EXTENDED TIME SERIES IN THE SWEDISH ENVIRONMENTAL ACCOUNTS

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FOREWORD

Statistics Sweden has developed physical environmental accounts since 1993. In some areas, for example energy use and air emissions, the first phase of research and development of methodology is now turning into another phase of building and refining a statistical production system. This report includes parts of the whole development process, from first time calculations of some emissions to efforts to construct production systems for regular, up-to-date publication.

The report is prepared on commission from Eurostat, who supports and co-ordinates development of environmental accounts in the EU member states. The European Commission (Directorate-General for Regional Policy and Cohesion) has contributed financially to the project. Gunnar Brånvall, Sara Ribacke, Helena Rudander and Gia Wickbom have all contributed in preparing this report.

1. INTRODUCTION

The aim of environmental accounting is in a broad sense to describe the links between environment and economy. Environmental accounts can cover a wide range of areas, from the recreational importance of preserved natural forests to the emission reduction achieved by changing from one sort of material to another in industrial production processes. One of the areas where most work have been put down is to describe the environmental pressures caused by the economic activities of different industries. In Sweden, the primary focus of this work has been air emissions largely resulting from energy use. Statistics Sweden has presented data on energy use and air emissions of a number of substances in earlier publications[1]. At the start, only four air emissions were presented for sixteen industries, government and households. Over the years, the aim has been to calculate emission data for all of the most important air emissions at the same level of industrial disaggregation that is used in the national accounts.

For the normal production process, the energy accounts produced by the national accounts are a very important basis. However, since the calculation of air emissions is so largely dependant on the energy accounts, the environmental accounts publication of emissions from different industries has been published at least two years after the year in question. Not until about that time have the energy parts of the national accounts been laid down. Also, the ongoing revision of the national accounts (the adaptation to the European System of Accounts) have delayed the production of energy accounts and air emission data for the years following 1993.

The aim of this project was to develop a method to calculate preliminary energy and air emission data for more recent years than 1993, with the hope to use the developed calculation method to produce environmental accounts data within shorter time than has earlier been the case. Furthermore, the aim was also to include more greenhouse gas emissions besides carbon dioxide into the environmental accounts.

We have now succeeded to develop the calculation methods to produce environmental accounts data for most of the air emissions that are covered in the Swedish environment statistics. We have also made some preliminary calculations of energy use and air emissions. Thus, we have achieved many of the objectives for the project, but some parts of the project were harder to accomplish than anticipated. Also, some of the motives to develop a calculation procedure for preliminary data have changed during the project. In the two following sections the objectives are described in more detail, and the problems encountered in meeting the objectives are reported. In chapter two, results are presented both in tables and graphs, showing how the environmental pressure from different industries have changed over time. Chapter three describes the method used to calculate the data and the data sources used. Some of the more extensive tables

[1] Statistics Sweden and The National Institute of Economic Research (1994), Statistics Sweden (1996a), Statistics Sweden (1997a).

have been collected in the Annex, for the reader with a more detailed interest in the different steps of calculation.

1.1 Objectives

The goal of the project has been to improve the calculation of new emission data in the Swedish NAMEA, both with respect to rapidity and number of substances presented, and thereby create longer time series of data.

We planned to calculate preliminary energy and emission data for the years 1995 and 1997, thereby creating longer time series. This would have to be done without the use of energy accounts fully consistent with the national accounts, but with the help of some information from energy statistics, national accounts and with distribution keys from earlier years.

Furthermore, the project included calculation of carbon oxides (CO), methane (CH_4) and nitrous oxide (N_2O) emissions for the environmental accounts. In 1997 methods and emission factors were established to calculate these emissions in Sweden, which also made it possible to allocate the emissions to different industries, government and households according to the environmental accounts framework. First of all the objective was to do this for the year 1993. Thereafter preliminary data for 1995 and 1997 should be calculated according to above. The presentation should cover approximately 50 classes of industry (following as far as possible the classification for environmental accounts proposed by Eurostat).

Another objective was to present the results in an easily comprehensible manner. Indicators should be presented for the most relevant time series, as well as so called environmental profiles for some industries.

1.2 Deviations from plan

Due to major problems with data sources, a number of changes in the original plan have been necessary during the project. Also, some of the motives to develop a calculation procedure for preliminary data have changed since the start of the project.

As a result of the changes being made in the production process at the national accounts in connection to the change to ESA, the publication of final national account estimates will be one year faster than before. The final estimates will be published about thirteen months after the end of the year in question. Another necessary data source for the environmental accounts calculation of air emissions are the ordinary environment statistics on air emissions. These statistics are normally produced about ten months after the end of the year in question. Taking these facts into consideration, it seems reasonable to plan for a publication of environmental accounts statistics at about the same time as the national accounts are published. Probably, the environmental accounts data will even be incorporated in the national accounts publications in the future.

As a consequence, the aim of developing a method to calculate preliminary energy and air emission data, to be able to use the developed calculation method to produce environmental accounts data within shorter time than has earlier been the case, was not a topic of interest any more. Still, there was a strong need to produce some data that were more up-to-date than the figures for 1993. The objective to produce preliminary statistics remained, since the next final environmental accounts statistics are not planned until 1999, waiting for the national accounts to finalise their ESA adaptation. Meanwhile, preliminary statistics would still be very useful.

Important data sources for the calculation were energy statistics, mainly energy balances, but also other statistics on electric energy supply, district heating and supply of gas, deliveries and consumption of fuel and energy statistics for buildings. All these data sources contained valuable information to be able to calculate the energy use, but a number of different classifications are used in the different surveys.

The environmental accounts describe environmental pressures using the industrial classification used in the national accounts (SNI[2]). The annual energy balances are in certain respects more functionally oriented in their breakdown than the activity-based breakdown in the national accounts. The industrial breakdown is also, particularly with regard to some industries, more aggregated than that required as a basis for showing the energy use in the industrial breakdown proposed by Eurostat. In the normal calculation of energy accounts the quantity data for certain industry aggregates has thus been calculated on the basis of larger aggregates using existing data on values of bought or sold energy for the disaggregation. In this project, such value data were not possible to use since they were not yet prepared in the national accounts. Also, the idea to use distribution keys from the energy use already calculated for 136 classes of industry for the year 1993[3], and adjust these with the change in production between the years had problems. Since the national accounts are in a transformation process, changing to the ESA, production values and value added have only been calculated for a limited level of industry breakdown. Economic data could therefore not be obtained from the national accounts at the desired level of industries.

Confronted with these problems, we felt that the quality of the data that would be possible to estimate at a disaggregated level would be questionable. The original intention to calculate the energy use and air emissions with an industrial break-down of more than 50 classes of industry therefore had to be changed. Energy use and air emissions in the environmental accounts had been published for 16 industries, government and households for the years 1989, 1991 and 1993. To create as long time series as possible, we decided to use the same classification for the preliminary data.

The last obstacle in the calculations was finding data sources that covered the years we wanted to describe. The energy statistics were, like the national accounts,

[2] At a four digit level the Swedish SNI-codes correspond to the international NACE system.
[3] Statistics Sweden (1997a).

undergoing major changes in their production process. Energy balances for 1996 were much delayed, and were not available when we made our calculations. The survey on energy use within manufacturing industries were moved from industry statistics to energy statistics, and was also delayed. National accounts for 1997 were not available. We decided to calculate preliminary data for 1994 and 1995, which were the years possible to find sufficient source data for.

In connection to the new calculations of greenhouse gases, an improvement of earlier calculations of ammonia (NH_3) was made. These results are also included in this report, although not planned from the beginning.

2. RESULTS

In this chapter, we present results from the calculation of both the preliminary data and the greenhouse gas emissions. Using data calculated earlier, time series for the period 1989-1995 can be shown. Environmental economic profiles show the different industries share of the Swedish economy, employment, energy use and air emissions. We also present time series for energy use and emissions in relation to the production volume in the industries. This measure can be interpreted as an indicator for the industries eco-efficiency.

The industry classification used in Sweden changed in 1993[4], which affects the time series shown here. Data before and after 1993 is not completely comparable, since some industries are not classified exactly the same way. We therefore present two sets of data for 1993 in the graphs, one using the old classification and one with the new one. For nitrogen oxide, the method to allocate the mobile emissions to different industries has also been improved for the 1993-1995 data. This reinforces the need to show the two sets of data for 1993. All numbers for the new 1993-1995 calculations still have to be considered as preliminary, though.

First environmental economic profiles are presented. Thereafter follow time series for energy use and emissions. Finally, eco-efficiency indicators are presented for some industries. Tables with the relevant data appear in connection to the graphs.

2.1 Environmental economic profiles

In the environmental economic profiles the industries shares of the Swedish economy and environmental pressure are shown. The profiles are comparable between industries. The year presented is 1995.

In the environmental economic profiles, it is clear that trade and services and government are the sectors that produce the most value added. Machinery and equipment are extremely important for the Swedish export. Transport industry, production of electricity, gas and district heating and households cause the largest air emissions.

[4] From SNI 69 to SNI 92.

Figure 1. Environmental economic profiles for Sweden, 1995.

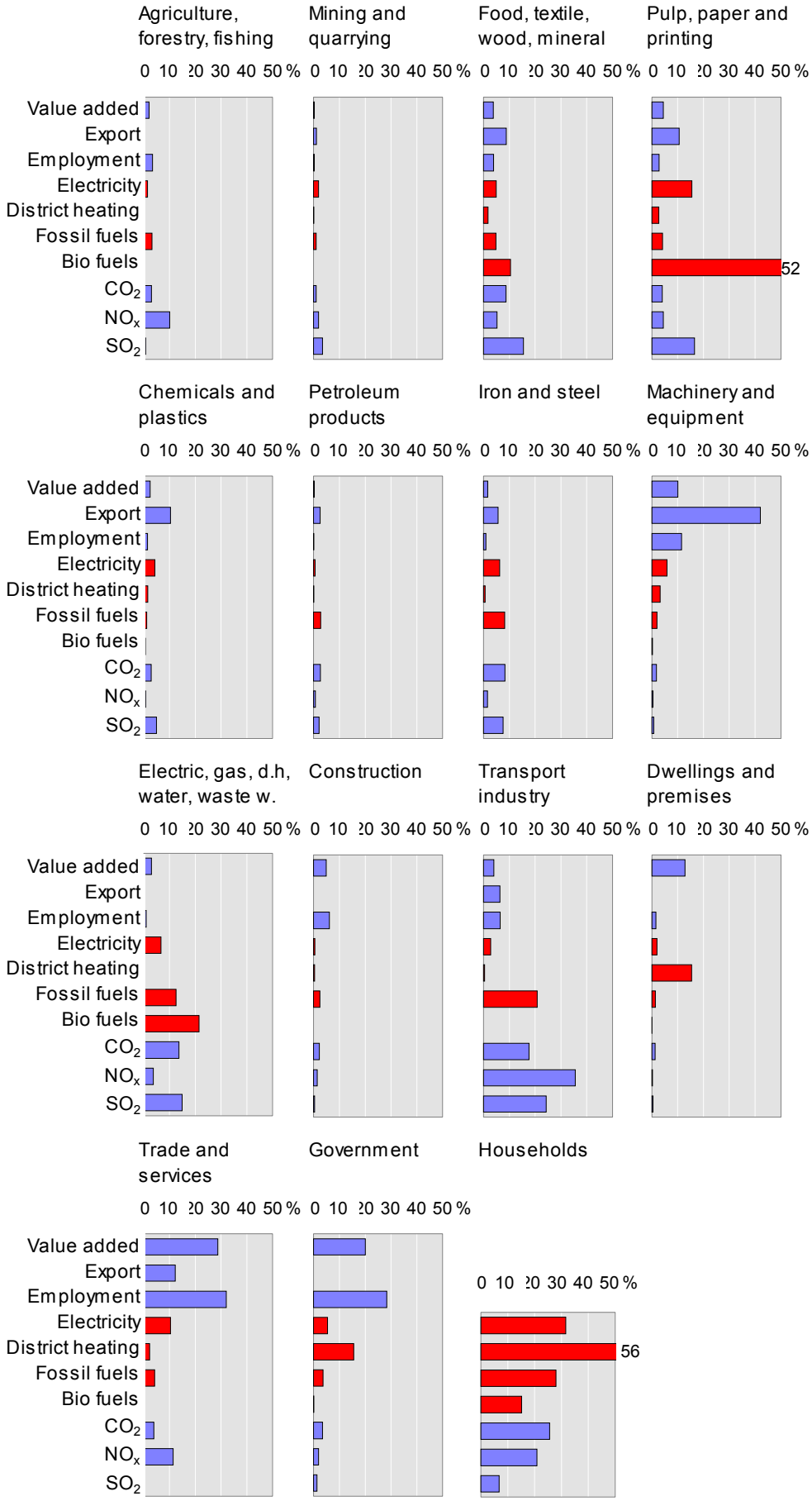


Table 1 Consumption of energy products by product type and kind of economic activity of industries, government services and private consumption in 1989-1995. PetaJoule.

Fuel consumption refers to combustion in the wide sense. It includes self-produced fuels and amounts for transport.

Group Nr	Activity	Year	Total	of which			
				Fossil	Bio fuel	Electricity	District heating
1	Agriculture	1989	29	20	0	9	0
		1991	28	18	0	9	0
		1993*	28	18	0	9	0
		1993	25	19	0	6	0
		1994	26	19	0	7	0
		1995	26	18	0	7	0
2	Forestry	1989	7	6	0	1	0
		1991	7	6	0	1	0
		1993*	7	6	0	1	0
		1993	6	6	0	0	0
		1994	6	6	0	0	0
		1995	6	6	0	0	0
3	Fishing	1989	3	3	0	0	0
		1991	3	3	0	0	0
		1993*	2	2	0	0	0
		1993	2	2	0	0	0
		1994	2	2	0	0	0
		1995	2	2	0	0	0
4	Mining and quarrying	1989	17	8	0	9	0
		1991	15	6	0	9	0
		1993*	14	6	0	8	0
		1993	15	6	0	9	0
		1994	15	6	0	9	0
		1995	17	7	0	9	0
5	Food, textile, wood, mineral production	1989	97	46	24	25	2
		1991	93	40	26	25	2
		1993*	91	38	26	25	2
		1993	88	37	26	22	2
		1994	87	36	26	22	2
		1995	91	38	28	23	3
6	Pulp, paper and printing	1989	233	25	130	75	2
		1991	229	21	132	73	3
		1993*	236	26	136	71	3
		1993	239	26	136	74	3
		1994	244	32	136	74	3
		1995	248	33	137	74	4
7	Chemicals and plastics	1989	44	14	1	26	3
		1991	36	9	2	21	3
		1993*	33	7	1	21	3
		1993	33	8	1	21	3
		1994	34	9	1	21	3
		1995	34	9	2	21	2
8	Petroleum refineries	1989	17	15	0	2	0
		1991	19	17	0	2	0
		1993*	25	23	0	2	0
		1993	26	23	0	2	0
		1994	26	23	0	2	0
		1995	25	22	0	3	0
9	Iron and steel	1989	83	55	0	28	1
		1991	80	53	0	27	0
		1993*	90	63	0	26	1
		1993	84	58	0	25	1
		1994	90	61	0	27	1
		1995	96	65	0	30	1

Table 1 Consumption of energy products by product type and kind of economic activity of industries, government services and private consumption in 1989-1995. PetaJoule.

Fuel consumption refers to combustion in the wide sense. It includes self-produced fuels and amounts for transport.

Group Nr	Activity	Year	Total	of which			
				Fossil	Bio fuel	Electricity	District heating
10	Machinery and equipment	1989	52	19	0	30	4
		1991	48	16	0	28	4
		1993*	44	14	0	26	4
		1993	45	15	0	25	4
		1994	46	16	0	26	4
		1995	49	15	0	28	5
11	Electricity, gas, district heating	1989	166	99	22	46	0
		1991	191	114	25	53	0
		1993*	205	120	36	49	0
		1993	221	150	38	32	0
		1994	193	111	58	24	0
		1995	183	99	57	26	0
12	Water and waste water treatment	1989	5	0	0	5	0
		1991	5	0	0	5	0
		1993*	6	0	0	5	0
		1993	6	0	0	6	0
		1994	6	0	0	6	0
		1995	6	0	0	6	0
13	Construction	1989	25	21	0	3	0
		1991	25	21	0	4	0
		1993*	23	20	0	3	0
		1993	23	19	0	3	1
		1994	22	19	0	3	0
		1995	22	19	0	2	1
14	Transport industry	1989	161	151	0	9	1
		1991	185	175	0	9	1
		1993*	168	158	0	8	1
		1993	165	153	0	12	1
		1994	167	154	0	12	1
		1995	178	164	0	13	1
15	Dwellings and premises	1989	46	12	0	20	14
		1991	52	12	0	23	17
		1993*	54	10	0	26	18
		1993	39	11	0	9	19
		1994	42	11	0	9	22
		1995	43	11	0	9	23
16	Trade and services	1989	96	50	0	41	4
		1991	103	51	0	44	7
		1993*	95	46	0	41	7
		1993	86	33	0	49	4
		1994	87	33	0	49	4
		1995	87	33	0	49	3
17	Government	1989	82	31	0	31	20
		1991	83	29	0	33	21
		1993*	85	27	0	35	22
		1993	81	32	0	24	25
		1994	79	31	0	25	23
		1995	78	29	0	25	23
18	Households	1989	440	212	39	119	70
		1991	452	205	39	128	79
		1993*	454	201	40	129	84
		1993	485	215	40	148	81
		1994	491	221	37	151	82
		1995	495	221	40	151	83

Table 2 Emissions of SO_2 and NO_x from different sources by kind of economic activity of industries, government services and private consumption 1989-1995. Metric tons.

Group Nr	Activity	Year	SO_2	tons			NO_X	tons		
			Total	of which			Total	of which		
				stationary	mobile	ind. proc.		stationary	mobile	ind. proc.
1	Agriculture	1989	3 294	1 782	1 512	0	19 909	715	19 194	0
		1991	1 391	859	532	0	19 304	610	18 694	0
		1993*	616	452	165	0	19 042	465	18 577	0
		1993	679	450	229	0	20500	460	20040	0
		1994	538	385	152	0	20 428	406	20 022	0
		1995	551	403	148	0	18 679	365	18 314	0
2	Forestry	1989	640	159	481	0	14 435	67	14 368	0
		1991	275	87	187	0	13 911	67	13 844	0
		1993*	132	67	65	0	13 785	59	13 726	0
		1993	158	71	88	0	12970	70	12900	0
		1994	122	62	59	0	12 953	52	12 901	0
		1995	115	58	58	0	14 071	43	14 028	0
3	Fishing	1989	156	0	156	0	5 331	0	5 331	0
		1991	86	0	86	0	4 691	0	4 691	0
		1993*	56	0	56	0	4 724	0	4 724	0
		1993	60	0	60	0	3500	0	3500	0
		1994	24	0	24	0	3 500	0	3 500	0
		1995	23	0	23	0	3 475	0	3 475	0
4	Mining and quarrying	1989	4 825	2 558	167	2 100	4 424	999	1 425	2 000
		1991	3 050	1 084	66	1 900	4 221	717	1 514	1 990
		1993*	2 637	773	24	1 840	4 570	878	1 442	2 250
		1993	2 440	570	30	1 840	5 260	490	2 520	2 250
		1994	2 273	610	19	1 644	6 368	1 664	2 514	2 190
		1995	3 259	971	18	2 270	6 808	2 073	2 035	2 700
5	Food, textile, wood, mineral production	1989	18 338	9 356	482	8 500	18 678	11 263	2 215	5 200
		1991	13 015	3 847	168	9 000	16 715	9 387	2 128	5 200
		1993*	12 033	3 279	64	8 690	15 776	7 878	1 983	5 915
		1993	12 090	3 350	50	8 690	16 990	7 900	3 170	5 920
		1994	9 111	3 951	42	9 112	18 036	7 698	4 012	6 326
		1995	14 639	3 864	41	10 735	18 660	8 648	2 890	7 122
6	Pulp, paper and printing	1989	18 592	3 705	87	14 800	13 173	5 335	1 838	6 000
		1991	18 103	4 982	30	13 090	16 375	5 630	1 713	9 032
		1993*	17 603	4 858	15	12 730	16 014	5 420	1 568	9 026
		1993	17 510	4 770	10	12 730	14 690	5 370	300	9 020
		1994	16 529	5 751	12	10 766	17 087	5 544	295	11 248
		1995	15 643	5 871	12	9 760	15 726	5 516	273	9 937
7	Chemicals and plastics	1989	9 326	2 614	43	6 668	6 367	1 417	1 838	3 112
		1991	4 357	1 193	20	3 144	4 604	1 058	1 713	1 834
		1993*	3 917	771	9	3 137	4 318	786	1 568	1 964
		1993	3 850	690	0	3 160	2 890	810	90	1 990
		1994	4 658	795	6	3 857	2 836	847	94	1 895
		1995	4 646	735	6	3 904	2 667	825	88	1 754
8	Petroleum refineries	1989	6 332	0	0	6 332	4 278	0	1 390	2 888
		1991	4 896	0	0	4 896	4 566	0	1 258	3 308
		1993*	5 821	0	0	5 821	3 908	0	1 113	2 795
		1993	6 076	255	0	5 821	2 972	177	0	2 795
		1994	4 288	69	0	4 219	2 907	34	0	2 873
		1995	1 976	38	0	1 937	2 273	22	0	2 251
9	Iron and steel	1989	15 456	3 424	32	12 000	7 528	2 090	1 938	3 500
		1991	11 237	1 301	17	9 920	5 697	1 434	1 814	2 450
		1993*	8 821	1 131	8	7 682	6 623	1 314	1 669	3 641
		1993	8 820	1 130	0	7 690	5 480	1 320	560	3 600
		1994	7 730	1 060	5	6 665	5 603	1 260	556	3 787
		1995	7 141	1 010	5	6 127	5 507	1 176	517	3 814

Table 2 Emissions of SO_2 and NO_x from different sources by kind of economic activity of industries, government services and private consumption 1989-1995. Metric tons.

Group Nr	Activity	Year	SO_2	tons			NO_X	tons		
			Total	of which			Total	of which		
				stationary	mobile	ind. proc.		stationary	mobile	ind. proc.
10	Machinery and equipment	1989	2 702	2 490	212	0	3 777	1 404	2 037	335
		1991	942	865	77	0	3 300	1 050	1 915	335
		1993*	750	701	49	0	2 569	800	1 770	335
		1993	780	770	10	0	1 730	850	880	405
		1994	845	802	42	0	2 161	862	894	405
		1995	693	651	42	0	1 630	712	918	405
11	Electricity, gas, district heating	1989	22 686	22 638	48	0	19 663	18 876	787	0
		1991	17 699	17 670	29	0	19 188	18 403	784	0
		1993*	15 083	15 060	23	0	15 981	15 149	832	0
		1993	15 990	15 980	10	0	16 430	16 300	130	0
		1994	16 385	16 380	6	0	15 449	15 298	151	0
		1995	14 067	14 062	6	0	13 239	13 093	146	0
12	Water and waste water treatment	1989	0	0	0	0	0	0	0	0
		1991	0	0	0	0	1 336	1	1 336	0
		1993*	3	0	3	0	989	2	987	0
		1993	1	0	1	0	0	0	0	0
		1994	1	0	1	0	0	0	0	0
		1995	1	0	1	0	0	0	0	0
13	Construction	1989	2 117	808	1 309	0	7 844	429	7 415	0
		1991	809	318	491	0	6 595	452	6 143	0
		1993*	454	275	179	0	5 923	346	5 577	0
		1993	430	200	230	0	6 130	300	5 830	0
		1994	355	192	164	0	6 061	284	5 777	0
		1995	351	191	160	0	4 813	237	4 576	0
14	Transport industry	1989	33 286	0	33 286	0	112 663	0	112 663	0
		1991	26 059	0	26 059	0	116 025	0	116 025	0
		1993*	22 053	275	22 053	0	119 616	0	119 616	0
		1993	22 540	30	22 510	0	132 710	50	132 660	0
		1994	22 010	33	21 977	0	131 661	55	131 606	0
		1995	22 998	31	22 967	0	127 395	49	127 346	0
15	Dwellings and premises	1989	2 319	2 309	9	0	2 592	1 043	1 549	0
		1991	1 307	1 295	13	0	2 827	1 024	1 803	0
		1993*	595	585	10	0	2 141	637	1 504	0
		1993	430	360	70	0	1 020	470	550	0
		1994	396	354	42	0	1 031	458	573	0
		1995	382	340	41	0	842	389	453	0
16	Trade and services	1989	3 809	2 725	1 084	0	58 576	1 721	56 854	0
		1991	2 372	1 869	503	0	57 972	1 730	56 242	0
		1993*	1 051	773	278	0	55 677	1 246	54 431	0
		1993	490	140	350	0	44 550	270	44 280	0
		1994	464	160	304	0	44 556	297	44 259	0
		1995	464	161	303	0	40 773	281	40 492	0
17	Government	1989	4 789	4 302	488	0	3 284	1 871	1 413	0
		1991	2 247	2 005	242	0	3 320	1 606	1 714	0
		1993*	1 322	1 134	188	0	2 822	1 091	1 731	0
		1993	1 550	1 320	230	0	6 620	1 330	5 290	0
		1994	1 382	1 179	203	0	8 074	1 149	6 925	0
		1995	1 242	1 062	180	0	6 658	921	5 737	0
18	Households	1989	13 230	10 683	2 547	0	114 720	7 558	107 162	0
		1991	8 816	7 270	1 546	0	108 405	7 629	100 775	0
		1993*	5 984	4 601	1 384	0	101 930	6 338	95 592	0
		1993	6 480	5 030	1 450	0	82 520	7 400	75 120	0
		1994	6 691	5 248	1 444	0	79 488	7 146	72 342	0
		1995	6 380	4 913	1 467	0	74 550	6 332	68 218	0

Table 3 Emissions of CO_2 from different sources by kind of economic activity of industries, government services and private consumption 1989-1995. 1000 metric tons.

Group Nr	Activity	Year	Total excl bio-fuel	of which		
				stationary combustion	mobile sources	industrial processes
1	Agriculture	1989	1 527	442	1 085	0
		1991	1 388	387	1 001	0
		1993*	1 377	433	944	0
		1993	1 400	431	969	0
		1994	1 364	388	975	0
		1995	1 352	405	947	0
2	Forestry	1989	421	47	374	0
		1991	424	47	377	0
		1993*	424	47	377	0
		1993	434	55	379	0
		1994	429	47	382	0
		1995	418	47	371	0
3	Fishing	1989	192	0	192	0
		1991	192	0	192	0
		1993*	157	0	157	0
		1993	150	1	149	0
		1994	150	0	150	0
		1995	145	0	145	0
4	Mining and quarrying	1989	644	537	107	0
		1991	476	362	114	0
		1993*	441	344	96	0
		1993	470	350	120	0
		1994	495	378	118	0
		1995	593	480	114	0
5	Food, textile, wood, mineral production	1989	5 766	3 234	356	2 176
		1991	5 713	3 290	334	2 089
		1993*	4 661	2 406	284	1 972
		1993	4 630	2 450	230	1 950
		1994	4 833	2 515	270	2 048
		1995	5 546	2 604	263	2 679
6	Pulp, paper and printing	1989	1 954	1 819	103	31
		1991	1 604	1 483	90	31
		1993*	1 972	1 860	81	31
		1993	1 950	1 840	80	30
		1994	2 443	2 329	83	31
		1995	2 537	2 423	83	31
7	Chemicals and plastics	1989	2 422	1 198	49	1 175
		1991	2 222	923	54	1 245
		1993*	2 025	474	47	1 504
		1993	2 060	530	30	1 500
		1994	2 273	589	43	1 641
		1995	1 873	608	43	1 222
8	Petroleum refineries	1989	1 008	1 008	0	0
		1991	1 279	1 279	0	0
		1993*	1 739	1 739	0	0
		1993	1 744	1 742	2	0
		1994	1 683	1 681	2	0
		1995	1 674	1 672	2	0
9	Iron and steel	1989	5 250	4 873	28	349
		1991	5 177	4 777	31	369
		1993*	6 374	5 941	36	397
		1993	5 810	5 390	30	390
		1994	5 053	4 607	33	413
		1995	5 282	4 824	30	427

Table 3 Emissions of CO_2 from different sources by kind of economic activity of industries, government services and private consumption 1989-1995. 1000 metric tons.

Group Nr	Activity	Year	Total excl bio-fuel	of which stationary combustion	mobile sources	industrial processes
10	Machinery and equipment	1989	1 385	1 047	338	0
		1991	1 161	850	311	0
		1993*	1 005	713	292	0
		1993	1 090	790	260	40
		1994	1 163	869	295	0
		1995	1 134	839	296	0
11	Electricity, gas, district heating	1989	7 572	7 439	133	0
		1991	8 636	8 468	169	0
		1993*	8 893	8 732	161	0
		1993	9	9	0	0
		1994	9 571	9 533	38	0
		1995	8 680	8 642	38	0
12	Water and waste water treatment	1989	0	0	0	0
		1991	1	1	0	0
		1993*	20	2	18	0
		1993	0	0	0	0
		1994	5	0	5	0
		1995	5	0	5	0
13	Construction	1989	1 596	414	1 182	0
		1991	1 556	441	1 115	0
		1993*	1 466	391	1 075	0
		1993	1 440	370	1 070	0
		1994	1 428	354	1 074	0
		1995	1 407	354	1 054	0
14	Transport industry	1989	11 280	0	11 280	0
		1991	13 151	0	13 151	0
		1993*	11 892	0	11 892	0
		1993	11 460	50	11 410	0
		1994	10 382	65	10 317	0
		1995	11 173	65	11 108	0
15	Dwellings and premises	1989	875	827	48	0
		1991	902	811	91	0
		1993*	717	644	73	0
		1993	800	520	280	0
		1994	802	528	275	0
		1995	796	528	268	0
16	Trade and services	1989	3 716	1 793	1 923	84
		1991	3 753	1 855	1 898	98
		1993*	3 416	1 556	1 860	88
		1993	2 480	310	2 080	90
		1994	2 517	339	2 085	94
		1995	2 528	357	2 079	92
17	Government	1989	2 293	1 325	968	0
		1991	2 128	1 197	931	0
		1993*	1 994	958	1 036	0
		1993	2 360	1 190	1 170	0
		1994	2 323	1 159	1 164	0
		1995	2 164	1 121	1 043	0
18	Households	1989	15 571	4 671	10 900	0
		1991	15 004	4 656	10 347	0
		1993*	14 749	4 621	10 128	0
		1993	15 790	5 510	10 280	0
		1994	16 225	5 822	10 404	0
		1995	16 234	5 660	10 573	0

Table 4 Economic data by kind of economic activity of industries 1989-1995. Gross output, value added and hours worked.

Group	Activity	Year	Gross output billion SEK	Value added billion SEK	Hours worked million hours
1	Agriculture	1989		13,4	173,2
		1991	28,9	12,6	158,6
		1993	29,7	12,3	154,4
		1994	29,3	11,7	156,4
		1995	29,4	12,3	152,6
2	Forestry	1989		18,4	60,8
		1991	22,1	17,8	54,5
		1993	22,0	18,1	50,1
		1994	23,2	19,2	50,4
		1995	24,5	20,3	51,1
3	Fishing	1989		0,8	9,0
		1991	1,1	0,7	8,9
		1993	0,8	0,5	7,4
		1994	1,0	0,6	7,7
		1995	1,1	0,6	7,5
4	Mining and quarrying	1989		4,0	18,4
		1991	10,3	3,8	16,7
		1993	9,5	3,6	14,6
		1994	9,8	3,8	15,0
		1995	11,0	4,3	15,8
5	Food, textile, wood, mineral production	1989		61,0	285,1
		1991	177,7	55,5	262,1
		1993	167,3	50,5	226,7
		1994	177,2	53,9	232,0
		1995	180,7	55,4	238,5
6	Pulp, paper and printing	1989		41,5	202,4
		1991	119,2	40,8	189,9
		1993	117,2	41,8	166,7
		1994	125,7	45,2	169,1
		1995	125,3	46,1	172,4
7	Chemicals and plastics	1989		25,5	100,9
		1991	68,0	26,2	90,1
		1993	72,6	28,9	81,7
		1994	80,7	32,7	89,1
		1995	83,1	34,1	92,5
8	Petroleum refineries	1989		6,9	5,4
		1991	24,6	6,8	5,2
		1993	27,3	7,9	5,0
		1994	26,8	7,6	5,3
		1995	25,6	7,8	5,2
9	Iron and steel	1989		13,3	71,4
		1991	50,3	12,5	60,1
		1993	51,3	12,9	52,5
		1994	59,4	15,2	54,7
		1995	63,2	16,4	57,7

Table 4 Economic data by kind of economic activity of industries 1989-1995. Gross output, value added and hours worked.

Group	Activity	Year	Gross output billion SEK	Value added billion SEK	Hours worked million hours
10	Machinery and equipment	1989		128,9	761,2
		1991	318,1	115,4	699,4
		1993	299,8	109,5	605,4
		1994	364,8	132,6	643,8
		1995	451,8	163,3	708,0
11	Electricity, gas, district heating	1989		33,9	0,0
		1991	53,0	35,2	0,0
		1993	52,7	34,6	0,0
		1994	53,2	34,8	0,0
		1995	54,4	35,9	0,0
12	Water and waste water treatment	1989	0,0	5,3	0,0
		1991	8,9	5,3	0,0
		1993	8,9	4,9	0,0
		1994	8,6	4,7	0,0
		1995	8,5	4,7	0,0
13	Construction	1989		98,4	517,3
		1991	187,1	98,5	505,7
		1993	159,9	84,8	395,8
		1994	154,2	81,2	380,1
		1995	152,2	80,8	378,8
14	Transport industry	1989		54,2	395,0
		1991	133,2	57,8	414,3
		1993	122,7	54,1	384,6
		1994	128,2	58,3	393,4
		1995	131,5	59,9	398,3
15	Dwellings and premises	1989		144,8	87,4
		1991	218,0	147,4	90,4
		1993	220,1	156,3	94,9
		1994	223,0	157,2	95,0
		1995	223,9	157,2	96,8
16	Trade and services	1989		344,4	1957,7
		1991	570,7	354,3	1944,0
		1993	541,8	341,9	1850,9
		1994	575,4	364,0	1913,8
		1995	605,6	385,3	1972,2

2.2 Time series for energy use and emissions, 1989-1995

The energy consumption in Sweden is today about the same as in 1973. Generally, the electricity consumption has increased, and also the use of district heating and bio fuels. During the same period the consumption of fossil fuels, especially oil, has decreased radically. About half the Swedish electricity is today produced with hydro power and the other half with nuclear power. About half of the district heating is produced with wood, peat and waste. Altogether, summing up the different energy sources contribution to energy used, approximately 30-40 % of the energy used is produced with renewable resources.

Below, the energy use in different industries is shown. The energy use for each industry includes all consumption of fuels, including fuels that are burnt for production of other energy carriers such as electricity and district heating. Another possibility would have been to present only the net consumption, subtracting the energy produced for distribution. The presentation here is chosen to show the connection between fuel combustion and emissions to air, which are presented later.

Figure 2. Energy – consumption of fuels, all industries, 1989-1995

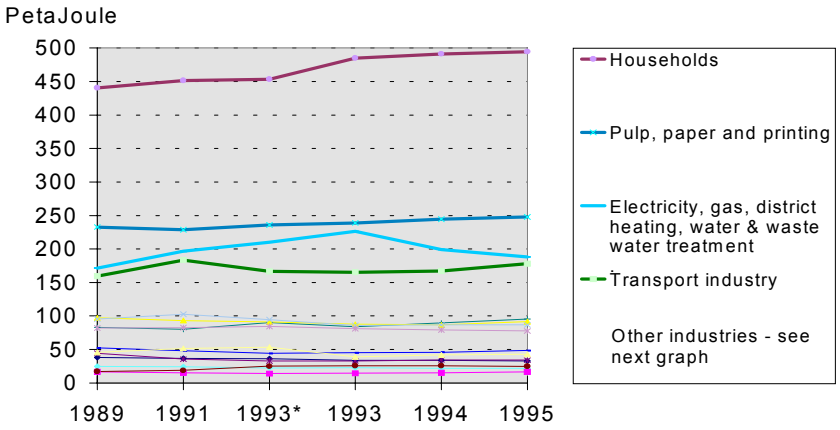
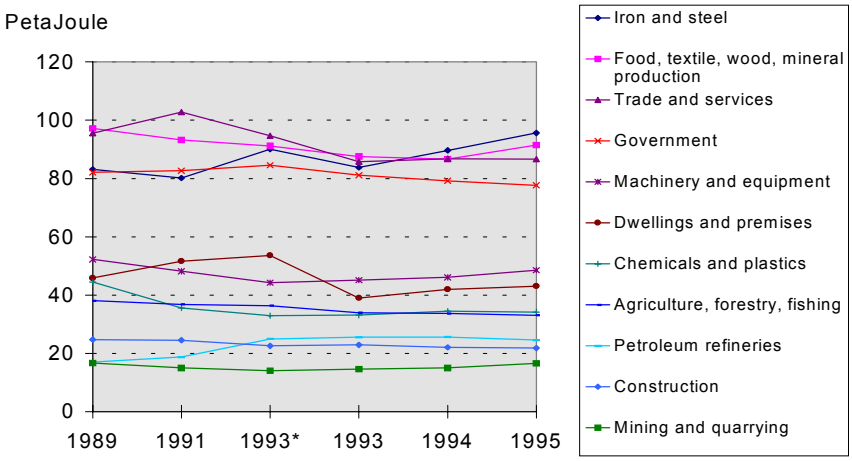


Figure 3. Energy - consumption of fuels, industries with less consumption than 120 PetaJoule/year, 1989-1995



As can be seen in the graphs, the change of industry classification affects the results to some extent. Taking this into consideration, it is, however, clear that the households' energy consumption increased between 1989 and 1995. The same pattern is seen for dwellings and premises and iron, steel and metal works. For iron, steel and metal works the increase is partly a consequence of increased production, when the Swedish economy recovered from a deep recession in 1991-1993.

As a consequence of the consumption of energy and other resources, different emissions occur. Emissions of carbon dioxide, sulphur dioxide and nitrogen oxides mainly come from combustion of fuels. The Swedish emissions of carbon dioxide have decreased 20 percent between 1980 and 1996. The main sources of emissions are traffic and stationary combustion for heating. Emissions from mobile sources have increased, while the stationary emissions have decreased.

Carbon dioxide emissions from bio fuels are excluded from the emissions. These emissions are not considered to contribute to the greenhouse effect, since they do not cause a net increase of carbon dioxide. The carbon emitted is balanced by the plants capture of carbon.

Figure 4. Emissions of carbon dioxide (CO_2) – all industries, 1989-1995

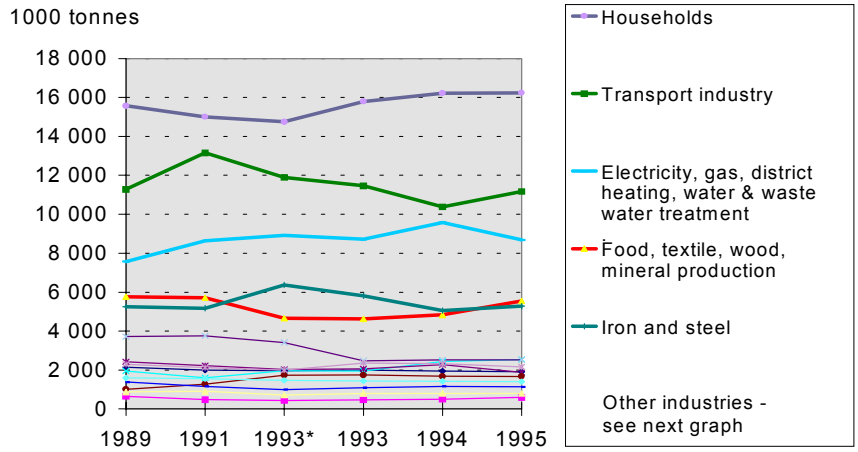
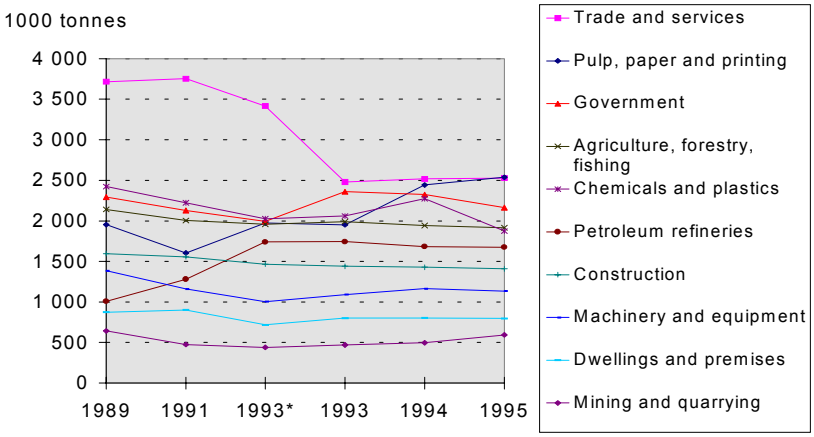


Figure 5. Emissions of carbon dioxide (CO_2) – industries with less emissions than 4 million tonnes/year, 1989-1995



Much of the energy consumption pattern shown in diagram 2 and 3 is reflected in the carbon dioxide emissions. Households have the largest emissions, a consequence both of oil combustion for heating and of petrol and diesel use in private cars. The energy intensive industry 'Pulp, paper and printing' does not have large carbon emissions, though. That is because large parts of their energy consumption consist of recoverable wood material from their production process, i e bio fuel.

The Swedish emissions of sulphur dioxide have decreased with more than 80 percent since 1980. It is mainly emissions from stationary combustion that have decreased, as a result of reduced oil consumption, transition to district heating oil with lesser sulphur content and installation of abatement equipment.

Figure 6. Emissions of sulphur dioxide (SO_2) – all industries, 1989-1995

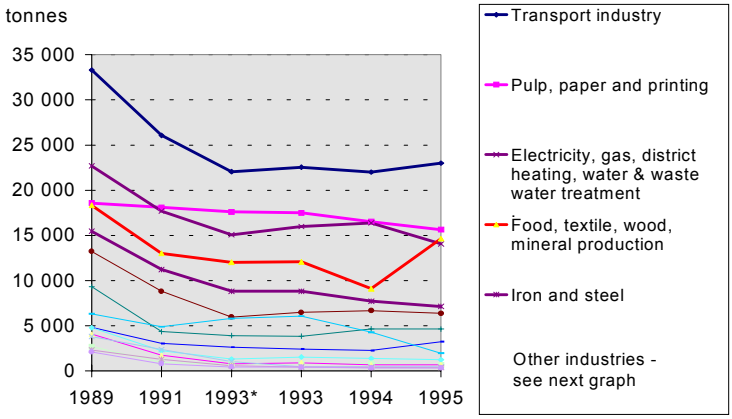
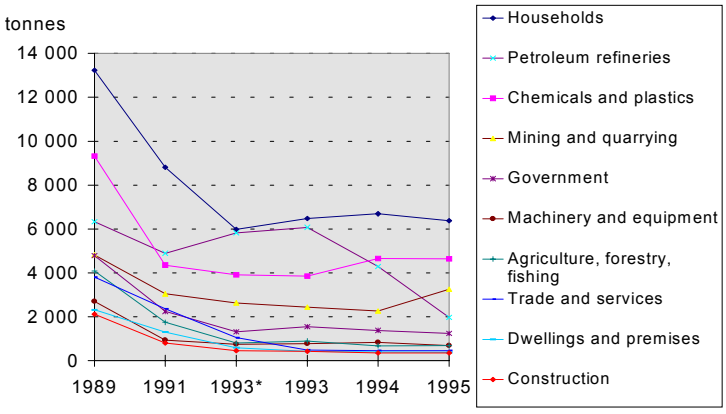


Figure 7. Emissions of sulphur dioxide (SO_2) – industries with less emissions than 14 000 tonnes/year, 1989-1995



In 1995, the transport industry caused 24 percent of the sulphur emissions. That is almost exclusively caused by sea transport, where fuel with high sulphur content is still used. 'Pulp, paper and printing' were responsible for 17 percent of the emissions, partly from combustion for energy reasons, partly from the industrial process where sulphur is an input in the production of pulp. However, the pulp

and paper industry has radically decreased it's emissions since 1980. In the period 1989-1995, almost all industries reduced their sulphur emissions.

The emissions of nitrogen oxides have also been decreasing in Sweden since 1980, with 21 percent. 80 percent of the emissions come from mobile sources. That implies that the transport industry is the largest emitter (36 percent of the emissions in 1995), but since most industries own some cars, lorries or mobile machinery, parts of the emissions are distributed to them. The households caused 21 percent of the emissions in 1995, mostly caused by private cars.

Figure 8. Emissions of nitrogen oxides (NO_x) – all industries, 1989-1995

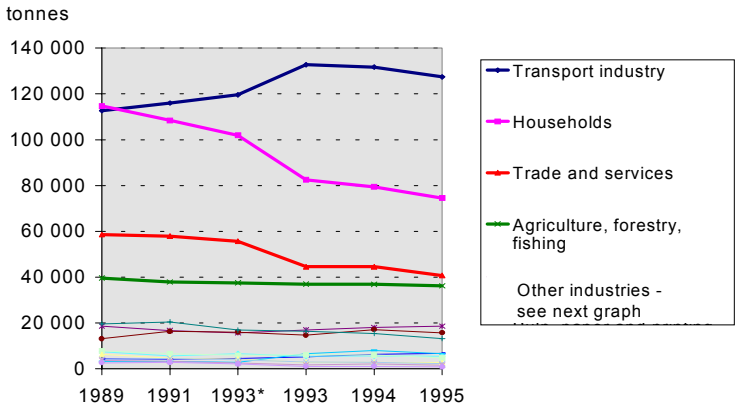
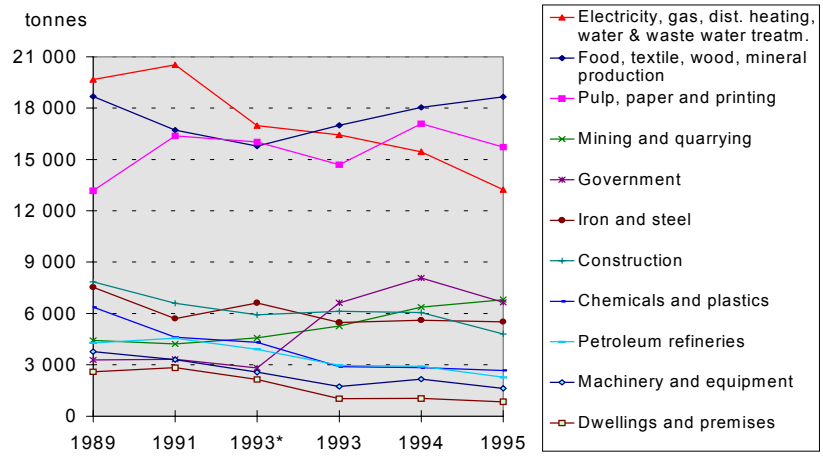


Figure 9. Emissions of nitrogen oxides (NO_x) – industries with less emissions than 21 000 tonnes/year, 1989-1995



In the time series, it is evident that the new calculation method for distribution of mobile emissions between industries has caused quite large changes in the results. The new method[5], which is used for the calculation 1993-1995, distributes more of the mobile emissions to the transport industry than before. The method takes account of the fact that the vehicles within the transport industry have longer driving distances than most other vehicles.

[5] The calculation method is extensively described in Statistics Sweden (1997).

Table 5

Within this project, emissions of the greenhouse gases carbon oxide (CO), nitrous oxide (N_20) and methane (CH_4) have been included in the environmental accounts for the first time. The calculations have been made with an industry disaggregation of 136 industries, but for reasons of secrecy and data quality, the emissions are shown in table 5 aggregated to 58 industries, government and households. Also, improved calculations of ammonia emissions are included in the table.

For carbon oxides, private consumption causes the largest emission, 70 % of the total emission. The second largest emitter is the chemical industry (SNI 24, which includes producers of basic chemicals, pesticides, paint, pharmaceutics etc.), but their emissions only constitutes 3 % of total emissions. This illustrates the fact, that except for private consumption, the carbon oxide emissions are divided between a large number of industries.

61 % of the methane emissions come from agriculture, where the emission sources are ruminating animals and spreading of manure. Waste treatment causes 26 % of the emissions. Nitrous oxide is not as dominated by a few large emitters as carbon oxide and methane. The largest emitter is the chemical industry, which causes 24 % of the total emissions. For ammonia, agriculture is responsible for 92 % of the total emission.

2.3 Eco-efficiency indicators 1989-1995

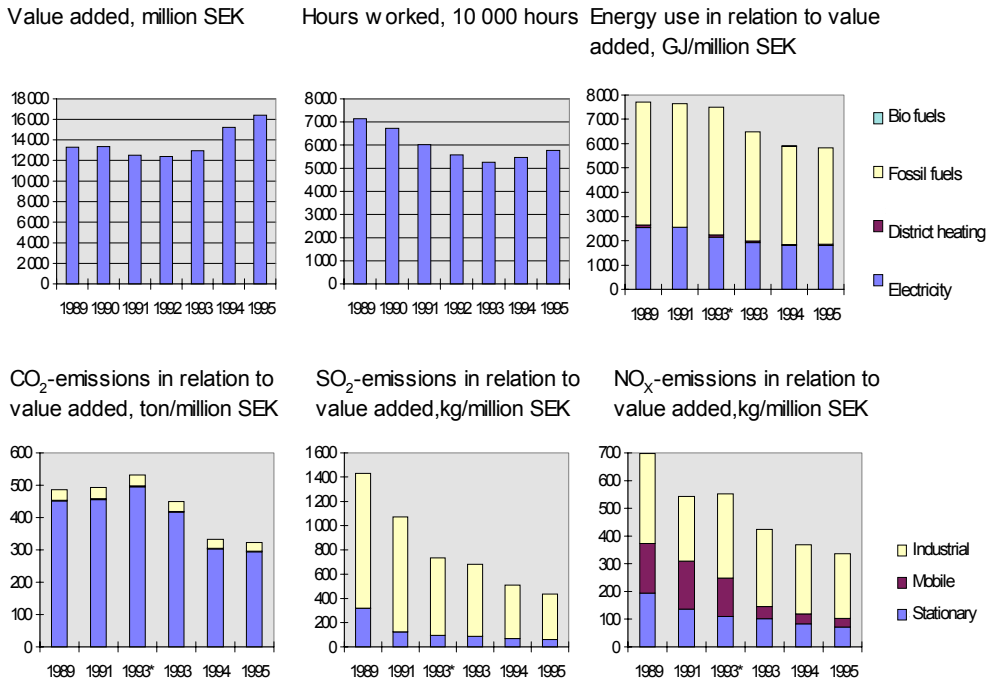
By calculating the relation between an industry's environmental pressure such as air emissions and the volume of production, a measure of the industries environmental efficiency is obtained. The production of an industry, and accordingly also the environmental pressures, can vary depending on for example the business cycle. However, environmental pressure related to the production volume is a measure that is unaffected by economic booms or recessions. An eco-efficiency indicator shows if an industry's production is performed more or less environmentally harmful over time.

As a measure of the production volume value added in constant prices is used. Value added is defined as the market price of the production less the cost of input goods. The constant price value added is a measure of the production volume in an industry. The constant price calculation take the price changes for input goods, products and services into consideration, for each industry individually.

Below, eco-efficiency indicators are shown for a selection of industries, as an example of how the indicators can be presented[6]. In connection to the efficiency indicators, the development of value added and employment is also presented for each industry. 1991 constant prices are used.

[6] A presentation for all industries, government and households is given in Statistics Sweden (1998).

Figure 10. Iron-, steel- and metal works – Value added, employment and eco-efficiency indicators 1989-1995



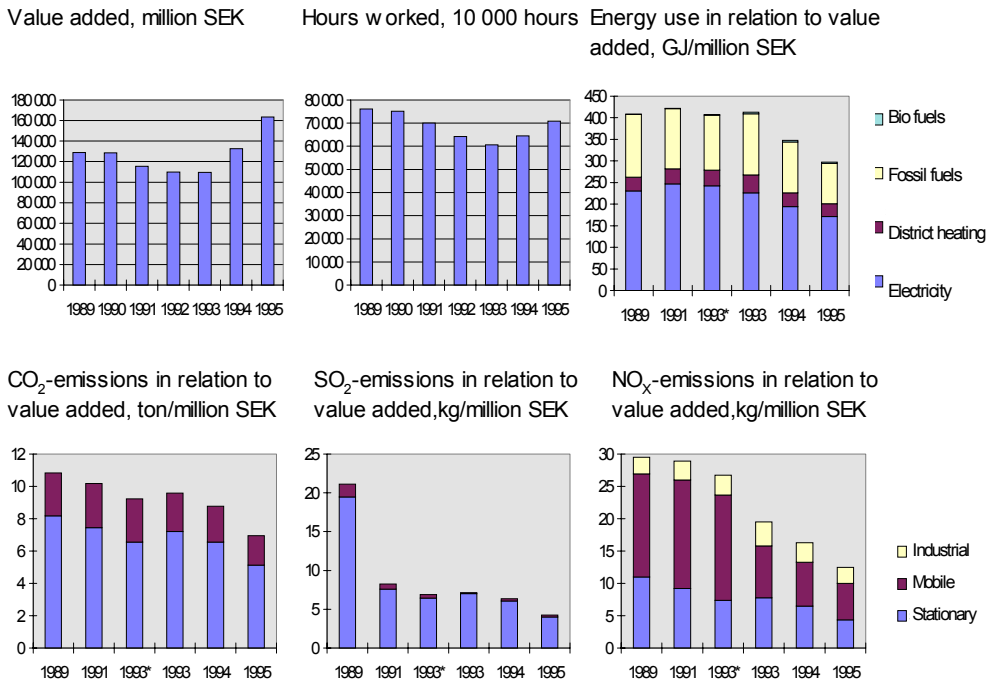
The 'Iron-, steel- and metal works' industry includes producers of iron and other metals from ore or scrap, and some further processing such as manufacturing of pipes, rolling of metal sheets, bars and wire etc.

The production volume decreased somewhat between 1989 and 1992, and then markedly increased. Number of hours worked decreased considerably until 1993. The increase in hours worked that took place in 1994-1995 did not correspond to the considerable rise in production. This indicates increased industry productivity.

The energy consumption is high in iron-, steel- and metal works. The industry has the highest total energy use in relation to production volume in Sweden. Between 1993 and 1994 a certain improvement seem to have occurred. The large use of fossil fuels and also the industrial processes themselves lead to large emissions of carbon and sulphur dioxide. In 1991-1993 the carbon dioxide emissions in relation to production volume increased somewhat as a consequence of a small increase in the use of fossil fuels. The opposite occurred between 1993 and 1995. In combination with a rise in production volume 1994 and 1995, this lead to a substantial decrease in carbon dioxide per value added.

The emissions of sulphur dioxide are caused by the industrial process. Due to abatement measures at the plants, the sulphur dioxide emission in relation to production volume was more than halved during the period. The nitrogen oxide emissions have also decreased.

Figure 11. Manufacturing and equipment – Value added, employment and eco-efficiency indicators 1989-1995

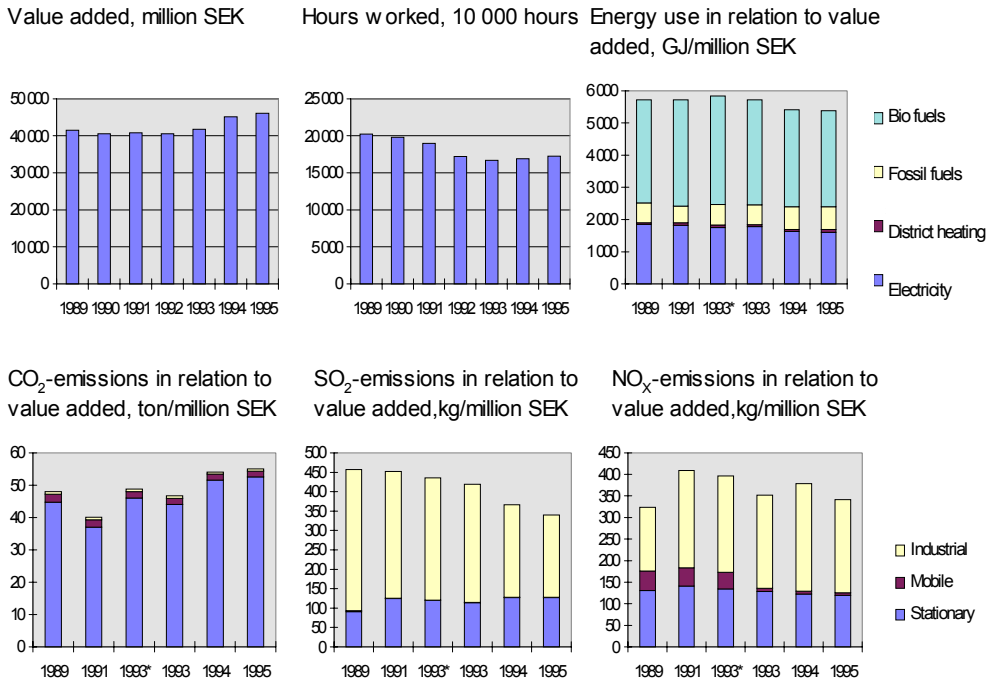


The industry includes manufacturing of metal goods, machinery, cars and other vehicles, electric equipment, optics, office equipment, tele com, furniture etc.

After a decline 1989-1993 the production volume has increased considerably. The growth has principally taken place in electric and tele communication equipment. The industry's energy use is low in relation to production volume. This is because the energy intensive refinement of raw materials, for example extraction and processing of metals, take place in other industries. During the period energy use in relation to production has decreased. This is partly caused by a decline in energy consumption in absolute terms between 1989-93 and partly by the considerable rise in production combined with only a small rise in energy consumption in 1993-95.

A reduced use of fossil fuels has caused the carbon dioxide emissions to decrease somewhat. This is also part of the reason why the sulphur dioxide emissions was significantly reduced in the beginning of the period. Another reason for this was also the generally decreasing sulphur content in oil products. Reduced fuel combustion is also an explanation to the decline in nitrogen oxide emissions.

Figure 12. Pulp, paper and printing – Value added, employment and eco-efficiency indicators 1989-1995



The production of pulp and paper products contributed to a little less than 50 percent of the value added in the pulp, paper and printing industry. Printing and publishing contributed to the rest.

The production was relatively constant between 1989 and 1993, after which it increased. During 1989-1993 the number of hours worked declined markedly, but did not increase to the same extent as the production 1993-1995.

Pulp and paper industry is a large consumer of energy while printing and publishing is relatively low consuming. Since the production of pulp is mainly based on wood which leaves large amounts of recoverable waste and also process waste which can be used for energy production, bio fuels is the dominating energy source. Since only small amounts of fossil fuels are used the net emissions of carbon dioxide are relatively low. Between 1993 and 1995 the use of fossil fuels increased somewhat which also caused the carbon dioxide emissions in relation to production to increase. At the same time a small decrease occurred in the energy use.

The emissions of sulphur dioxide have decreased notably since the beginning of the 1980-s. The emissions were still decreasing 1989-1995, mainly because of abatement measures at the production of sulphite and sulphate pulp.

3. METHOD

The NAMEA concept tries to integrate information from many sources into a comprehensive, detailed and consistent picture. To produce energy accounts and calculate emissions, many data sources have to be gathered and integrated into the framework of national accounts and environmental accounts. The degree of empirical evidence behind various cells in the matrix vary according to availability of data sources.

In chapter 3.1 a general description of data sources normally used are given, and some difficulties in producing energy accounts and calculating emissions are highlighted. In connection to energy and emission data, maybe the most important difficulties concern the integration into the matrix of mobile sources, represented by the products petrol and diesel. The methodology used for this is well documented[7].

For 1994-1995 no regular energy accounts were available, so special models had to be found to produce preliminary energy accounts. These computations are described in chapter 3.2. A strategy for producing data for 1996 is also presented.

The energy accounts and emissions calculations will not be described in great detail, further information can be found in other sources[8].

3.1 Data sources

The data sources are here divided between data for computation of energy use in different industries and data for the calculation of emissions, even though the energy data in itself can be considered as an emission data source.

3.1.1 Energy data sources

Statistics are produced to describe the total production, trade and use of energy carriers in Sweden as well as the economic side of these activities. Several surveys are performed regularly at Statistics Sweden on various aspects of these flows. Quite detailed surveys on fairly large portions of the populations are performed on a yearly basis, whereas smaller surveys are made on a quarterly basis. The trade with fossil fuels is followed more or less continuously and yearly summaries from these deliveries will be referred to below as Supplier Statistics.

Based on these data, *energy balances* are estimated for the flows, both yearly and quarterly. The flows are expressed both in original quantity units and translated into general energy units like PJ, TWh or toe. In these calculations, a distinction is made between use ”for energy transformation” and ”final use”. Use for energy transformation is defined to comprise all use within SNI 40 (Production of electricity, gas and district heating) as well as some uses within the manufacturing industry, chiefly oil refineries, industrial power stations, coke-oven plants and

[7] Statistics Sweden (1997a)
[8] Statistics Sweden (1995), Statistics Sweden (1997a) and Statistics Sweden (1998b).

blast-furnaces. In the energy balances detailed estimates of input and output of energy carriers are given for these categories.

More closely related to the NAMEA concept are the *energy accounts*. This refers to an input table of industry times product (around 30 different energy carriers are considered). The most important table for our purpose is given in physical quantities, but a table of monetary values (in purchasers price) is also produced. The methods for constructing this input table differ between the types of fuel.

Fuels for mobile sources.
We refer here to jet fuel, aviation paraffin, diesel, petrol and also some heavy duty oil (for bunkers). The most important difficulties concern diesel and petrol, where model assumptions are used to distribute the total consumption over industries. The models use ownership data for various types of vehicles as well as some information on mileage and fuel consumption.

Fuels for stationary combustion
Here we refer to the rest of the energy products. Since, for these fuels, user survey data can be used for the manufacturing and energy industries, estimates in this part of the matrix are probably quite reliable. There also exist survey data on fuel consumption in dwellings, but certain parts of the matrix must be constructed from more crude estimates given by fuel suppliers. For electricity and hot water, however, supplier statistics may be considered quite reliable.

Some minor modifications should be mentioned concerning the energy accounts for the manufacturing industries. Standard accounting rules are based on *purchases* of the products, independently of how they are used. Some amounts of oil are used for lubrification or syntheses within the chemical industry. These amounts are not big but they have been deducted from the statistics in this context.

On the other hand, statistics on bought fuels has been *augmented by estimates of self-produced products*. This modification is more important since the two largest energy consuming industries - the pulp and paper industry and the steel industry - both rely to a large extent on self-produced energy carriers, chiefly wood fuel, coke and gas from coke ovens and blast-furnaces.

In the preliminary data which we have used, it has been assumed though that the consumption of self-produced wood fuel within the pulp and paper industry has remained constant since 1993.

After these modifications, the estimated energy amount could be interpreted as ”used for energy purposes”. As a rule this may be translated to ”used for combustion in the wide sense”, intended to mean simply that the fuel is burnt. In emission statistics combustion for the purpose of providing energy to industrial processes is sometimes distinguished from combustion for energy production, which may in such cases be called ”combustion in the narrow sense”. Actually the rules for this delineation vary depending on which emitted substance is considered. The only exception to this rule concerns the energy transformations in the steel industry. These are commented below in greater detail.

A list of the fuels together with the constants used for computing their energy content is given in Appendix B. Also noted in the list are the standard classification of the fuels - stationary or mobile, fossil or biological fuel.

3.1.2 Emission data sources

The most important data source for emission calculations is normally the energy accounts. In this project, preliminary use tables for energy products had to be used, as already pointed out. The calculations based on energy accounts/preliminary energy tables also need to be complemented, using a number of other data sources.

Emission factors play a very important role in the emissions calculations. In Sweden the Swedish EPA are responsible for producing relevant factors each year.

The most important point source emissions are estimated yearly in individual *environmental reports*. More than one hundred of the largest point sources, referred to as ”A enterprises”, are requested to send those reports to the Swedish EPA, where they are analysed by industry experts who present summary data on so-called ”process emissions”. Such data are used in statistics on SO_2 and NO_x, but they are not used to compute statistics on CO_2 emissions, since the environmental reports not always include data for CO_2.

The Swedish EPA is also responsible for estimating emissions from mobile sources. This work is largely based on model calculations, some of which are performed at Statistics Sweden.

3.2 Methods of computation

The different data sources mentioned above are normally not all used to calculate the energy consumption and emissions for different industries, government and households within the environmental accounts. Normally, the environmental accounts can use the energy accounts produced at the national accounts as a starting point. In this project, however, efforts had to be made to construct preliminary energy accounts, using a new method of computation. This is described in section 3.2.1 below.

For the emission calculations, the methods for combining data from the data sources described above vary between different emitted substances. Some emissions, for example CO_2, depend *only* on the elemental mixture of the fuel, but not on combustion technique, end of pipe equipment and so on. These emissions may be computed quite straightforwardly from the energy consumption. In other cases, like NO_x and SO_2, emission factors depend more on those other circumstances, and more complex computing models are used in order to take account of those factors. Some further details will be mentioned in section 3.2.2 below.

3.2.1 Energy consumption

When the calculations started, the national accounts were able to provide preliminary energy accounts data regarding the energy and manufacturing industries for 1994 and 1995. Naturally these have been used for the present compilation, even if some adjustments to the data were necessary. The introduction of new model computations has thus been restricted to the other industries. Also, a computation model was set up for calculating preliminary energy accounts data for 1996. Due to lack of necessary source statistics (se section 1.2 above) it was never possible to use this model. However, the suggested method is presented in section c) below.

a) Energy and manufacturing industries 1994 and 1995
The statistics on use of fuels for energy purposes is mainly based on the data given in the energy accounts, by summing the products of used amounts times energy content (information on constants used in the computations are given in Appendix B). The most important exceptions to this rule are described below.

In order to avoid double-counting in energy processes some conventions are used for the most energy intensive industries:

Steel industry
Most of the coal which is used in Sweden is used in this industry, chiefly for the purpose of producing coke, although some coke is also bought by this industry. The coke, in turn, is used in the steel processes, yielding coke gas and LD gas as by-products. These are to some extent used within steel industry but part of it is sold to the energy industry.

The principle for calculating the net energy use in steel production is to try to account for it in that production phase where the combustion takes place. Thus coal used for coke production is *not* counted as combustion, and a reduction is also made in the coke consumption. Instead no reductions are made in the energy contents of the (self-produced) gasses.

Oil refineries
Combustion is assumed to consist of around half a million tons of heavy fuel oil (and some negligible amounts of other fuels.) This figure stems from information on fuel ”used in the refining processes”. There are five refineries in Sweden.

Pulp and paper industry
As mentioned earlier, the consumption of sulphite and sulphate lyes has been assumed to be constant since 1993.

b) Computations for other industries 1994 and 1995
Since these parts of the input matrices had not been computed in the preliminary energy accounts, preliminary statistics has been produced, roughly according to the following principles.

- For petrol and diesel the shares among industries are assumed to be constant since 1993. The totals are taken from supplier statistics.
- Some of the industry categories can be found in the Yearly Energy Balance Sheets, notably Agriculture, Forestry, Fishing and Private consumption. In those cases remaining data have been taken from this source.
- For stationary fuels in the service industries, the change of consumption since 1993 has been assumed to equal that of value added in the national accounts.
- For Governmental Services, the same assumption has been made for some of the fuels, whereas for others the relative change has been assumed to equal that of the relative share in a corresponding category in the suppliers statistics.

A picture of the computation scheme is shown in figure 13.

Figure 13. Computations of energy consumption for other industries concerning 1994 and 1995

	Fuel oil 1	Fuel oil 2-5	Wood fuel	Pro-pane	Other gas	Coal	Petrol	Diesel
Agriculture	EBS	EBS	EBS	EBS	EBS	EBS	SS1	SS1
Forestry	EBS	EBS	0	0	0	0	SS1	SS1
Fishing	EBS	0	0	0	0	0	SS1	SS1
Service industries	NA	NA	NA	NA	NA	NA	SS1	SS1
Private consumption	EBS	EBS	EBS	0	EBS	0	SS1	SS1
Governmental services	SS2	SS2	NA	SS2	NA	NA	SS1	SS1

Explanations:

EBS: Statistics for 1994 and 1995 taken from the Yearly Energy Balance Sheets[9].

SS1: The relative shares among industries are assumed to be constant since 1993. Totals are taken from the suppliers statistics[10].

SS2: The relative change since 1993 is assumed to be the same as that of the category ”Public services, other (than energy)” in the suppliers statistics[11].

NA: The relative change since 1993 is assumed to be the same as that of value added (producers price in the value of 1991) as given in the National Accounts Statistics[12].

[9] Statistics Sweden (1997b)
[10] Statistics Sweden (1998c)
[11] Statistics Sweden (1998c)
[12] Statistics Sweden (1997c)

c) Computation model for all industries 1996, not used

The trials to ”predict” energy account data from data available at earlier times started by assembling and comparing data from several statistical sources. The most important ones were (letters and numbers refer to internal abbreviations used at Statistics Sweden):
E11: (Definite) statistics on production and distribution of electricity, district heating and gas (which also contains information on fuels used) [13].
E31: Statistics on the use of fuels in industry (NACE 10-40, based on sampling)[14].
IS: Statistics on the use of fuels in the manufacturing industry, an (almost) complete census. [15]

In addition to these sources one can also compare with energy balances, preliminary and definitive.

We found quite many differences between these sources. After discussions with the producers of the energy accounts the following strategy was recommended:

- NACE 10-37: use IS for fossil fuels and E31 for biological fuels.
- For heating oil, add a certain contribution for enterprises with fewer than 20 employees (these are excluded from the manufacturing industry survey, and their consumption of other fuels than oil is considered to be negligible).
- NACE 40: Use E11 for all fuels.
- In the remaining part of the table, use the methods mentioned in section b).
- For petrol and diesel a methodology like NA described in section 3.2.1.b was proposed.

3.2.2 Emissions

Carbon dioxide

These emissions are closely related to the energy accounts. The standard method for computing combustion emissions is to multiply the consumption of each fuel by the corresponding average coal concentration (actually this concentration is first computed as energy content times emission factor, see Annex B). There are a couple of exceptions to this general rule. Within steel industry CO_2 emissions are computed from the net consumption of energy which was described earlier. However, some extra gas amounts (representing losses) are added.

Process emissions are also added, stemming from a few industrial processes, chiefly the use of $CaCO_3$ in industry. Most of these are attributed to cement industry, but some amounts are also used in other industries, for example glass industry. Another source for process emissions emanates from the use of coal electrodes in electro-metallurgical processes. Furthermore, around 1 million tons of CO_2 is attributed to the chemical industry for their use of propane.

[13] Statistics Sweden (1997d)
[14] Statistics Sweden (1998c)
[15] Statistics Sweden (1996b)

Sulphur dioxide and nitrogen oxide

Stationary sources

Here emission estimates for various processes are delivered from the Swedish EPA for around 100 large point sources. These emissions are classified as ”process emissions” and make up one part of the total emissions.

For the corresponding industries model assumptions are used to calculate the fuel amount not used for the processes and standard emission factors are applied to these reduced amounts. The reduction rules are as follows:

- No further emission stemming from combustion of gas from the coke and steel processes is assumed to exist within any industry. The same assumption is made for coal and coke within the metal and manufacturing industries.
- For the pulp and paper industry some further emissions are assumed to take place; the total fuel consumption is reduced by standard amounts related to the production and standard emission factors are applied to the reduced amounts of five fuel types.

For the remaining industries and fuels, emissions are estimated by multiplying the fuel consumption by appropriate emission factors. These may vary between industries. They are shown in Appendix B.

Emissions from mobile sources

In a former report *Disaggregation and improvement of the Swedish NAMEA*[16] these were called ”not fuel-related” and were described in quite great detail in Section 4.3.2. The first steps in the calculations for road traffic are made by a model developed by the Swedish Road and Transport Research Institute, VTI, and produces summary emissions for various types of road vehicles.

The step of dividing those totals between industries has been performed at Statistics Sweden, using statistics on traffic work as a distribution key. More details on the principles can be found in the paper mentioned. In the paper it was mentioned that the sulphur content in bunker oil is quite uncertain (p. 13). This also applies to the present statistics.

Carbon oxide, methane, nitrous oxide and ammonia

For methane and NH_3, agriculture is the dominating source. Emissions have been estimated in connection with the Swedish survey of manure handling. A small amount of NH_3 has also been attributed to Private consumption for pet animals.

For CO and N_2O some process emissions are reported by the Swedish EPA. These have been attributed to the chemical industry. Emissions from stationary combustion have been estimated with fuel consumption computed in a similar way as for CO_2 and with emission factors according to Appendix B.

[16] Statistics Sweden (1997a).

Emissions from mobile sources play a dominant role for CO and are important also for N_2O. Total estimates of these have been made by the Swedish EPA for each of five categories of vehicles. These totals have been distributed over the industries by Statistics Sweden, using similar principles as for NO_x emissions. Statistics on traffic work and ownership of vehicles have been used as distribution keys.

The methods used for calculation of CO, CH_4, N_2O and NH_3, and the distribution to NACE categories are documented[17].

3.3 Some experiences

One might say that our work has suffered *partly from lack of data* and *partly from abundance of data*. The statistical system for energy statistics is quite tricky. Preliminary statistics are regularly revised as results from more extensive surveys become available and comparisons are made by analysts. In fact, one may get the impression that even historical energy and emission statistics never come to piece; they seem to remain alive.

Of course this presents problems to students of time series, since differences caused by real changes in the underlying real world may be hard to distinguish from differences caused by variations in the statistical computing processes. This danger gets more accentuated when the statistics are disaggregated and when methods get more complicated.

[17] Statistics Sweden (1998b)

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Statistics Sweden (1998c), Fuels. Deliveries and consumption of fuels during 4th quarter 1997 and during 1997, E 31 SM 9801. (In Swedish)

Appendix A Industry classification used in this report

The Swedish system SNI-92 is equal to NACE up to the fourth digit.
Non-standard from an international point of view are the groups 12 and, as a consequence 16. This is due to a Swedish tradition of accounting jointly for all water treatment, drinking water as well as waste water).

Group Nr	SNI-92	SNI-69	Activity title (short)	Activity title (longer)
1	01	11	Agriculture	Agriculture, hunting and related service activities
2	02	12	Forestry	Forestry, logging and related service activities
3	05	13	Fishing	Fishing
4	10-14	2	Mining and quarrying	Mining and quarrying
5	15-20,26	31-33, 36	Food, textile, wood, mineral products	Manufacture of food, beverages, tobacco, textile, wood products and non-metallic mineral products
6	21-22	34	Pulp, paper and paper products, printing	Manufacture of pulp, paper and paper products; publishing and printing
7	24-25	35 (excl. 353)	Chemicals, plastics	Manufacture of chemicals and chemical products, except petroleum refining
8	23	353	Petroleum refineries	Manufacture of refined petroleum products
9	27	37	Iron and steel etc.	Manufacture of iron and steel etc.
10	28-39	38,39	Machinery and equipment	Manufacturing of machinery and equipment
11	40	41	Electricity, gas and district heating	Electricity, gas and district heating
12	41+90001	42, 92001	Water and wastewater treatment	Water and wastewater treatment
13	45	5	Construction	Construction
14	60-63	71	Transport	Transport
15	70	83	Dwellings and premises	Dwellings and premises
16	remaining	6, 72, 8	Trade and services	Trade and services
17		(excl. 83), 9	Governmental services	
18		(excl. 92001)	Private consumption	

With some exceptions (Table 2) compilation of statistics referring to the years up to 1993 have been based on SNI-69. The two classification columns above provide only an *approximate* key between the two classifications.

Appendix B: Emission factors 1990--1997 (gram CO / MJ)

Fuel Type	Industry	Residential*	Distr. Heating	Electricity	Thermal value GJ/unit
Residual fuel oil (Eo 1)	0,02	0,05	0,02	0,01	35,59
Residual fuel oil (Eo 2-5	0,025	0,075	0,025	0,01	38,94
Propane	0,01	0,01	0,01	0,01	46,05
Gas works gas	0,01	0,01	0,01	0,01	16,75
Natural gas	0,01	0,025	0,01	0,01	38,88
Coke oven gas	0,01	0,01	0,01	0,01	16,75
Blast furnace gas	0,01	0,01	0,01	0,01	3,35
LD gas	0,01	0,01	0,01	0,01	8,37
Coal	0,05	0,05	0,04	0,04	26,5
Coke	0,05	0,05	0,04	0,04	28,05
Wood/wood waste	0,15	3	0,15	0,15	41,87
Peat	0,1	0	0,15	0,15	41,87
Municipal Solid Waste	0,15	0	0,05	0,05	41,87
Black liquor	0,15	0	0	0	41,87
Tall oil	0,025	0,075	0,025	0,025	38,94
Other (except nuclear fu	0,01	0,01	0,01	0,01	41,87
Motor gasoline & diesel	0,02	0,05	0,02	0,02	35,59

*) Fuel consumption for residential heating includes black liquor, peat and municipal solid waste (However, wood/wood waste is most used).

Fuel consumption specifications are based on quarterly statistics from Statistics Sweden (M/EN)
Emission factors have been provided by the Swedish Environmental Protection Agency.