	kg
Wooden pallet (EURO) [Waste for recovery]	6,57E-09	kg
1,2-Dibromoethane [Halogenated organic emissions to fresh water]	1,48E-08	kg
Acenaphthene [Hydrocarbons to sea water]	0,000289	kg
Acenaphthene [Hydrocarbons to fresh water]	4,34E-05	kg
Acenaphthylene [Hydrocarbons to fresh water]	1,58E-05	kg
Acenaphthylene [Hydrocarbons to sea water]	0,00011	kg
Acetaldehyde (Ethanal) [Group NMVOC to air]	0,023147	kg
Acetic acid [Group NMVOC to air]	0,067954	kg
Acetic acid [Hydrocarbons to sea water]	7,76E-05	kg
Acetic acid [Hydrocarbons to fresh water]	0,000921	kg
Acetone (dimethylcetone) [Group NMVOC to air]	0,020909	kg
Acid (calculated as H+) [Inorganic emissions to fresh water]	692,7737	kg
Acrolein [Group NMVOC to air]	0,000129	kg
Acrylonitrile [Hydrocarbons to fresh water]	1,33E-07	kg
Adsorbable organic halogen compounds (AOX) [Analytical measures to fresh water]	51,17584	kg
Adsorbable organic halogen compounds (AOX) [Analytical measures to sea water]	2,12E-07	kg
Aldehyde (unspecified) [Group NMVOC to air]	28,62015	kg
Alkane (unspecified) [Hydrocarbons to fresh water]	4,10E-05	kg
Alkane (unspecified) [Group NMVOC to air]	0,044989	kg
Alkene (unspecified) [Group NMVOC to air]	0,017956	kg
Alkene (unspecified) [Hydrocarbons to fresh water]	3,74E-06	kg
Aluminium (3+) [Inorganic emissions to industrial soil]	0,027307	kg
Aluminum [Inorganic emissions to fresh water]	107402,4	kg
Aluminum [Inorganic emissions to sea water]	7,58E-07	kg
Americium (Am241) [Radioactive emissions to fresh water]	58,66146	Bq
Ammonia [Inorganic emissions to industrial soil]	12,56734	kg
Ammonia [Inorganic emissions to air]	968,5623	kg
Ammonia [Inorganic emissions to sea water]	2,25E-05	kg
Ammonia [Inorganic emissions to fresh water]	14,44229	kg
Ammonium [Inorganic emissions to air]	4,99E-08	kg
Ammonium / ammonia [Inorganic emissions to fresh water]	7089,645	kg
Ammonium nitrate [Inorganic emissions to air]	4,50E-07	kg
Animal/vegetal fats and oils [Not classified flows]	0,143757	kg
Anthracene [Hydrocarbons to fresh water]	8,65E-05	kg
Anthracene [Hydrocarbons to sea water]	0,00017	kg
Anthracene [Group PAH to air]	1,83E-05	kg
Antimony [Heavy metals to air]	0,000362	kg
Antimony [Heavy metals to fresh water]	6,54E-07	kg

Table 1b. (continued)

Antimony (Sb124) [Radioactive emissions to air]	0,023403	Bq
Antimony (Sb124) [Radioactive emissions to fresh water]	0,611639	Bq
Antimony (Sb125) [Radioactive emissions to fresh water]	0,416625	Bq
Argon (Ar41) [Radioactive emissions to air]	130055,1	Bq
Aromatic hydrocarbons (unspecified) [Group NMVOC to air]	4529,496	kg
Aromatic hydrocarbons (unspecified) [Hydrocarbons to sea water]	0,002342	kg
Aromatic hydrocarbons (unspecified) [Hydrocarbons to fresh water]	5591,256	kg
Arsenic [Heavy metals to sea water]	0,032685	kg
Arsenic [Heavy metals to air]	0,002844	kg
Arsenic [Heavy metals to fresh water]	220,9775	kg
Arsenic [Heavy metals to industrial soil]	9,71E-06	kg
Arsenic trioxide [Heavy metals to air]	5,22E-08	kg
Barium [Inorganic emissions to sea water]	0,369192	kg
Barium [Inorganic emissions to air]	0,643868	kg
Barium [Inorganic emissions to fresh water]	24825,48	kg
Barytes [ocean]	0,007309	kg
Benzaldehyde [Group NMVOC to air]	3,79E-09	kg
Benzene [Hydrocarbons to sea water]	0,1345	kg
Benzene [Group NMVOC to air]	1916,38	kg
Benzene [Hydrocarbons to fresh water]	0,120284	kg
Benzo(a)anthracene [Group PAH to air]	9,28E-06	kg
Benzo(a)anthracene [Hydrocarbons to fresh water]	3,45E-06	kg
Benzo(a)anthracene [Hydrocarbons to sea water]	5,73E-05	kg
Benzo(a)pyrene [Group PAH to air]	5,58E-05	kg
Benzo(ghi)perylene [Group PAH to air]	8,21E-06	kg
Benzo(a)fluoranthene [Group PAH to air]	1,68E-05	kg
Benzo(a)fluoranthene [Hydrocarbons to fresh water]	3,90E-07	kg
Benzo(a)fluoranthene [Hydrocarbons to sea water]	5,88E-05	kg
Beryllium [Inorganic emissions to sea water]	0,000143	kg
Beryllium [Inorganic emissions to fresh water]	1,31E-06	kg
Beryllium [Inorganic emissions to air]	7,13E-05	kg
Biological oxygen demand (BOD) [Analytical measures to fresh water]	1537,428	kg
Biological oxygen demand (BOD) [Analytical measures to sea water]	0,234172	kg
Boron [Inorganic emissions to sea water]	1,23E-05	kg
Boron [Inorganic emissions to fresh water]	0,001122	kg
Boron compounds (unspecified) [Inorganic emissions to air]	0,021716	kg
Bromate [Inorganic emissions to fresh water]	6,05E-09	kg
Bromide [Inorganic emissions to industrial soil]	0,003716	kg
Bromine [Inorganic emissions to fresh water]	4,48E-05	kg
Bromine [Inorganic emissions to air]	0,009722	kg
Butadiene [Group NMVOC to air]	3,84E-08	kg
Butane [Group NMVOC to air]	20,78614	kg
Butane (n-butane) [Group NMVOC to air]	0,30778	kg

Table 1b. (continued)

Butene [Group NMVOC to air]	1,05E-05	kg
Cadmium [Heavy metals to fresh water]	12,70497	kg
Cadmium [Heavy metals to industrial soil]	0,003791	kg
Cadmium [Heavy metals to air]	28,53752	kg
Cadmium [Heavy metals to sea water]	0,016407	kg
Calcium [Inorganic emissions to fresh water]	4599,775	kg
Calcium [Inorganic emissions to sea water]	0,001339	kg
Calcium (2+) [Inorganic emissions to industrial soil]	0,006832	kg
Carbon (C14) [Radioactive emissions to air]	61102,81	Bq
Carbon (C14) [Radioactive emissions to fresh water]	3295,487	Bq
Carbon (unspecified) [Organic emissions to industrial soil]	0,11088	kg
Carbon dioxide [Inorganic emissions to air]	6,32E+08	kg
Carbon disulphide [Inorganic emissions to air]	2,76E-06	kg
Carbon monoxide [Inorganic emissions to air]	160106,3	kg
Carbon, organically bound [Organic emissions to fresh water]	233,9891	kg
Carbonate [Inorganic emissions to sea water]	23,19514	kg
Carbonate [Inorganic emissions to fresh water]	30,82928	kg
Cesium [Heavy metals to fresh water]	3,10E-07	kg
Cesium (Cs134) [Radioactive emissions to fresh water]	7277,485	Bq
Cesium (Cs134) [Radioactive emissions to air]	16,29582	Bq
Cesium (Cs137) [Radioactive emissions to air]	33,31462	Bq
Cesium (Cs137) [Radioactive emissions to fresh water]	27571,61	Bq
CFC 114 (dichlorotetrafluoroethane) [Halogenated organic emissions to air]	1,54E-05	kg
CFC 116 (hexafluoroethane) [Halogenated organic emissions to air]	1,92E-06	kg
Chemical oxygen demand (COD) [Analytical measures to sea water]	4,124573	kg
Chemical oxygen demand (COD) [Analytical measures to fresh water]	18529,86	kg
Chlorate [Inorganic emissions to fresh water]	92,36952	kg
Chloride [Inorganic emissions to sea water]	1837,592	kg
Chloride [Inorganic emissions to industrial soil]	4,336221	kg
Chloride [Inorganic emissions to fresh water]	4171583	kg
Chloride (unspecified) [Inorganic emissions to air]	0,006603	kg
Chlorinated hydrocarbons (unspecified) [Halogenated organic emissions to fresh water]	6,238893	kg
Chlorine [Inorganic emissions to air]	0,011261	kg
Chlorine (dissolved) [Inorganic emissions to fresh water]	0,117913	kg
Chlorobenzene [Halogenated organic emissions to fresh water]	2,26E-13	kg
Chloromethane (methyl chloride) [Halogenated organic emissions to air]	0,004737	kg
Chloromethane (methyl chloride) [Halogenated organic emissions to fresh water]	0,009659	kg
Chromium (unspecified) [Heavy metals to air]	0,001448	kg
Chromium (unspecified) [Heavy metals to sea water]	0,181026	kg
Chromium (unspecified) [Heavy metals to industrial soil]	0,019153	kg
Chromium (unspecified) [Heavy metals to fresh water]	1127,862	kg
Chromium +III [Heavy metals to industrial soil]	0,049532	kg

Table 1b. (continued)

Chromium +III [Heavy metals to air]	1,12E-05	kg
Chromium +III [Heavy metals to fresh water]	0,01163	kg
Chromium +VI [Heavy metals to fresh water]	0,01132	kg
Chromium +VI (Copy) [Heavy metals to fresh water]	1,05E-07	kg
Chrysene [Hydrocarbons to fresh water]	1,18E-05	kg
Chrysene [Group PAH to air]	2,26E-05	kg
Chrysene [Hydrocarbons to sea water]	0,000313	kg
Cobalt [Heavy metals to air]	0,000822	kg
Cobalt [Heavy metals to sea water]	0,002494	kg
Cobalt [Heavy metals to industrial soil]	0,000434	kg
Cobalt [Heavy metals to fresh water]	2,62E-05	kg
Cobalt (Co58) [Radioactive emissions to fresh water]	22,85022	Bq
Cobalt (Co58) [Radioactive emissions to air]	0,109073	Bq
Cobalt (Co60) [Radioactive emissions to fresh water]	12783,37	Bq
Cobalt (Co60) [Radioactive emissions to air]	2,658396	Bq
Cobalt (Copy) [Heavy metals to fresh water]	8,01E-05	kg
Copper [Heavy metals to sea water]	0,059185	kg
Copper [Heavy metals to fresh water]	545,9828	kg
Copper [Heavy metals to air]	0,002131	kg
Copper [Heavy metals to industrial soil]	0,004292	kg
Cresol (methyl phenol) [Hydrocarbons to sea water]	1,70E-07	kg
Cresol (methyl phenol) [Hydrocarbons to fresh water]	2,21E-07	kg
Curium (Cm alpha) [Radioactive emissions to fresh water]	77,74407	Bq
Cyanide [Inorganic emissions to fresh water]	36,09434	kg
Cyanide (unspecified) [Inorganic emissions to air]	0,000113	kg
Cyclohexane (hexahydro benzene) [Group NMVOC to air]	6,32E-05	kg
Cypermethrin [Pesticides to air]	9,6	kg
Detergent (unspecified) [Other emissions to fresh water]	0,592222	kg
Dibenz(a)anthracene [Group PAH to air]	5,12E-06	kg
Dichloroethane (ethylene dichloride) [Halogenated organic emissions to fresh water]	4,14E-12	kg
Dichloroethane (ethylene dichloride) [Halogenated organic emissions to air]	5,44E-07	kg
Dichloromethane (methylene chloride) [Halogenated organic emissions to fresh water]	3,54E-07	kg
Dichloromethane (methylene chloride) [Halogenated organic emissions to air]	3,18E-10	kg
Dichloromethane (methylene chloride) (Copy) [Halogenated organic emissions to air]	0,002382	kg
Dichloropropane [Halogenated organic emissions to fresh water]	1,81E-12	kg
Diethyl amine (ethylene ethane amine) [Group NMVOC to air]	1,25E-12	kg
Dioxins (unspec.) [Halogenated organic emissions to air]	4,26E-10	kg
Dissolved organic carbon, DOC (Ecoinvent) [Fresh water]	0,000145	kg
Dust (PM10) [Particles to air]	1,114232	kg
Dust (PM2.5) [Particles to air]	3,157401	kg
Dust (unspecified) [Particles to air]	6,56E+09	kg

Table 1b. (continued)

Dust (unspecified) (Copy) [Particles to air]	0,190894	kg
Ethane [Group NMVOC to air]	77,13174	kg
Ethanol [Group NMVOC to air]	0,013587	kg
Ethene (ethylene) [Group NMVOC to air]	0,008197	kg
Ethine (acetylene) [Group NMVOC to air]	1,82E-06	kg
Ethyl benzene [Hydrocarbons to fresh water]	0,013458	kg
Ethyl benzene [Group NMVOC to air]	0,019416	kg
Ethyl benzene [Hydrocarbons to sea water]	0,009488	kg
Exhaust [Other emissions to air]	137980,3	kg
Fluoranthene [Hydrocarbons to fresh water]	1,50E-05	kg
Fluoranthene [Group NMVOC to air]	5,96E-05	kg
Fluoranthene [Hydrocarbons to sea water]	7,73E-05	kg
Fluorene [Group NMVOC to air]	0,000189	kg
Fluoride [Inorganic emissions to industrial soil]	0,123883	kg
Fluoride [Inorganic emissions to fresh water]	3,210808	kg
Fluoride (unspecified) [Inorganic emissions to air]	0,013016	kg
Fluorides [Inorganic emissions to air]	0,005836	kg
Fluorine [Inorganic emissions to fresh water]	0,001856	kg
Fluorine [Inorganic emissions to air]	1,526303	kg
Formaldehyde (methanal) [Group NMVOC to air]	0,312872	kg
Formaldehyde (methanal) [Hydrocarbons to fresh water]	2,41E-09	kg
Glutaraldehyde [Hydrocarbons to fresh water]	9,04E-07	kg
Gypsum (contaminated) [Waste for recovery]	213,8309	kg
Halogenated hydrocarbons (unspecified) [Halogenated organic emissions to air]	0,071685	kg
Halon (1301) [Halogenated organic emissions to air]	31,06159	kg
Halon (1301) (Copy) [Halogenated organic emissions to air]	1,97E-06	kg
Heavy fuel oil [Crude oil products]	0,00015	kg
Heavy metals to air (unspecified) [Heavy metals to air]	-2,54E-06	kg
Heavy metals to water (unspecified) [Heavy metals to fresh water]	0,00199	kg
Helium [Inorganic emissions to air]	0,267081	kg
Heptane (isomers) [Group NMVOC to air]	0,216565	kg
Hexamethylene diamine (HMDA) [Group NMVOC to air]	2,26E-09	kg
Hexane (isomers) [Group NMVOC to air]	0,321505	kg
Hexane (isomers) [Hydrocarbons to sea water]	1,85E-08	kg
Hexane (isomers) [Hydrocarbons to fresh water]	2,45E-08	kg
Hydrocarbons (unspecified) [Organic emissions to air (group VOC)]	0,051815	kg
Hydrocarbons (unspecified) [Hydrocarbons to fresh water]	6,117169	kg
Hydrocarbons (unspecified) (Copy) [Hydrocarbons to fresh water]	0,007844	kg
Hydrocarbons, aromatic [Group NMVOC to air]	0,072949	kg
Hydrocarbons, chloro-/fluoro- [Halogenated organic emissions to air]	4,24E-11	kg
Hydrogen [Inorganic emissions to air]	1,887356	kg
Hydrogen (H3) [Radioactive emissions to fresh water]	91227611	Bq

Table 1b. (continued)

Hydrogen (H3) [Radioactive emissions to air]	253211,8	Bq
Hydrogen arsenic (arsine) [Heavy metals to air]	4,33E-06	kg
Hydrogen bromine (hydrobromic acid) [Inorganic emissions to air]	3,06E-05	kg
Hydrogen chloride [Inorganic emissions to fresh water]	1,13E-05	kg
Hydrogen chloride [Inorganic emissions to air]	33795,09	kg
Hydrogen cyanide (prussic acid) [Inorganic emissions to air]	0,039177	kg
Hydrogen fluoride [Inorganic emissions to air]	3563,856	kg
Hydrogen fluoride (hydrofluoric acid) [Inorganic emissions to fresh water]	5,63E-05	kg
Hydrogen iodide [Inorganic emissions to air]	2,68E-08	kg
Hydrogen phosphorous [Inorganic emissions to air]	7,67E-09	kg
Hydrogen sulphide [Inorganic emissions to fresh water]	1,72E-06	kg
Hydrogen sulphide [Inorganic emissions to air]	6,411558	kg
Hydrogen sulphide (Copy) [Inorganic emissions to air]	0,000115	kg
Hydroxide [Inorganic emissions to fresh water]	0,000298	kg
Indeno[1,2,3-cd]pyrene [Group PAH to air]	6,14E-06	kg
Inert gases [Radioactive emissions to air]	5,53E-09	Bq
Inorganic salts and acids (unspecified) [Inorganic emissions to fresh water]	2916999	kg
Iodide [Inorganic emissions to fresh water]	3,10E-05	kg
Iodine [Inorganic emissions to air]	3,71E-05	kg
Iodine (I129) [Radioactive emissions to fresh water]	9438,29	Bq
Iodine (I129) [Radioactive emissions to air]	127,2177	Bq
Iodine (I131) [Radioactive emissions to fresh water]	0,435895	Bq
Iodine (I131) [Radioactive emissions to air]	19,56772	Bq
Iron [Heavy metals to industrial soil]	0,035487	kg
Iron [Heavy metals to fresh water]	49783,14	kg
Iron [Heavy metals to air]	0,005458	kg
Iron [Heavy metals to sea water]	0,030654	kg
Krypton (Kr85) [Radioactive emissions to air]	2,44E+09	Bq
Krypton (Kr85m) [Radioactive emissions to air]	2244,884	Bq
Land use II-III [Hemeroby]	7,169323	m ² *yr
Land use III-IV [Hemeroby]	0,084247	m ² *yr
Land use II-IV [Hemeroby]	0,16403	m ² *yr
Land use IV-IV [Hemeroby]	0,028733	m ² *yr
Lanthanides [Heavy metals to air]	3,27E-06	kg
Lead [Heavy metals to industrial soil]	0,07381	kg
Lead [Heavy metals to air]	261,2771	kg
Lead [Heavy metals to fresh water]	590,1623	kg
Lead [Heavy metals to sea water]	0,013326	kg
Lead dioxide [Inorganic emissions to air]	6,57E-09	kg
Magnesium [Inorganic emissions to fresh water]	0,258409	kg
Magnesium [Inorganic emissions to sea water]	0,041199	kg
Magnesium (2+) [Inorganic emissions to industrial soil]	0,000984	kg
Magnesium chloride [Inorganic emissions to fresh water]	5,99E-06	kg

Table 1b. (continued)

Manganese [Heavy metals to air]	85,24698	kg
Manganese [Heavy metals to industrial soil]	0,00508	kg
Manganese [Heavy metals to sea water]	0,003208	kg
Manganese [Heavy metals to fresh water]	0,057772	kg
Manganese (Mn54) [Radioactive emissions to fresh water]	1981,802	Bq
Meat and Bone Meal [Not classified flows]	68974,18	kg
Mercaptan (unspecified) [Group NMVOC to air]	1,33076	kg
Mercury [Heavy metals to fresh water]	0,334612	kg
Mercury [Heavy metals to industrial soil]	0,000497	kg
Mercury [Heavy metals to air]	7,513722	kg
Mercury [Heavy metals to sea water]	0,000152	kg
Metal ions (unspecific) [Inorganic emissions to fresh water]	3,053078	kg
Metals (unspecified) [Particles to air]	20539,31	kg
Metals (unspecified) [Particles to fresh water]	50912,46	kg
Methane [Organic emissions to air (group VOC)]	1191581	kg
Methane (Copy) [Organic emissions to air (group VOC)]	0,243255	kg
Methanol [Group NMVOC to air]	0,014376	kg
Methanol [Hydrocarbons to fresh water]	0,316163	kg
Molybdenum [Heavy metals to fresh water]	0,001124	kg
Molybdenum [Heavy metals to air]	0,000109	kg
Molybdenum [Heavy metals to sea water]	6,51E-08	kg
Naphthalene [Group PAH to air]	0,001921	kg
Naphthalene [Organic emissions to sea water]	0,010088	kg
Naphthalene [Organic emissions to fresh water]	0,001998	kg
Natural gas LNG [Natural gas products]	0,079187	kg
Neutral salts [Inorganic emissions to fresh water]	0,201168	kg
Nickel [Heavy metals to air]	2164,174	kg
Nickel [Heavy metals to fresh water]	557,5591	kg
Nickel [Heavy metals to sea water]	0,021977	kg
Nickel [Heavy metals to industrial soil]	0,02825	kg
Nitrate [Inorganic emissions to sea water]	0,030106	kg
Nitrate [Inorganic emissions to fresh water]	109477	kg
Nitrate (Copy) [Inorganic emissions to fresh water]	0,001213	kg
Nitrogen [Inorganic emissions to industrial soil]	0,008424	kg
Nitrogen [Inorganic emissions to fresh water]	7209,646	kg
Nitrogen (atmospheric nitrogen) [Inorganic emissions to air]	88,88482	kg
Nitrogen dioxide [Inorganic emissions to air]	71,0763	kg
Nitrogen monoxide [Inorganic emissions to air]	1,498624	kg
Nitrogen organic bounded [Inorganic emissions to fresh water]	645,8658	kg
Nitrogen oxides [Inorganic emissions to air]	1421962	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	10589,44	kg
Nitrous oxide (laughing gas) (Copy) [Inorganic emissions to air]	0,00491	kg
NMVOC (unspecified) [Group NMVOC to air]	1051334	kg

Table 1b. (continued)

non used primary energy from water power [Other emissions to fresh water]	2445,268	MJ
non used primary energy from wind power [Other emissions to air]	43,38085	MJ
Occup. as Forest land [Hemeroby]	24628,54	m2*yr
Octane [Group NMVOC to air]	0,11908	kg
Oil (unspecified) [Hydrocarbons to sea water]	0,815812	kg
Oil (unspecified) [Hydrocarbons to fresh water]	173258,8	kg
Oil (unspecified) [Organic emissions to industrial soil]	0,002336	kg
Organic chlorine compounds [Organic emissions to air (group VOC)]	2,44E-07	kg
Organic chlorine compounds (unspecified) [Organic emissions to fresh water]	3,24E-05	kg
Organic compounds (dissolved) [Organic emissions to fresh water]	0,000136	kg
Organic compounds (dissolved) (Copy) [Organic emissions to fresh water]	7,42E-05	kg
Organic compounds (unspecified) [Organic emissions to fresh water]	1,09E-09	kg
Oxygen [Inorganic emissions to air]	30,54503	kg
Palladium [Heavy metals to air]	2,20E-11	kg
Paper (unspecified) [Consumer waste]	2,76E-09	kg
Pentane (n-pentane) [Group NMVOC to air]	9,385943	kg
Permethrin [Pesticides to air]	1,92	kg
Phenanthrene [Group PAH to air]	0,000603	kg
Phenol (hydroxy benzene) [Hydrocarbons to fresh water]	942,1049	kg
Phenol (hydroxy benzene) [Hydrocarbons to sea water]	0,160674	kg
Phenol (hydroxy benzene) [Group NMVOC to air]	2,59E-06	kg
Phenol (hydroxy benzene) (Copy) [Hydrocarbons to fresh water]	4,77E-05	kg
Phosphate [Inorganic emissions to fresh water]	6466,839	kg
Phosphorus [Inorganic emissions to air]	1,84E-05	kg
Phosphorus [Inorganic emissions to sea water]	7,50E-11	kg
Phosphorus [Inorganic emissions to industrial soil]	1,289901	kg
Phosphorus [Inorganic emissions to fresh water]	20,51091	kg
Platinum [Heavy metals to air]	2,18E-12	kg
Plutonium (Pu alpha) [Radioactive emissions to fresh water]	320,9797	Bq
Plutonium (Pu alpha) [Radioactive emissions to air]	1,274991	Bq
Polychlorinated biphenyls (PCB unspecified) [Halogenated organic emissions to air]	9,50E-06	kg
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD) [Halogenated organic emissions to air]	1,59E-07	kg
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD) [Halogenated organic emissions to fresh water]	1,27E-08	kg
Polychlorinated dibenzo-p-furans (2,3,7,8 - TCDD) [Halogenated organic emissions to air]	1,31E-08	kg
Polycyclic aromatic hydrocarbons (carcinogenic) [Group PAH to air]	2,44E-08	kg
Polycyclic aromatic hydrocarbons (PAH) [Group PAH to air]	25,89996	kg
Polycyclic aromatic hydrocarbons (PAH, unspec.) [Hydrocarbons to fresh water]	84,66289	kg
Potassium [Inorganic emissions to fresh water]	26,88368	kg
Potassium (+) [Inorganic emissions to industrial soil]	3,132355	kg
Propane [Group NMVOC to air]	79,10698	kg
Propene (propylene) [Group NMVOC to air]	0,001563	kg

Table 1b. (continued)

Propionic acid (propane acid) [Group NMVOC to air]	0,000224	kg
Purified waste water [Not classified flows]	16433,72	m3
R 11 (trichlorofluoromethane) [Halogenated organic emissions to air]	0,000356	kg
R 114 (dichlorotetrafluoroethane) [Halogenated organic emissions to air]	0,000365	kg
R 116 (hexafluoroethane) [Halogenated organic emissions to air]	3,90E-08	kg
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to air]	7,65E-05	kg
R 13 (chlorotrifluoromethane) [Halogenated organic emissions to air]	4,81E-05	kg
R 22 (chlorodifluoromethane) [Halogenated organic emissions to air]	8,37E-05	kg
Radioactive substances (unspecified) [Radioactive emissions to air]	1,95E+08	Bq
Radioactive substances (unspecified) [Radioactive emissions to fresh water]	1804884	Bq
Radium (Ra226) [Radioactive emissions to fresh water]	1022430	Bq
Radon (Rn222) [Radioactive emissions to air]	31981862	Bq
Radon (Rn-daughter nukleade) [Radioactive emissions to air]	0,000196	Bq
Rhodium [Heavy metals to air]	2,12E-11	kg
Ruthenium (Ru106) [Radioactive emissions to fresh water]	58,721	Bq
Scandium [Inorganic emissions to air]	1,62E-06	kg
Selenium [Heavy metals to air]	0,002383	kg
Selenium [Heavy metals to fresh water]	0,000402	kg
Silicate particles [Inorganic emissions to fresh water]	2,35E-06	kg
Silicon dioxide (silica) [Particles to fresh water]	5,25E-19	kg
Silver [Heavy metals to sea water]	1,93E-07	kg
Silver [Heavy metals to air]	6,29E-13	kg
Silver [Heavy metals to fresh water]	0,000246	kg
Silver (Ag110m) [Radioactive emissions to fresh water]	0,089389	Bq
Slag (deposited) [Stockpile goods]	0,084195	kg
Sodium [Inorganic emissions to sea water]	4,676517	kg
Sodium [Inorganic emissions to fresh water]	2115,948	kg
Sodium (+) [Inorganic emissions to industrial soil]	0,000591	kg
Sodium chloride (rock salt) [Inorganic emissions to fresh water]	3,42E-10	kg
Soil loss by erosion into water [Particles to fresh water]	2280,147	kg
Solids (dissolved) [Analytical measures to fresh water]	829,6543	kg
Solids (suspended) [Particles to fresh water]	416554,8	kg
Solids (suspended) [Particles to sea water]	186,3679	kg
Spoil (deposited) [Stockpile goods]	698,433	kg
Steam [Inorganic emissions to air]	40844,39	kg
Strontium [Heavy metals to industrial soil]	7,938544	kg
Strontium [Inorganic emissions to air]	7,62E-05	kg
Strontium [Heavy metals to fresh water]	0,273131	kg
Strontium [Heavy metals to sea water]	0,005188	kg
Strontium (Sr90) [Radioactive emissions to fresh water]	4741,554	Bq
Styrene [Group NMVOC to air]	6,99E-08	kg
Sulphate [Inorganic emissions to industrial soil]	0,39671	kg
Sulphate [Inorganic emissions to fresh water]	816463,4	kg

Table 1b. (continued)

Sulphate [Inorganic emissions to sea water]	9,886283	kg
Sulphide [Inorganic emissions to industrial soil]	2,380263	kg
Sulphide [Inorganic emissions to fresh water]	215,5543	kg
Sulphide [Inorganic emissions to sea water]	4,200755	kg
Sulphite [Inorganic emissions to fresh water]	0,000315	kg
Sulphur [Inorganic emissions to sea water]	6,56E-06	kg
Sulphur [Inorganic emissions to fresh water]	1,81E-05	kg
Sulphur dioxide [Inorganic emissions to air]	5694079	kg
Sulphur hexafluoride [Inorganic emissions to air]	7,08E-05	kg
Sulphuric acid [Inorganic emissions to air]	0,002186	kg
Sulphuric acid [Inorganic emissions to fresh water]	0,00145	kg
Surfactants (tensides) [Operating materials]	0,004356	kg
Tallow [Not classified flows]	68974,18	kg
Tellurium [Heavy metals to air]	1,49E-06	kg
Tetrafluoromethane [Halogenated organic emissions to air]	9,26E-06	kg
Thallium [Heavy metals to air]	0,000195	kg
Thallium [Heavy metals to fresh water]	2,73E-06	kg
Tin [Heavy metals to air]	0,001397	kg
Tin [Heavy metals to sea water]	2,31E-07	kg
Tin [Heavy metals to fresh water]	8,90E-07	kg
Tin oxide [Inorganic emissions to air]	5,71E-10	kg
Titanium [Heavy metals to sea water]	2,36E-08	kg
Titanium [Heavy metals to fresh water]	0,002538	kg
Titanium [Heavy metals to air]	0,000236	kg
Toluene (methyl benzene) [Hydrocarbons to fresh water]	773,2641	kg
Toluene (methyl benzene) [Hydrocarbons to sea water]	0,082209	kg
Toluene (methyl benzene) [Group NMVOC to air]	0,018145	kg
Total dissolved organic bounded carbon [Analytical measures to fresh water]	564,4436	kg
Total organic bounded carbon [Analytical measures to sea water]	0,234172	kg
Total organic bounded carbon [Analytical measures to fresh water]	88398,04	kg
Total organic bounded carbon (Copy) [Analytical measures to fresh water]	0,008815	kg
Trichloroethene (isomers) [Halogenated organic emissions to fresh water]	4,66E-08	kg
Trimethylbenzene [Group NMVOC to air]	5,57E-09	kg
Tungsten [Heavy metals to fresh water]	4,35E-07	kg
Unused primary energy from geothermal [Other emissions to fresh water]	1802,68	MJ
Unused primary energy from solar energy [Other emissions to air]	20,06974	MJ
Uranium [Radioactive emissions to fresh water]	21985,02	Bq
Uranium (total) [Radioactive emissions to air]	602,2573	Bq
Uranium (total) (Copy) [Radioactive emissions to air]	1,05E-05	Bq
Uranium (U234) [Radioactive emissions to air]	140,0711	Bq
Uranium (U235) [Radioactive emissions to air]	6,696376	Bq
Uranium (U238) [Radioactive emissions to air]	365,3284	Bq
Used air [Other emissions to air]	2665,202	kg

Table 1b. (continued)

Used oil [Hazardous waste for recovery]	1,73E-10	kg
Vanadium [Heavy metals to sea water]	0,00171	kg
Vanadium [Heavy metals to air]	0,046196	kg
Vanadium [Heavy metals to fresh water]	0,000574	kg
Vinyl chloride (VCM; chloroethene) [Halogenated organic emissions to fresh water]	7,61E-11	kg
Vinyl chloride (VCM; chloroethene) [Halogenated organic emissions to air]	0,001375	kg
VOC (unspecified) [Organic emissions to air (group VOC)]	31697,4	kg
VOC (unspecified) (Copy) [Organic emissions to air (group VOC)]	0,0915	kg
Waste heat [Other emissions to fresh water]	8820,181	MJ
Waste heat [Other emissions to air]	309995,3	MJ
Waste heat to soil [Not classified flows]	1,336228	MJ
Water (desalinated; deionized) [Operating materials]	0,006697	kg
Water (river water) [Water]	146646,2	kg
Wood (dust) [Particles to air]	2,11E-07	kg
Xenon (Xe131m) [Radioactive emissions to air]	1796,099	Bq
Xenon (Xe133) [Radioactive emissions to air]	291604,3	Bq
Xenon (Xe133m) [Radioactive emissions to air]	2346,376	Bq
Xenon (Xe135) [Radioactive emissions to air]	82871,89	Bq
Xenon (Xe135m) [Radioactive emissions to air]	14591,94	Bq
Xenon (Xe137) [Radioactive emissions to air]	25,46125	Bq
Xenon (Xe138) [Radioactive emissions to air]	3300,346	Bq
Xylene (dimethyl benzene) [Group NMVOC to air]	0,075864	kg
Xylene (dimethyl benzene) (Copy) [Group NMVOC to air]	0,000658	kg
Xylene (isomers; dimethyl benzene) [Hydrocarbons to fresh water]	0,398603	kg
Xylene (isomers; dimethyl benzene) [Hydrocarbons to sea water]	0,030932	kg
Xylene (isomers; dimethyl benzene) (Copy) [Hydrocarbons to fresh water]	2,98E-05	kg
Zinc [Heavy metals to air]	213,8382	kg
Zinc [Heavy metals to fresh water]	1133,4	kg
Zinc [Heavy metals to sea water]	0,052329	kg
Zinc oxide [Inorganic emissions to air]	1,14E-09	kg
Zinc sulphate [Inorganic emissions to air]	0,000109	kg
Zirconium (Zr) [Air]	3,43E-08	kg

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