



Review of activity data in the Other-sector - CRF 1A2f, construction and CRF 1A4, Other

1. Pilot study

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SMED is short for Swedish Environmental Emissions Data, which is a collaboration between IVL Swedish Environmental Research Institute, SCB Statistics Sweden, SLU Swedish University of Agricultural Sciences, and SMHI Swedish Meteorological and Hydrological Institute. The work co-operation within SMED commenced during 2001 with the long-term aim of acquiring and developing expertise within emission statistics. Through a long-term contract for the Swedish Environmental Protection Agency extending until 2014, SMED is heavily involved in all work related to Sweden's international reporting obligations on emissions to air and water, waste and hazardous substances. A central objective of the SMED collaboration is to develop and operate national emission databases and offer related services to clients such as national, regional and local governmental authorities, air and water quality management districts, as well as industry. For more information visit SMED's website www.smed.se.

Summary

In Sweden's Air Emission Inventory submission 2005 to the UNFCCC, EU (Monitoring Mechanisms) and the CLRTAP, reported emissions from stationary combustion for the years 1990-2003 in CRF 1A2f (Construction) and CRF 1A4 (Other Sectors) - are based on energy statistics from Statistics Sweden.

Questions have been raised whether current methodologies for fuel consumption estimates and methods for allocating different fuels on mobile and stationary combustion are in line with the IPCC guidelines.

This study has aimed at exploring the background data, and identifying and documenting their sources and underlying models. Where time series inconsistencies have been identified, thorough investigations on reasons and consequences have been performed. Furthermore, background data has been traced back to its original sources in order to clearly distinguish stationary combustion from mobile combustion.

Results show that biomass fuel time series for several sectors are inconsistently estimated. Models used to estimate biomass fuel consumption in the Service sector (both public and private) 1990-2000 are in need of revision. Furthermore, biomass fuel in holiday cottages (Residential sector) have not been estimated for the years 1990-2000.

During the review process, it was discovered that historical activity data (before 2003) in the Inventory were not up-to-date for all years.

Investigations carried out in this project show that methodologies used for separating activity data in mobile and stationary combustion are in line with the IPCC guidelines.

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1 Introduction

1.1 Background

Sweden submits yearly compilations of air emissions to the UNFCCC, EU (Monitoring Mechanisms) and the CLRTAP. On behalf of the Swedish EPA, SMED¹ (Swedish Methodology for Environmental Data) collects background data and performs the calculations for these compilations. In Sweden's submission 2005, reported emissions from stationary combustion for the years 1990-2003 in CRF 1A2f (Construction) and CRF 1A4 ("Other Sectors" including Commercial/Institutional, Residential and Agriculture/Forestry/Fishing) – hereafter referred to as the Other-sector² - are based on energy statistics from Statistics Sweden^{3,4}. This statistics includes various background sources; monthly, quarterly, yearly and yearly intermittent surveys, which are compiled into yearly reports. The yearly reports include energy statistics with a two year lag for two subsequent years. The statistics for the latest of the two years is always preliminary, but finalized in the report in the following year.

The background activity data for the Other-sector is divided into six categories: Agriculture and Fishery, Forestry, Construction, Service (Public and Private), and Households. Each category is presented per fuel type (e.g. Coal, Biomass, etc.). In the Air Emission Inventory, it is assumed that only fuel consumption related to stationary combustion for each category should be included in the Other-sector. Reported amounts of diesel oil, gasoline, light distillates and kerosene, predominantly used in mobile sources, are therefore allocated to other reporting sectors than the "other-sector" studied here.. In order to fit the IPCC and CLRTAP source categories for reporting, activity data has been aggregated where needed.

Currently, Statistics Sweden uses models to allocate and estimate fuel consumption in some categories in the Other-sector. Questions have been raised concerning time series consistency and accuracy in these models.

IPCC guidelines call for separation of stationary and mobile combustion in the reporting of estimated emissions. Questions have also been raised concerning the accuracy in methods of agglomerating background data to IPCC codes. For example, energy statistics in the Other-sector does not distinguish clearly between stationary and mobile activities.

¹ SMED is a consortium consisting of the Swedish Environmental Research Institute, Statistics Sweden and the Swedish Metrological and Hydrological Institute.

² The Other-sector is not equal to the Other Sectors in the CRF-system.

³ Statistics Sweden. 1993, 1994, 1995, 1997, 1998, 2000, 2001, 2002a, 2004a. EN20SM. Yearly Energy Balance Sheets. Energy Statistics.

⁴ Statistics Sweden. 2004b.

1.2 Aim of project

The aim of this study has been to explore the energy statistics used as background activity data in the Air Emission Inventory in the Other-sector for the period 1990-2003 from an IPCC point of view in order to:

- Identify and document sources of all fuel consumption
- Distinguish stationary consumption from mobile consumption
- Identify and analyze methods and models used for fuel consumption allocation and estimation
- Pinpoint areas in need of corrections or improvement, and give suggestions and recommendations on how to carry out such work

It has not been within the scope of this project to perform any recalculations or develop new estimation models.

2 Method

2.1 Identification of background data

According to IPCC guidelines⁵ it is *good practice* to use fuel consumption statistics rather than delivered amounts of fuel when possible. However, since data on fuel consumption is rarely available for all categories, a mixture of consumed and delivered amounts is recommended to reach full coverage.

Relying on delivered amounts of fuels can give rise to systematic errors when allocating fuels on sub-sectors. First hand suppliers might not have the necessary information on the final user in order to make a correct classification. This could be the case with small commercial customers and households. It is recommended to use sample survey data to adjust for possible misclassifications.

In the IPCC guidelines it is also stated that there is a risk of double counting when using delivered amounts of fuels as a base for emission estimates. The delivered fuels could have been used during one stage, thus producing by-products which in turn might be used later on as fuel in other processes, e.g. blast furnace gas. This possible error is however not very likely for the activities concerned in the Other-sector.

To ensure activity data time series consistency, IPCC guidelines suggests as a Tier 1 Quality Control procedure that methodologies and data changes are checked. If any time series divergences are identified, these should, if possible, be investigated and documented. If data gaps occur or if activity data time series are incomplete, IPCC suggests that interpolation or extrapolation methods based on available and reliable data are used to ensure time series consistency. It is also recommended that, if available, multiple references sources on activity data are used to conduct comparisons in order to shed light on possible errors.

Where time series inconsistencies have been identified, thoroughly investigated and it is determined that better methodologies or activity data are available, it is recommended by IPCC that recalculations are carried out.

In this study, sources of all activity data used for emission estimates 1990-2003 have been examined by national experts on energy statistics at Statistics Sweden together with air emission inventory experts. Each figure has been traced back to its original survey. Whenever changes in survey methodology, inconsistencies in specific fuel type time series, or between categories have been discovered, data has been thoroughly examined.

In order to establish good understanding and credibility for variations in fuel consumption in the Other-sector over the years 1990-2003, parallel comparisons of variations in energy statistics on national level, and variations in ambient temperature and fuel prices have been performed.

⁵ IPCC. 2000.

2.2 Mobile or stationary activity?

IPCC guidelines addresses the difficulty in separating stationary and mobile combustion in some source categories (e.g. in Agriculture). It is *good practice* to use indirect sources of information, such as number of pumps, machinery or average consumption, etc., to make necessary assumptions to enable separation between stationary and mobile sources.

In this project, we have investigated how different fuels in the energy statistics have been assigned to different categories, whether they originate from available information specifying mobile or stationary combustion, or if assumptions were made in order to carry out a separation. This was done by selecting those fuels where possible misallocation could occur, e.g. different fuels in Agriculture and Fishery, as well as oils used for heating in households and premises. By tracing each activity data back to its survey result, we could determine its original classification.

2.3 Models and assumptions for fuel consumption estimation

To shed some light on the relevance and accuracy of assumptions and models used for fuel consumption estimations, we have investigated when the models were implemented in the energy statistics, on what basis it was done, and if any verification has been performed. Results and analyses are given in the following chapters.

3 Results

3.1 Energy carriers and sectors

Time series of background activity data used in the Air Emission Inventory 1990-2003 for submission 2005 are given for all fuels and all sectors in Appendix I. For 1990-2002 they are collected from Yearly Energy Balance Sheets⁶, whereas data for 2003 is based on compiled preliminary quarterly statistics⁷. There is a well-known discrepancy in data between the quarterly statistics and the Yearly Energy Balance Sheets, which has not been reviewed in this project.

The following chapter presents tables for each energy carrier per sector (sectors are ordered according to their appearances in the Yearly Energy Balance Sheets), showing data sources, if any changes in methodologies have occurred in the time period 1990-2003, and possible explanations for any inconsistencies in activity data time series.

Note that fuel consumption in Gardening is included in the Agriculture sub-sector in the energy statistics.

⁶ Statistics Sweden. 1993, 1994, 1995, 1997, 1998, 2000, 2001, 2002a, 2004a. EN20SM. Yearly Energy Balance Sheets. Energy Statistics.

⁷ Statistics Sweden. 2004b.

3.1.1 Hard coal and brown coal

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Intermittent surveys. For Agriculture, surveys were carried out for 1980, 1986, 1994 and 2002 ⁸ . Value added ⁹ is used to estimate the energy consumption for intermediate years. For Gardening, surveys were carried out for 1990, 93, 96, 99 and 2002 ¹⁰ . For Fishery, surveys on the fishing fleet and engine size in boats were last carried out for 2001 ¹¹ . For both Gardening and Fishery, working hours ¹² are used to estimate energy consumption for intermediate years.	--	From the year 2001 there is no consumption of coal in these sectors.
1A4c	Forestry	No energy consumption of coal fuels.	--	--
1A2f	Construction	No energy consumption of coal fuels.	--	--
1A4a	Service, Public	No energy consumption of coal fuels.	--	--
1A4a	Service, Private	Monthly oil, coal and gas survey ¹³ . Deliveries to this sector. Usually there is no energy consumption of coal fuels in this sector.	--	In 1997 and 1998 there where some energy consumption for research purposes.
1A4b	Residential	No energy consumption of coal fuels.	--	--

⁸ Statistics Sweden. J63

⁹ Statistics Sweden. 1990-2003b

¹⁰ Statistics Sweden. JO36

¹¹ National Board of Fisheries F-INFO 2002:7. Fishery census were carried out for the years 1985, 1990 and 1995 by Statistics Sweden

¹² Statistics Sweden. 1990-2003b

¹³ Statistics Sweden. 1990-2003a

3.1.2 Coke

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Intermittent surveys. For Agriculture, surveys were carried out for 1980, 1986, 1994 and 2002. Value added is used to estimate the energy consumption for intermediate years. For Gardening, surveys were carried out for 1990, 93, 96, 99 and 2002. For Fishery, surveys on the fishing fleet and engine size in boats were last carried out for 2001. For both Gardening and Fishery, working hours are used to estimate energy consumption for intermediate years.	--	After 1993 there is no coke consumption for energy purposes in these sectors.
1A4c	Forestry	No energy consumption of coke	--	--
1A2f	Construction	No energy consumption of coke	--	--
1A4a	Service, Public	No energy consumption of coke	--	--
1A4a	Service, Private	Monthly oil, coal and gas survey. Deliveries to this sector. Usually there is no energy consumption of coke in this sector.	--	In 1997 and 1998 there where some energy consumption for research purposes.
1A4b	Residential	No energy consumption of coke	--	--

3.1.3 Biomass fuel

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Intermittent surveys. For Agriculture, surveys were carried out for 1980, 1986, 1994 and 2002. Value added is used to estimate the energy consumption for intermediate years. For Gardening, surveys were carried out for 1990, 93, 96, 99 and 2002. For Fishery, surveys on the fishing fleet and engine size in boats were last carried out for 2001. For both Gardening and Fishery, working hours are used to estimate energy consumption for intermediate years.	--	--
1A4c	Forestry	No energy consumption of biomass fuel	--	--
1A2f	Construction	No energy consumption of biomass fuel	--	--
1A4a	Service, Public	Survey of energy consumption in service sector ¹⁴	From 2001, biomass fuel is included in the survey. Before 2001, biomass fuel consumption is estimated by using the number of premises with biofuel heating.	From 2001 the figures on fuel consumption are considered to be reliable. Before 2001, fuel consumption is likely to be significantly underestimated in the model ¹⁵ .
1A4a	Service, Private	Survey of energy consumption in service sector	From 2001, biomass fuel is included in the survey. Before 2001, biomass fuel consumption is estimated by using the number of premises with biofuel heating.	From 2001 the figures on fuel consumption are considered to be reliable. The decrease in fuel consumption from 2001 onwards is due to increased usage of district heating ¹⁶ . Before 2001, fuel consumption is likely to be

¹⁴ Statistics Sweden. 1991-2004b.

¹⁵ Munkhammar, Inger. 2005-02-18. Personal communication

¹⁶ Ibid.

				significantly underestimated in the model ¹⁷ .
1A4b	Residential	<p>Survey of energy consumption in multi dwelling buildings¹⁸.</p> <p>Survey of energy consumption in one- and two-dwelling buildings from 1978¹⁹.</p> <p>In 2001 a survey about energy use in holiday cottages was carried out²⁰.</p>	<p>From 2001, biomass fuel is included in the survey for multi dwelling buildings. Before 2001, biomass fuel consumption in multi dwelling buildings is estimated by number buildings with biofuel heating.</p> <p>The result from the survey on holiday cottage is used from 2000, before there were no figures for energy consumption in holiday cottages.</p>	<p>In 1994, there is a dip in fuel consumption in multi dwelling buildings, due to a switch from biomass to medium and heavy fuel oil.</p> <p>From 2001 the figures on fuel consumption in multi dwelling buildings are considered to be reliable.</p> <p>Before 2001, fuel consumption in multi dwelling buildings is likely to be overestimated in the model²¹.</p> <p>In 2001, estimated fuel consumption in holiday cottages stands for approximately 6 % of total consumption in the Residential sector.</p>

¹⁷ Ibid.

¹⁸ Statistics Sweden. 1991-2004a.

¹⁹ Statistics Sweden. 1991-2004c.

²⁰ Statistics Sweden. 2002b.

²¹ Munkhammar, Inger. 2005-02-18. Personal communication

3.1.4 Propane and butane, LPG

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Intermittent surveys. For Agriculture, surveys were carried out for 1980, 1986, 1994 and 2002. Value added is used to estimate the energy consumption for intermediate years. For Gardening, surveys were carried out for 1990, 93, 96, 99 and 2002. For Fishery, surveys on the fishing fleet and engine size in boats were last carried out for 2001. For both Gardening and Fishery, working hours are used to estimate energy consumption for intermediate years.	--	--
1A4c	Forestry	No energy consumption of LPG.	--	--
1A2f	Construction	Intermittent surveys. The last survey was carried out for 1985 ²² . Working hours are used to estimate fuel consumption for subsequent years.	--	--
1A4a	Service, Public	Monthly oil, coal and gas survey. Deliveries to this sector. Values only for the years 1990 – 1992.	--	--
1A4a	Service, Private	Monthly oil, coal and gas survey. Deliveries to this sector.	--	Rise in 2001 because of increased deliveries to this sector
1A4b	Residential	Monthly oil, coal and gas survey. Deliveries to this sector.	--	--

²² Statistics Sweden. 1986.

3.1.5 Domestic heating oil

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Intermittent surveys. For Agriculture, surveys were carried out for 1980, 1986, 1994 and 2002. Value added is used to estimate the energy consumption for intermediate years. For Gardening, surveys were carried out for 1990, 93, 96, 99 and 2002. For Fishery, surveys on the fishing fleet and engine size in boats were last carried out for 2001. For both Gardening and Fishery, working hours are used to estimate energy consumption for intermediate years.	--	--
1A4c	Forestry	Survey carried out for 1985 ²³ .	The production volume ²⁴ has been used to estimate the energy use up to year 1995 after that value added is used.	--
1A2f	Construction	Intermittent surveys. The last survey was carried out for 1985. Working hours are used to estimate fuel consumption for subsequent years.	--	--
1A4a	Service, Public	Survey of energy consumption in service sector.	--	--
1A4a	Service, Private	Survey of energy consumption in service sector.	--	--
1A4b	Residential	Survey of energy consumption in multi dwelling buildings. Survey of energy consumption in one- and two-dwelling buildings. In 2001 a survey about energy use in holiday cottages was carried out.	(Although the survey indicate that holiday cottages consume about 1 % of the total amount of domestic heating oil in the Residential sector, these figures have not been used due to high uncertainty in the results ²⁵ .)	

²³ Statistics Sweden. 1986.

²⁴ National Board of Forestry.

²⁵ Statistics Sweden. 2002b.

3.1.6 Medium and heavy fuel oil

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Intermittent surveys. For Agriculture, surveys were carried out for 1980, 1986, 1994 and 2002. Value added is used to estimate the energy consumption for intermediate years. For Gardening, surveys were carried out for 1990, 93, 96, 99 and 2002. For Fishery, surveys on the fishing fleet and engine size in boats were last carried out for 2001. For both Gardening and Fishery, working hours are used to estimate energy consumption for intermediate years.	--	--
1A4c	Forestry	Survey carried out for 1985.	The production volume has been used to estimate the energy use up to year 1995 after that value added is used.	--
1A2f	Construction	Intermittent surveys. The last survey was carried out for 1985. Working hours are used to estimate fuel consumption for subsequent years.	--	--
1A4a	Service, Public	Survey of energy consumption in service sector.	--	In the time series there is a steady decrease in the use of heavy fuel oil. The variation in the time series, up and down, can be explained by the variation in the electricity prices.
1A4a	Service, Private	Survey of energy consumption in service sector.	--	In the time series there is a steady decrease in the use of heavy fuel oil. The variation in the time series, up and down, can be explained by the variation in the electricity prices.
1A4b	Residential	Survey of energy consumption in multi dwelling buildings. In one- and two-dwelling buildings and holiday cottages there are no use of heavy fuel oil.	--	In 1994, there is a peak in fuel consumption in multi dwelling buildings, due to a switch from biomass to medium and heavy fuel oil.

3.1.7 Natural gas

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Annual survey on natural gas and gas works gas ²⁶ . Natural gas appeared from year 1985.	--	--
1A4c	Forestry	No consumption of natural gas in this sector.	--	--
1A2f	Construction	Annual survey on natural gas and gas works gas. Natural gas appeared from year 1985.	--	A rise is appearing in the use from year 2002 due to expansion in the natural gas net
1A4a	Service, Public	Annual survey on natural gas and gas works gas. Natural gas appeared from year 1985.	--	--
1A4a	Service, Private	Annual survey on natural gas and gas works gas. Natural gas appeared from year 1985.	--	From year 2002 there is a shift shown in the use between this sector and the residential sector. This is due to a correction in the data reporting from earlier misallocation
1A4b	Residential	Annual survey on natural gas and gas works gas. Natural gas appeared from year 1985.	--	From year 2002 there is a shift shown in the use between this sector and service sector (private). This is due to a correction in the data reporting from earlier misallocation

3.1.8 Gas works gas

<i>CRF code</i>	<i>Sector</i>	<i>Source</i>	<i>Changes in methodology</i>	<i>Inconsistencies in times series</i>
1A4c	Agriculture and Fishery	Annual survey on natural gas and gas works gas.	--	--
1A4c	Forestry	Annual survey on natural gas and gas works gas.	--	--
1A2f	Construction	Annual survey on natural gas and gas works gas.	--	--
1A4a	Service, Public	Annual survey on natural gas and gas works gas.	--	--
1A4a	Service, Private	Annual survey on natural gas and gas works gas.	--	--
1A4b	Residential	Annual survey on natural gas and gas works gas.	--	--

²⁶ Statistics Sweden. 1991-2004d.

3.2 Differences between energy statistics and activity data used in the Air Emission Inventory

During the review process, it came to our attention that historical activity data (before 2003) in the Inventory were not all in line with the final annual energy statistics. It was obvious that activity data for several years in the Inventory was based on preliminary reports on energy statistics. Table 3.2.1 shows the discrepancies discovered when comparing activity data for the two (final energy statistics minus Inventory statistics). It seems that most of the differences between the final and the preliminary statistics lie in how the fuel amounts have been allocated to different sectors. However, for some fuels the differences in total amounts for the whole Other-sector are considerable.

Table 3.2.1. Differences in fuel amounts used in the Air Emission Inventory and final annual energy statistics for the years 1993, 1998-2000 (final energy statistics minus Inventory statistics).

Year	Sector	Hard coal and Brown coal (tonnes)	Biomass (toe)	Propane and Butane, LPG (tonnes)	Domestic heating oil (m3)	Medium and heavy fuel oil (m3)	Natural gas (1000 m3)	Gas works gas (1000 m3)
1993	Agriculture and Fishery	-4 000	-3 000		25 000			
	Construction				5 000	1 000		
	Service, Public				-9 000	9 000		
	Service, Private			5 000	-38 000	-11 000		
	Residential		-7 000		21 000	1 000	1 000	
	Total	-4 000	-10 000	5 000	4 000	0	1 000	
1998	Agriculture and Fishery				19 000	-19 000	1 300	
	Service, Public				26 000	6 000	961	-1 000
	Service, Private			5 000	-54 000	2 000	-2 361	
	Residential			2 000	10 000	-3 000		
Total			7 000	1 000	-14 000	-100	-1 000	
1999	Agriculture and Fishery	2 000					2 000	
	Construction				3 000			
	Service, Public				-20 000		1 000	1 000
	Service, Private				-4 000		-1 000	-1 000
	Residential			1 000				
Total	2 000		1 000	-21 000		2 000	0	
2000	Residential				45 000	11 000		
	Total				45 000	11 000		

Table 3.2.2 shows CO₂-emissions on total Other-sector level based on both final and preliminary energy statistics, and also what effect a transfer of data sources to the final updated statistics would have on the overall level and per fuel category. Implications on emission level for other parameters than CO₂ have not been estimated in this report. Note that Biomass is not included in Table 3.2.2 since it is not a fossil fuel.

Table 3.2.2. Estimated emissions of CO₂ (Gg) on total level and per fuel category using in final or preliminary energy statistics, and the difference between the two.

Year	Source	Hard coal and Brown coal (Gg CO ₂)	Coke (Gg CO ₂)	Propane and Butane, LPG (Gg CO ₂)	Domestic heating oil (Gg CO ₂)	Medium and heavy fuel oil (Gg CO ₂)	Natural gas (Gg CO ₂)	Gas works gas (Gg CO ₂)	Total Other-sector (Gg CO ₂)
1993	Final energy statistics	30	6	96	7,254	724	265	87	8,461
	Preliminary energy statistics	39	6	81	7,243	724	263	87	8,443
	Difference	-25%	0%	19%	0%	0%	1%	0%	0.2%
1998	Final energy statistics	5	3	108	6,341	300	306	126	7,188
	Preliminary energy statistics	5	3	87	6,339	340	306	127	7,207
	Difference	0%	0%	24%	0%	-12%	0%	-1%	-0.3%
1999	Final energy statistics	5	0	132	5,908	259	320	118	6,742
	Preliminary energy statistics	0	0	129	5,964	259	316	118	6,786
	Difference	-	-	2%	-1%	0%	1%	0%	-0.6%
2000	Final energy statistics	5	0	138	5,855	230	295	108	6,630
	Preliminary energy statistics	5	0	138	5,735	198	295	108	6,478
	Difference	0%	-	0%	2%	16%	0%	0%	2.3%

3.3 Mobile and stationary allocation

When investigating the origin of fuels in different sectors, whether they are used for mobile or stationary consumption, we came across a few interesting observations where possible misallocation might have been occurring. We were suspecting that diesel oil could have been used for heating in multi dwelling buildings. However, the questionnaires sent to respondents are not separating diesel oil and domestic heating oil; only the latter oil can be reported. No diesel oil is therefore reported for stationary combustion in multi dwelling buildings in the energy statistics.

Another issue that was investigated was whether any domestic heating oil, or medium or heavy oil reported in the Agriculture and Fishery sector were consumed in mobile sources. The results from the surveys on the number of fishing boats and on engine sizes show that only diesel oil has been used²⁷. In the Agriculture sub-sector, survey results separate diesel oil as mobile usage and domestic heating oil as stationary usage. This indicates that both

²⁷ National Board of Fisheries F-INFO 2002:7. Fishery census were carried out for the years 1985, 1990 and 1995 by Statistics Sweden

domestic heating oil and medium or heavy fuel oil are correctly allocated only to consumption in stationary sources, and that these fuels are not used in mobile sources.

3.4 Models and assumptions for fuel consumption estimation

Models used in biomass fuel consumption estimations have been addressed in chapter 3.1.3 where it is obvious that some of them have tended to give incorrect estimations, e.g. using number of premises with biofuel heating in the Service sector led to significant underestimations for the years 1990-2000.

Fuel consumption for Agriculture and Gardening are surveyed intermittently and to estimate the fuel consumption for the intermediate years, yearly changes in value added and working hours respectively for the sector are used²⁸. Comparisons have been made between the survey results and the estimations, verifying that the estimations are good approximations for fuel consumption.

When it comes to modeled fuel consumption in Forestry and Construction, estimations are based on a survey carried out for 1985²⁹. For Forestry, variation in production volume³⁰ has been used to estimate the energy use up to year 1995 and after that, the annual change in value added for the sector has been applied. For Construction, working hours have been used to estimate the fuel consumption for all years 1990-2003. These models gave good approximations at the time of introduction. However, they have not been possible to validate with up-to-date fuel consumption data.

For Fishery, results from fishery census 1990 and 1995, and surveys on the fishing fleet and engine size in boats, carried out for 2001³¹, have been used to estimate fuel consumption for those years. For the missing years during the period 1990-2003, fuel consumption have been estimated using the yearly change in working hours for the sector. Comparison of survey results and model estimation for 2001 shows good agreement.

²⁸ Statistics Sweden. 1990-2003b.

²⁹ Statistics Sweden. 1986.

³⁰ National Board of Forestry.

³¹ National Board of Fisheries F-INFO 2002:7. Fishery census were carried out for the years 1985, 1990 and 1995 by Statistics Sweden

4 Analysis and discussion

The results shown in chapter 3.1 indicate few changes in survey methodologies for the different fuels over the time span 1990-2003. Where changes have occurred, no significant inconsistencies in the time series have been observed, except for biomass fuel.

Starting with the reference year 2001, biomass consumption was included in the surveys for the Service sector (both public and private) and the multi dwelling buildings (Residential sector). In addition, a survey of biomass consumption in holiday cottages was carried out for 2001, and the results have been used for estimating their consumption from 2000 and onwards. For holiday cottages, no estimations of biomass fuel consumption have been made for the years before 2000. Before 2001, no biomass fuel consumption from surveys was available in the Service sector and for multi dwelling buildings, and thus estimates are based on models.

When comparing biomass fuel consumption for the Service sector (both official and private parts) it was obvious that estimation models covering the years before 2001 result in significant underestimations. It is believed that good quality background information from the major respondents in the surveys are available for the years 1990-2000, enabling revisions of the activity data time series in the Service sector (both public and private)³².

Estimated biomass fuel consumption in multi dwelling buildings 1990-2000 are likely to be overestimated. For example, in 2000 the fuel consumption was estimated to be 1,800 TJ, whereas the survey for 2001 resulted in only just above 780 TJ³³. However, little information is available to ensure more correct estimations³⁴, and since the marginal differences in consumption between 2000 and 2001 is relatively small, recalculation of the time series before 2001 should therefore not be considered to be good practise.

Consumed amounts of biomass in holiday cottages for 2000 onwards were estimated to be approximately 6 % of the total consumption of biomass in the Residential sector. Since no amounts were assigned to holiday cottages in previous years, it is believed that the consumption for the whole sector is significantly underestimated. Based on a survey of biomass consumption in holiday cottages for 1976 and information on number of cottages 1990-1995, we believe that a revision of biomass consumption in holiday cottages 1990-1999 could yield good approximations³⁵.

It is proposed by the IPCC guidelines that cross-checking references should be used to ensure the activity data time series. We suggest that further investigations are carried out on how production volumes and production capacities for biomass fuels on national level could be used for such purposes.

When it comes to observed inconsistencies in the time series due to other circumstances than changes in methodology, we were able to find plausible explanations for all of them. However, between 2001 and 2002 there is a shift in the fuel consumption of natural gas in

³² Munkhammar, Inger. 2005-02-18. Personal communication

³³ As a comparison, the total energy consumption in the Residential sector in 2001 was estimated to be about 36,000 TJ

³⁴ Munkhammar, Inger. 2005-02-18. Personal communication

³⁵ Ibid.

the Service sector (private) and the Residential sector. The reason for this is that data reporters have adjusted their way of responding in the survey questionnaire, correcting earlier misclassification. Despite the observed incorrectness for the before 2002, there is not enough information available to make reliable assumptions for recalculations. To assume that the same quota could be valid for all years 1990-2001 will not improve the quality of the estimated amounts.

In the Air Emission Inventory submission 2005, it has been assumed that all diesel oil (except for the amounts used by stationary combustion in Industry) and all gasoline have been used in mobile combustion. This study shows that this was a correct assumption, thus we recommend that activity data taken from the energy statistics is split between stationary and mobile combustion using the same assumptions as already used.

During the review process we discovered that activity data in the Air Emission Inventory for several years – 1993, 1998, 1999 and 2000 - were not in coherency with the final annual energy statistics. The statistics turned out to be taken from the preliminary reports for these years. Table 3.2.1 in chapter 3.2 displays the differences between the final and the preliminary statistics. The implications on CO₂-emission levels due to updated activity data are elucidated in Table 3.2.2. The biggest change was for 2000, where the emission level of CO₂ for the whole Other-sector is estimated to increase with 2.3%. We recommend that updated activity data on fuel consumption for 1993 and 1998-2000 will be used for Sweden's AEI submission 2006.

Models used and assumptions made in the energy statistics proved to be of different quality. Some models for estimating biomass fuel have resulted in incorrect estimations when compared to survey results, as apparent from the discussions above. For models in Agriculture, Gardening and Fishery, information on value added and working hours have proven to give good approximations on fuel consumption. Models on fuel consumption in Forestry and Construction have not been possible to verify due to lack of relevant data.

4.1 Conclusions and recommendations

To ensure time series consistency in accordance with IPCC guidelines and that the best available updated statistics are being used in the Air Emission Inventory, we recommend the following recalculations of activity data:

- Biomass fuel in the Service sector (both public and private) for the years 1990-2000
- Biomass fuel in the Residential sector, in terms of holiday cottages 1990-2000
- Updating preliminary annual energy statistics with final annual energy statistics for the years 1993 and 1998-2000

Furthermore, since historical activity data on biomass fuels are unreliable, we suggest that it should be investigated if cross-checking comparisons with other statistics on production volumes and capacities on national level could be performed.

We also recommend to keep existing methodologies when separating activity data for stationary and mobile combustion.

4.2 Future improvements.

In 2005, a survey on fuel consumption in the Construction sector will be carried out by Statistics Sweden on behalf of the Swedish Energy Agency. This will provide a good checkpoint for model estimates for the sector.

As for the Construction sector, we see a need for further checkpoints for fuel consumption also in the Forestry and Fishery sectors. Intermittent surveys would give useful information and permit validation of existing models. Possibilities to verify activity data in the energy statistics will also decrease uncertainty in activity data in the Air Emission Inventory. We would also like to address the importance of continuously carrying out intermittent surveys in Gardening and Agriculture in order to assess the quality in background data for these sectors.

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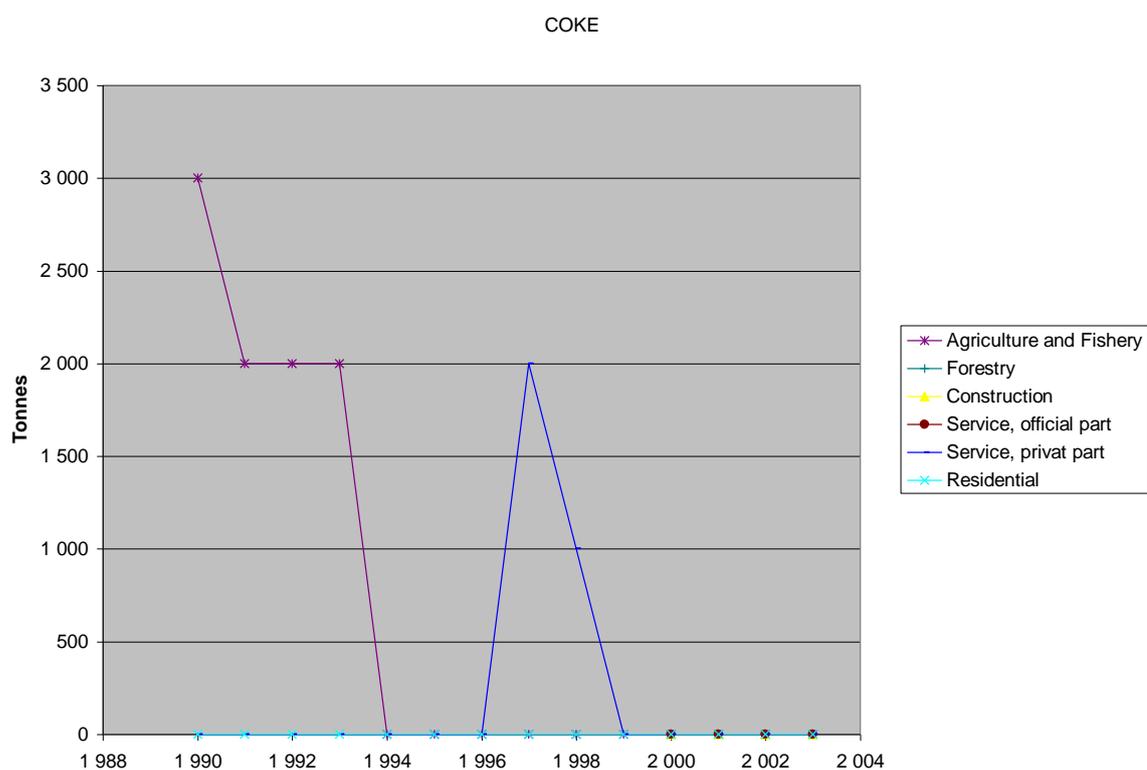
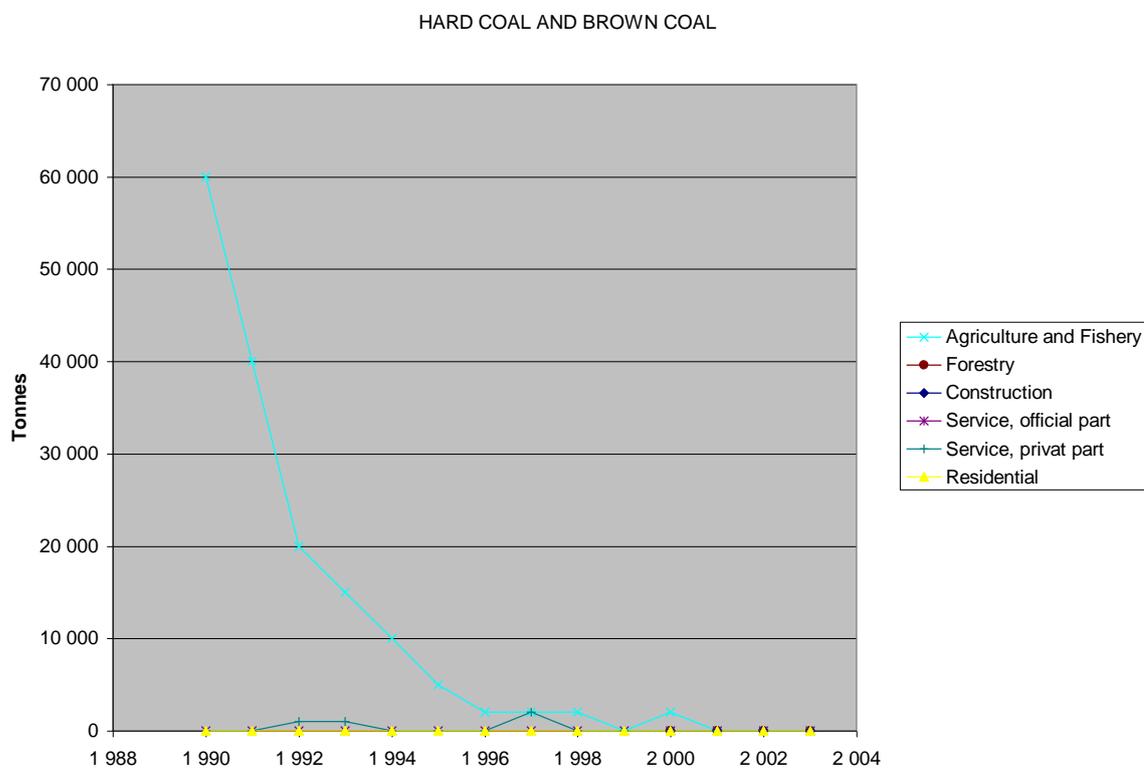
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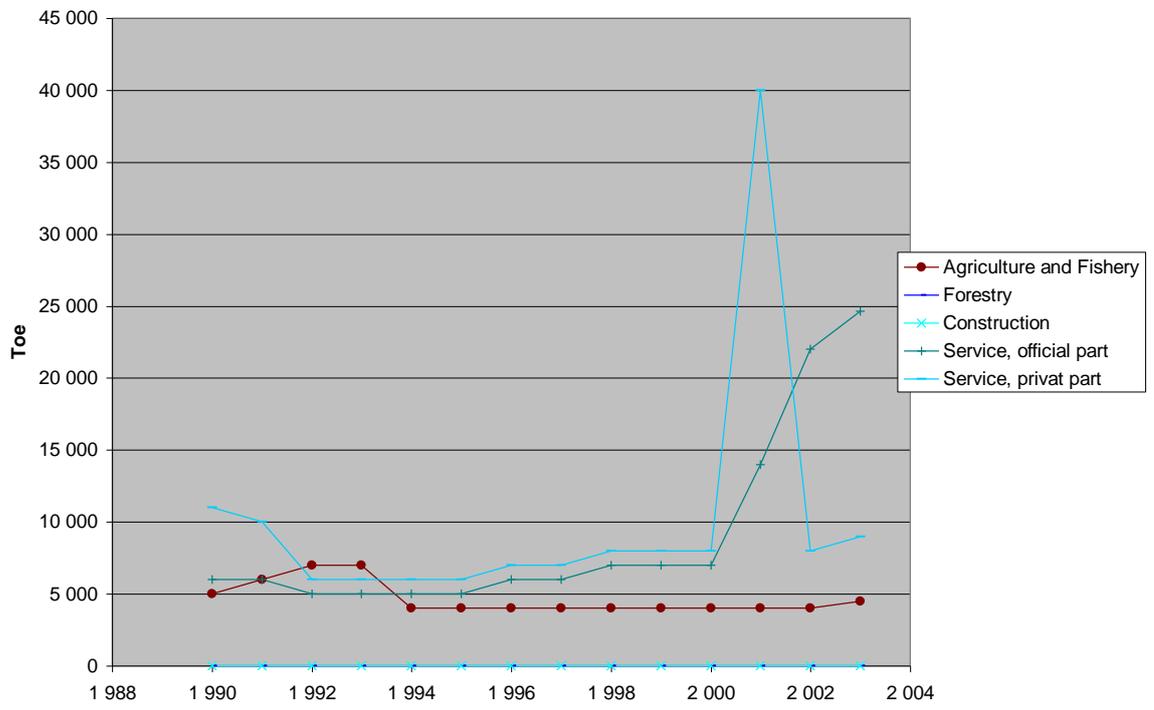
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APPENDIX I

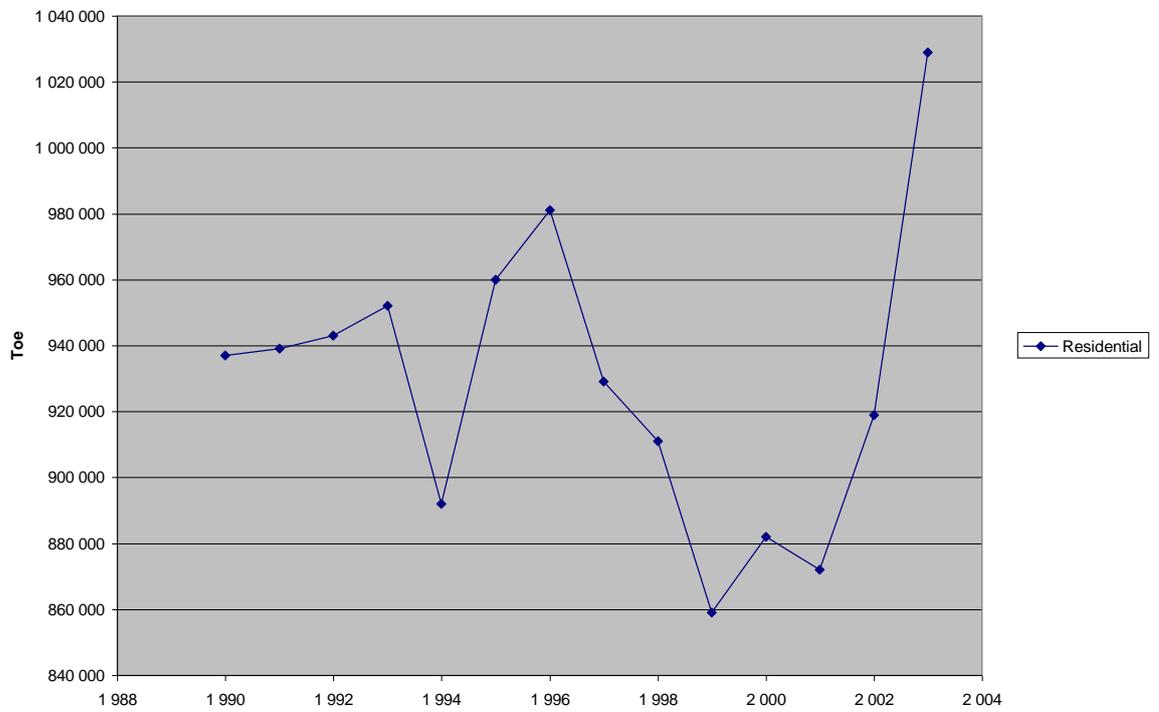
Time series of background activity data used in the Air Emission Inventory 1990-2003 for submission 2005.



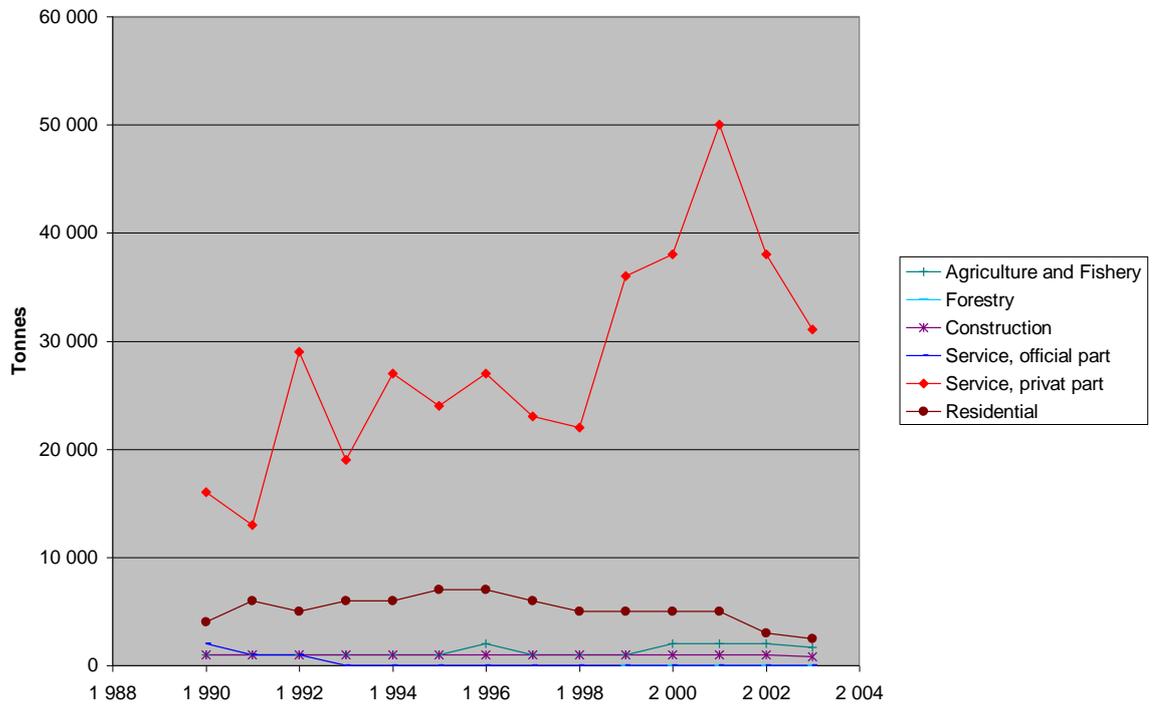
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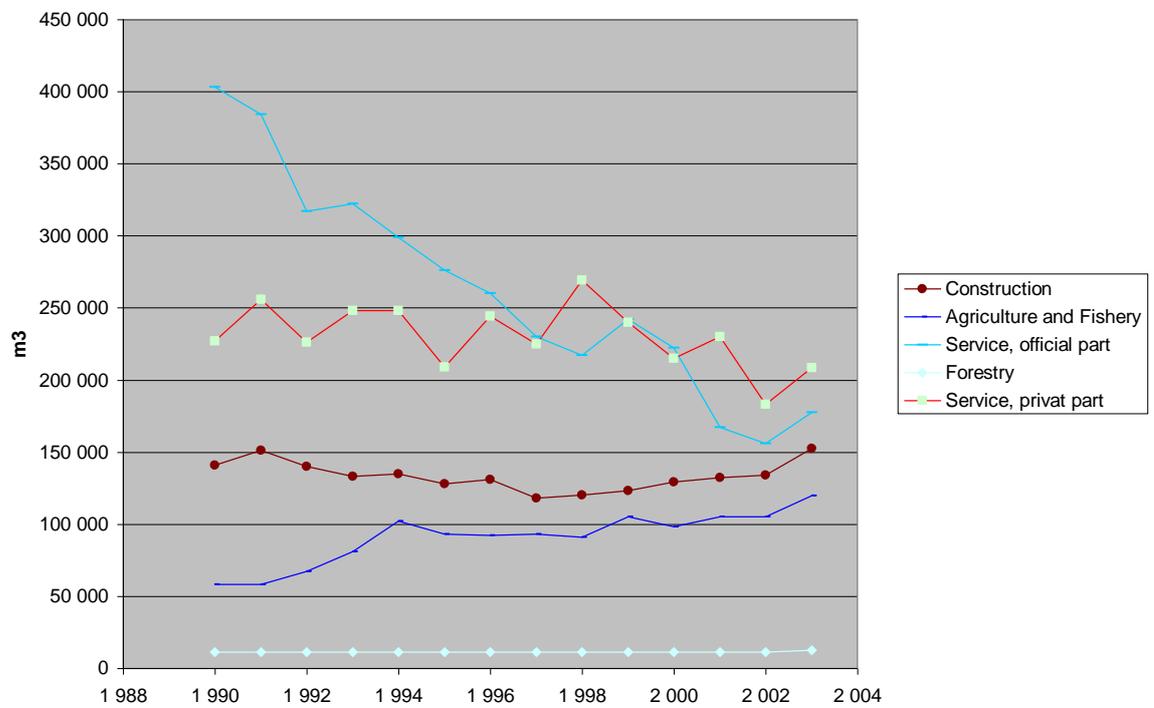
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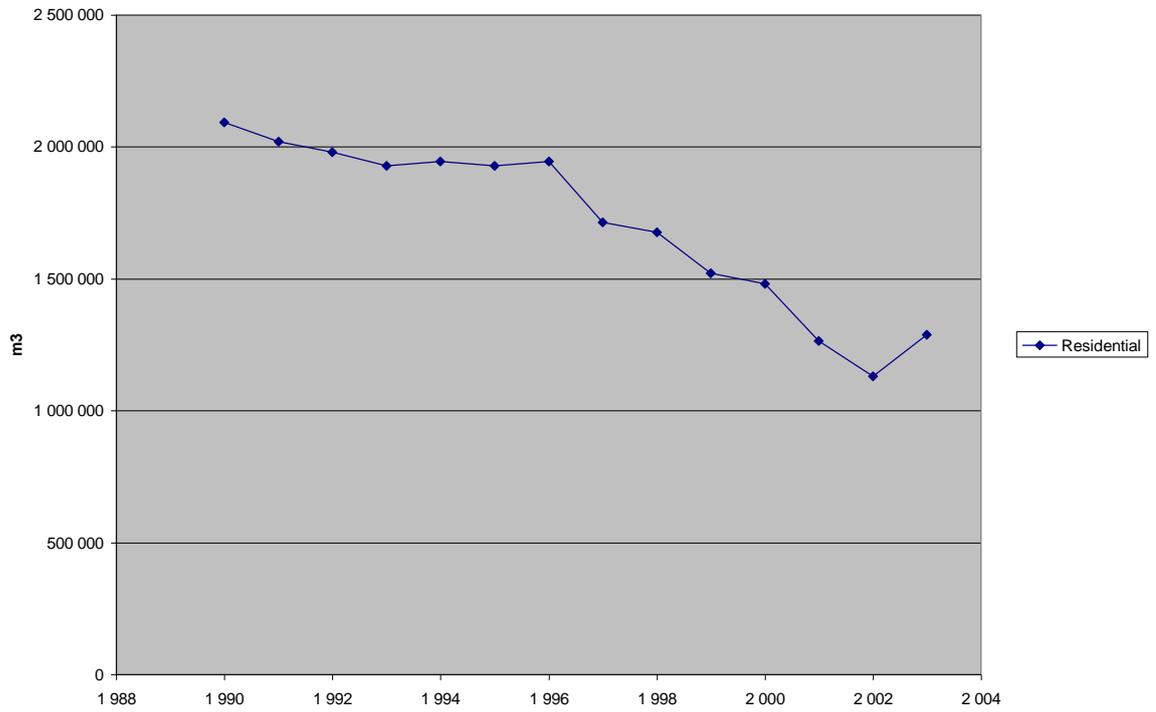
PROPANE AND BUTAN, LPG



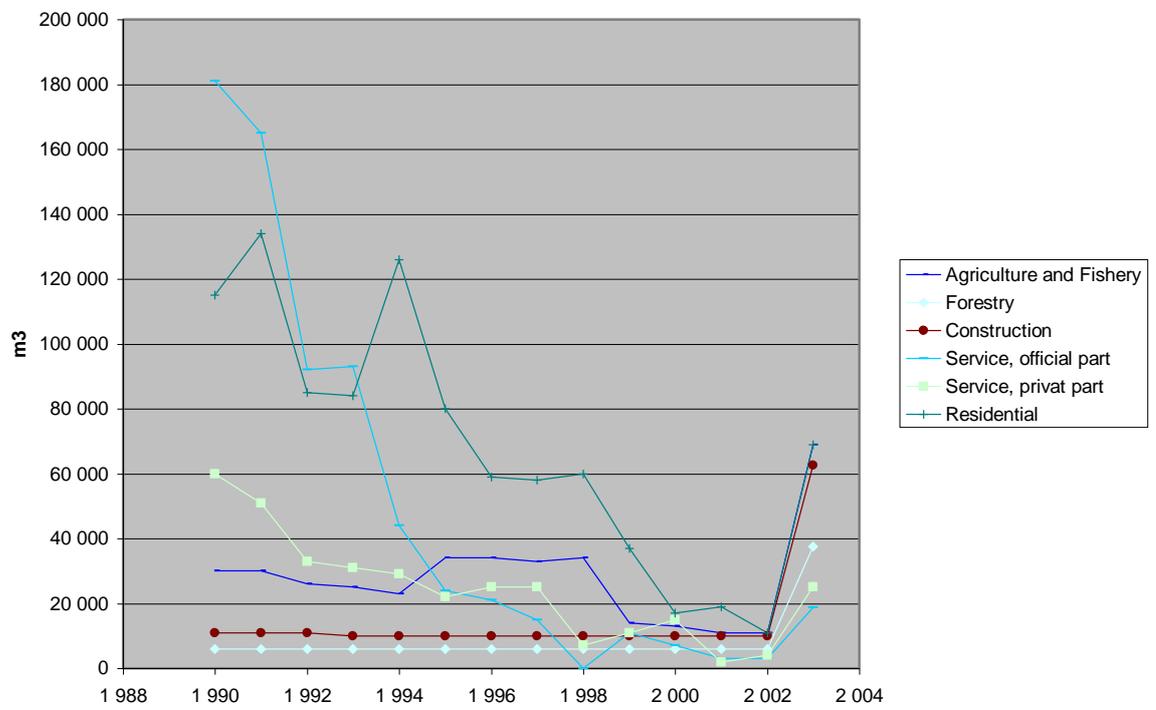
DOMESTIC HEATING OIL



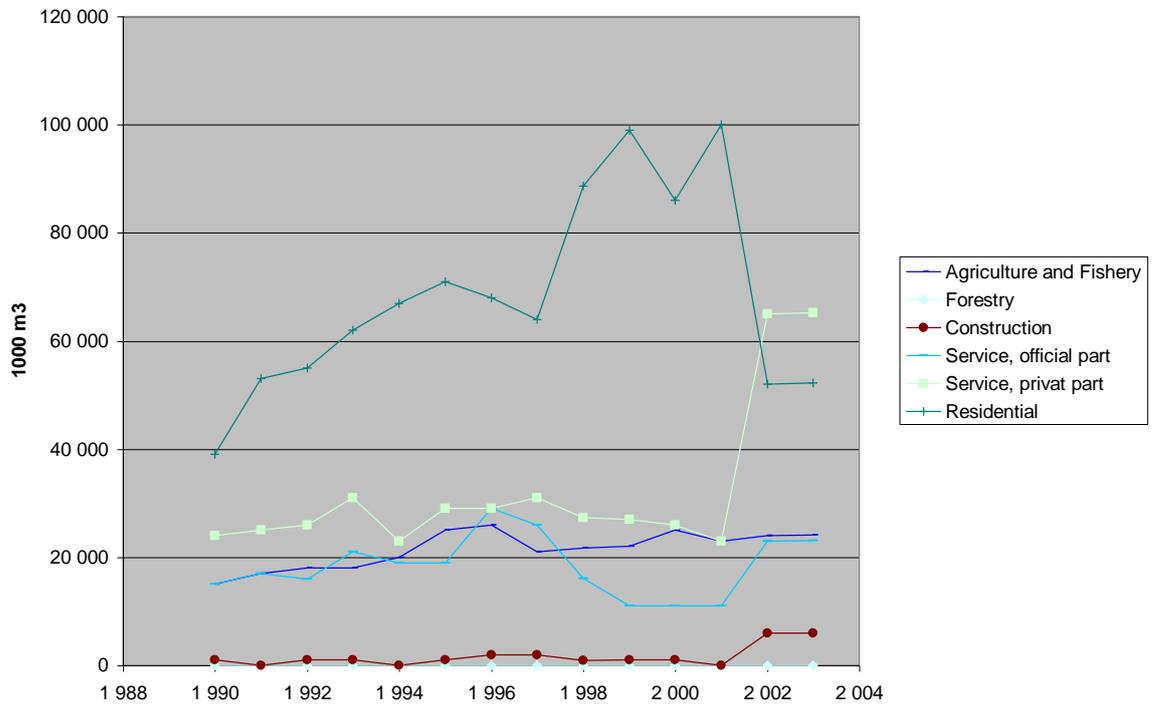
DOMESTIC HEATING OIL



MEDIUM AND HEAVY FUEL OIL



NATURAL GAS



GAS WORKS GAS

