Netherlands Informative Inventory Report 2010

Policy Studies

Netherlands Environmental Assessment Agency

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Netherlands Informative Inventory Report 2010

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The Netherlands Environmental Assessment Agency (PBL) is the national institute for strategic policy analysis in the field of environment, nature and spatial planning. We contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all our studies. We conduct solicited and unsolicited research that is both independent and always scientifically sound.

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Rapport in het kort

Emissies van luchtverontreinigende stoffen in Nederland 1990-2008

Dit rapport over de Nederlandse emissie-inventarisatie van grootschalige luchtverontreinigende stoffen licht de emissiecijfers toe die Nederland heeft geleverd aan het UNECE-secretariaat in het kader van de verplichtingen onder de Convention on Long-range Transboundary Air Pollution (CLRTAP), en aan de Europese Commissie in het kader van de verplichtingen onder de NEC[1]-richtlijn. De door Nederland gerapporteerde emissiecijfers zijn te vinden op de EMEP[2]-website: http://www.emep-emissions.at/ (EMEP data) en www.emissieregistratie.nl.

De IIR 2010 biedt een beter zicht op de toepasbaarheid (vergelijkbaarheid tussen landen, modelberekeningen voor luchtkwaliteit door EMEP) en afrekenbaarheid (transparantie, compleetheid, consistentie tussen jaren, sterkte en zwaktes in methoden, onzekerheden) van emissiecijfers. In de periode 1990–2008 vertonen de emissies van SO_2, NO_X, NMVOC, CO, NH_3, zware metalen en persistente organische vervuilende stoffen (POP's) een neerwaartse trend. De belangrijkste oorzaken van deze trend zijn emissiereductie maatregelen in industriële sectoren, schonere brandstoffen en schonere auto's.

Het laatste hoofdstuk over projecties geeft methodes, gegevensbronnen en aannames weer, die gebruikt zijn bij het schatten van ramingen per sector.

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1 National Emissions Ceilings Directive.

2 Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

Inhoud

- Rapport in het kort 5
- Acknowledgement 9
- Summary 11
- 1 Introduction 13
  - 1.1 National inventory background 13
  - 1.2 Institutional arrangements for inventory preparation 13
  - 1.3 The process of inventory preparation 14
  - 1.4 Methods and data sources 15
  - 1.5 Key source analysis 16
  - 1.6 Reporting, QA/QC and archiving 17
  - 1.7 Uncertainties 18
  - 1.8 Explanation on the use of notation keys 19
  - 1.9 Missing sources 20
- 2 Trends in emissions 21
  - 2.1 Trends in national emissions 21
  - 2.2 Trends in sulphur dioxide (SO_2) 22
  - 2.3 Trends in nitrogen oxides (NO_x) 23
  - 2.4 Trends in ammonia (NH_3) 24
  - 2.5 Trends in non-methane volatile organic compounds (NMVOC) 25
  - 2.6 Trends in PM_{10} 26
  - 2.7 Trends in $PM_{2.5}$ 27
  - 2.8 Trends in PAH 28
- 3 Energy, stationary fuel combustion (1A) 29
  - 3.1 Energy industries (1A1) 29
  - 3.2 Manufacturing industries and construction (1A2) 30
  - 3.3 Other sectors (1A4) 30
  - 3.4 Other (1A5) 32
  - 3.5 Mobile combustion (1A3) 32
  - 3.6 Evaporation, tyre and brake wear, road abrasion (1A3b) 35
  - 3.7 Energy, fugitive emissions from fuels (1B) 35
- 4 Industry (2) 37
  - 4.1 Overview of the sector 37
  - 4.2 Mineral production (2A) 37
  - 4.3 Chemical industry (2B) 38
  - 4.4 Metal production (2C) 38
  - 4.5 Pulp and paper (2D1) 39
  - 4.6 Food and drink production (2D2) 39
  - 4.7 Other production (2G) 39

5 Solvents and product use (3) 41
5.1 Overview of the sector 41
5.2 Paint application (3A) 41
5.3 Degreasing and dry cleaning (3B) 41
5.4 Other, including products containing HMs and POPs (3D) 41

6 Agriculture (4) 43
6.1 Dairy cattle (4B1A) 43
6.2 Non-dairy cattle (4B1b) 43
6.3 Swine (4B8) 44
6.4 Poultry (4B9) 44
6.5 Synthetic N-fertilisers (4D1a) 44
6.6 Farm-level agricultural operations including storage, handling and transport of agricultural products (4D2a) 44

7 Waste (6) 45
7.1 Waste incineration (6C) 45
7.2 Other waste (6D) 45

8 Other (7) 47

9 Recalculations and other changes 49
9.1 Recalculations of the 2010 submission 49
9.2 Improvements 49

10 Projections 51
10.1 Energy 51
10.2 Industrial processes 52
10.3 Agriculture 52

References 53

Colophon 55

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Summary

Emissions of transboundary air pollutants in the Nederlands 1990-2008

This report, constituting the Netherlands Informative Inventory Report (IIR), contains information on emission inventories in the Netherlands, from 1990 up to 2008 (see www.prtr.nl and EMEP[1] data on http://www.emep-emissions.at/). It includes descriptions of methods and data sources, QA/QC activities carried out and a trend analysis.

This IIR outlines such methods for estimating emissions as the extrapolation of emissions from individual companies to sectors. Estimations are given in more detail for sector and subsector for the key source categories (e.g. emission calculation from road transport in vehicle categories and road types).

In the 1990 – 2008 period emissions of SO_2, NO_x, NMVOC, CO, NH_3, heavy metals and persistent organic pollutants (POPs) showed a downward trend. The major overall drivers for this trend are emission reductions in the industrial sectors, cleaner fuels and cleaner cars.

The final chapter on emission projections includes descriptions of methods, assumptions and data sources, used to estimate projected emissions per sector.

1 Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

1 Introduction

Reporting emission data to the Executive Body of the Convention on Long-range Transboundary Air Pollution (CLRTAP) is required to fulfil obligations in compliance with the implementation of Protocols under the Convention. Parties are required to submit reports on annual national emissions of SO_2, NO_x, NMVOC, CO, NH_3 and various heavy metals and POPs using the Guidelines for Estimating and Reporting Emission Data under the CLRTAP (UNECE, 2009).

The Netherlands Informative Inventory Report (IIR) 2010 contains information on the Netherlands' inventories for the years 1990 to 2008, including descriptions of methods, data sources, QA/QC activities carried out and a trend analysis. The inventory covers all anthropogenic emissions to be reported in the Nomenclature for Reporting (NFR), including individual polycyclic aromatic hydrocarbons (PAHs), which are to be reported under persistent organic pollutants (POPs) in Annex IV.

1.1 National inventory background

Emissions in the Netherlands are registered in the Netherlands Pollutant Release and Transfer Register (PRTR). This PRTR database is the national database for target group monitoring, set up to monitor pollutants within the framework of National Emission Ceilings (EU), the Convention on Long-range Transboundary Air Pollution (CLRTAP), and to monitor the greenhouse gas emissions in conformance with United Nations Framework Convention on Climate Change (UNFCCC) requirements and the Kyoto Protocol (National System). PRTR encompasses the process of data collection, data processing, registration and reporting on emission data for some 350 compounds, and compound groups in air, water and soil. Emission data (for the most important pollutants) and documentation can be found at www.prtr.nl.

Emission estimates are based on official statistics of the Netherlands, e.g. energy and agricultural statistics as well as environmental reports of companies in the industrial sector and emission factors (both nationally developed and internationally recommended factors).

The Netherlands uses the 'Guidelines for Estimating and Reporting Emission Data' for reporting to the Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP). However, instead of using the EMEP/CORINAIR Emission Inventory Guidebook (EEA, 2005), the Netherlands often applies country-specific methods, including monitoring data and emission factors.

1.2 Institutional arrangements for inventory preparation

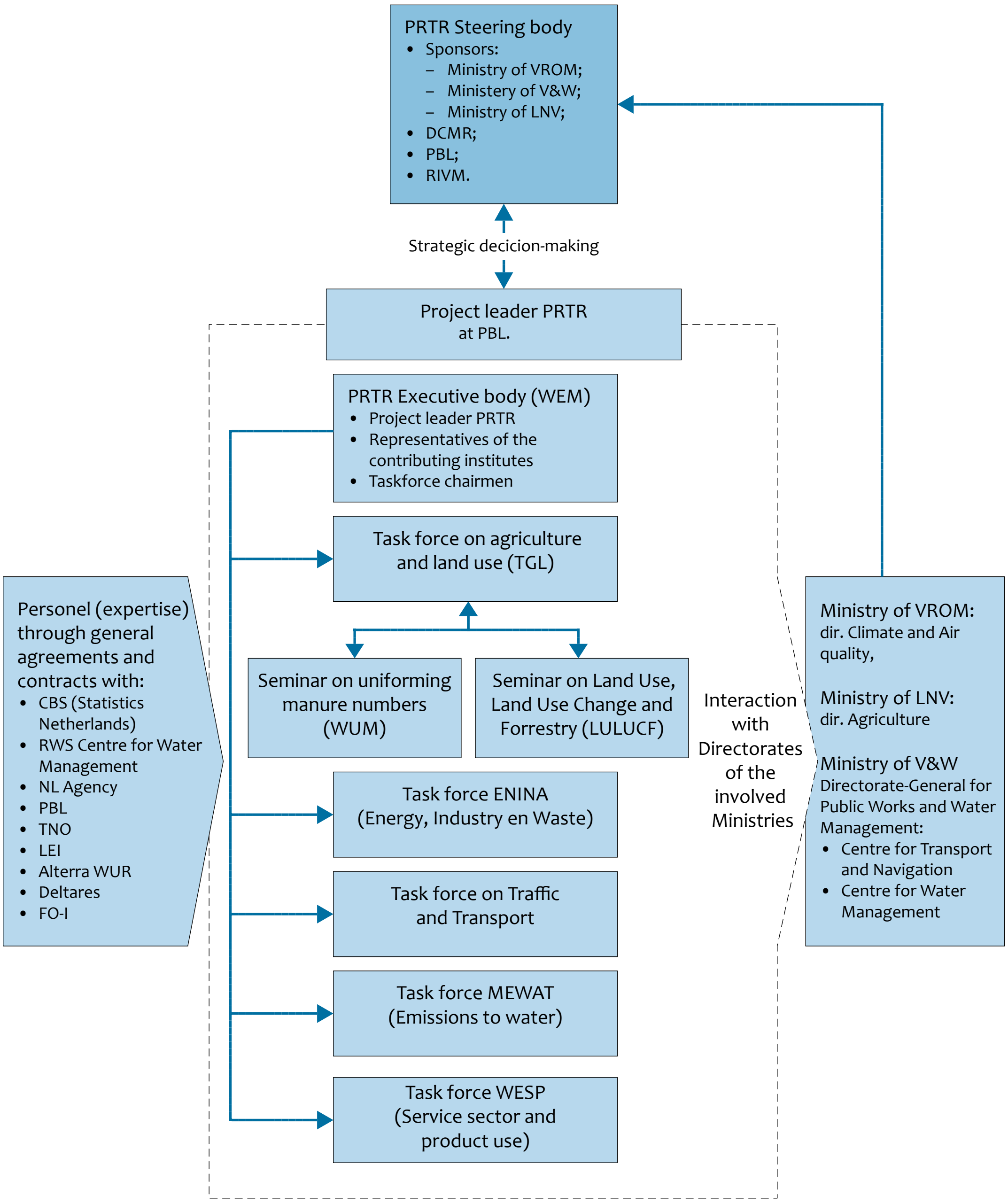
The Dutch Ministry of Housing, Spatial Planning and the Environment (VROM) has the overall responsibility for the emission inventory and submissions to CLRTAP. A Pollutant Release and Transfer Register (PRTR) system has been in operation in the Netherlands since 1974. From 2004 onwards, the Ministry of VROM has outsourced the full coordination of the PRTR to the Emission Registration team (ER-team) at the Netherlands Environmental Assessment Agency (PBL). The year 2010 marks the transition of responsibilities and staff of the ER-team from PBL to the National Institute for Public Health and the Environment (RIVM). This change in institutional arrangement will take effect in the IIR2011.

The main objective of the emission inventory is to produce an annual set of unequivocal emission data, which is up-to-date, complete, transparent, comparable, consistent and accurate. Emission data are produced in an annual (project) cycle (PBL, 2009) and various external agencies contribute to the PRTR by performing calculations or submitting activity data (see next section). Besides the PBL, the following institutes contribute to the PRTR:

- Statistics Netherlands (CBS);
- Netherlands Organisation for Applied Scientific Research (TNO);
- RWS Centre for Water Management (RWS-WD)
- Deltares
- Alterra WUR
- NL Agency (Waste management division);
- Agricultural Economics Research Institute (LEI);
- Facilitating Organisation for Industry (FO-I), which coordinates annual environmental reporting (AER) by companies.

Each of the contributing institutes has its own responsibility and role in the data collection, emission calculations and quality control. These are laid down in general agreements with PBL and in the annual project plan (PBL, 2009).

PRTR Organisational arrangement **Figure 1.1**



The organisational arrangement of the Netherlands Pollutant Release and Transfer Register (PRTR).

1.3 The process of inventory preparation

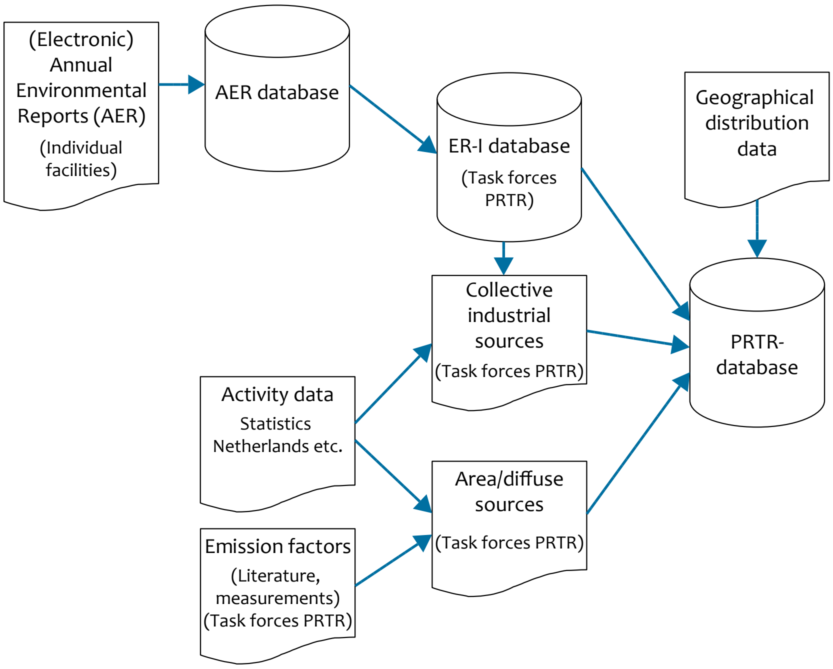
Data collection

For the collection and processing of data (according to pre-determined methods), the PRTR is organised in task forces. The task forces are formed by sector experts of the participating institutes. Methods are compiled on the basis of the best available scientific views. Changes in scientific views lead to changes in methods, and to recalculation of the historical emissions. The following task forces are recognised (see Figure 1.1):

- task force on agriculture and land use;
- task force on energy, industry and waste;
- task force on traffic and transport;
- task force on water and,
- task force on product use and service sector.

Every year, after collection of the emission data, several quality control checks are performed in the task forces during a yearly 'trend analysis' workshop. After approval by participating institutes, emission data are released for publication. Subsequently, emission data is des-aggregated to regional emission data for national use (e.g. 5x5 km grid data for provinces).

Data flow in the Netherlands Pollutant Release and Transfer Register (PRTR) **Figure 1.2**



The data flow in the Netherlands Pollutant Release and Transfer Register.

Data storage

In cooperation with the contributing research institutes, emission data are collected and stored in a database managed by PBL.

About 250 companies, representing several hundreds facilities, are legally obliged to submit an Annual Environmental Report (AER). As from 1 January 2002, they may submit their AERs electronically. Each of these companies has an emission monitoring and registration system in which the specifications are in agreement with the competent authority. Usually, the licensing authorities (Provinces, State, etc.) validate and verify the reported emissions. In addition, a number of companies are required to report information under the BEES/A legislation. Other companies (about 200) provide emission data voluntarily within the framework of environmental covenants. Information from the AERs is stored in a separate database at the PBL and formally owned by the companies involved.

Point-source emission data in the AER database are checked for consistency by the task forces. The result is a selection of validated point-source emissions and activity data, which are then stored in the individual PRTR database (ER-I). The ER-I data is combined with supplementary estimates for Small and Medium-sized Enterprises (SMEs). Several methods are applied for calculating these emissions. TNO has derived emission factors for NO_x emissions from small installations, for instance (Van Soest-Vercammen *et al.*, 2002), while, for other substances, the Implied Emission Factors (IEFs) derived from the AERs are applied to calculate sector emissions.

Emissions from the ER-I database and collectively estimated industrial as well as non-industrial sources are stored in the PRTR database (see Figure 1.2). The PRTR database, consisting of a large number of geographically distributed emission sources (about 1000), contains a complete record of emissions in the Netherlands for a particular year. Each emission source includes information on the Standard Industrial Classification code (SBI-code) and industrial sub sector, separate information in process and combustion emissions, and the relevant environmental compartment and location. These emission sources can be selectively aggregated, by NFR category.

As of January 2009 the Dutch legislation on PRTR is changed. New threshold values replaced reporting and as of January 2010 companies are obliged to submit there AER electronically to the Dutch AER database. The environmental effects will be reported in detail in the IIR 2011.

1.4 Methods and data sources

Methods used in the Netherlands are documented in several reports, protocols and in meta-data files, available on www.prtr.nl. However, some reports are only available in Dutch. For greenhouse gases (www.greenhousegases.nl), particulate matter (PM) and all emissions related to mobile sources, the documentation has been translated in English.

In general, two emission models are used in the Netherlands:
- A model for emissions of large *point sources* (e.g. large industrial, power plants) that are registered individually and supplemented with emission estimates for the remainder of the companies in a subsector (based mainly on IEFs from the individually registered companies). This is the so-called ‘bottom up’ method.

Key source categories for SO_x, NO_x, NH_3 and NMVOC

Component	SO_x		NO_x		NH_3		NMVOC	
Key source categories (Sorted from high to low from top to bottom)	*1 A 1 b*	49.7%	1 A 3 b iii	20.7%	4 B 1 a	29.0%	3 D 2	11.9%
	1 A 1 a	11.7%	1 A 3 b i	11.8%	4 B 8	23.0%	3 A 2	11.4%
	1 A 2 b	7.0%	1 A 1 a	8.4%	4 B 1 b	14.4%	1 A 3 b i	10.2%
	1 A 2 a	6.8%	1 A 3 d i (ii)	5.8%	4 D 1 a	8.9%	2 G	7.7%
	1 A 2 c	6.4%	1 A 3 b ii	5.4%	4 B 9 a	7.5%	3 D 3	5.8%
	1 A 2 f i	5.0%	1 A 4 a i	4.6%	4 B 9 b	4.6%	1 A 3 b iv	5.7%
	1 A 3 d i (ii)	2.4%	1 A 4 c ii	4.5%	7 A	3.8%	1 A 4 b i	5.4%
	2 A 7 d	1.8%	1 A 4 b i	4.4%	4 B 6	3.4%	2 B 5 a	4.5%
	1 A 4 c ii	1.4%	1 A 2 c	4.3%	1 A 3 b i	1.8%	1 B 2 a i	4.0%
	1 A 3 d ii	1.2%	1 A 4 c i	4.3%			2 D 2	3.2%
	1 A 4 a i	1.1%	1 A 3 d ii	3.8%			1 A 1 b	3.2%
	1 A 2 f ii	1.0%	1 A 4 c iii	3.5%			3 D 1	3.0%
			1 A 1 b	2.9%			1 A 3 b v	2.5%
			1 A 2 f ii	2.9%			1 B 2 a iv	2.5%
			1 A 2 f i	2.6%			3 A 1	2.3%
			1 A 1 c	1.9%			1 A 3 d ii	2.3%
			1 A 2 a	1.8%			1 A 3 b iii	1.9%
			1 A 4 a ii	1.7%			3 B 1	1.4%
Energy							1 A 4 c i	1.1%
Transport							1 A 4 b ii	1.0%
Industry							1 B 2 b	1.0%
Solvent and product use							1 A 4 c ii	0.9%
Agriculture							1 A 3 b ii	0.9%
Waste							1 A 2 f ii	0.7%
Other							1 A 3 d i (ii)	0.5%
Total (%)		95.6%		95.4%		96.4%		95.0%

- A model for emissions of *diffuse sources* (e.g. road transport, agriculture) that are calculated from activity data and emission factors from sectoral emission inventory studies in the Netherlands (e.g. SPIN documents produced by the 'Cooperation project on industrial emissions').

The following sections sketch these methods, which are discussed in more detail, by sector or subsector, for the top ten key sources mentioned in Chapter 3.

1.5 Key source analysis

For all components, more than 95% of national total emissions should be covered by the key source categories. The REPDAB generated key source category list is insufficient for this purpose. Table 1.1 shows the key source categories which cover 95% of the national total for a component. See UNECE (2009) for an explication of the source category coding.

Key source categories for CO and particulate matter (PM) species — Table 1.1b

CO		TSP		PM_{10}		$PM_{2.5}$	
1 A 3 b i	32.0%	4 B 9 a	13.0%	4 B 9 a	15.4%	1 A 3 b i	13.0%
1 A 2 a	13.3%	2 C 1	8.9%	2 D 2	7.3%	1 A 3 b ii	10.1%
1 A 3 b iv	10.0%	1 A 4 b i	7.6%	1 A 3 b i	6.9%	1 A 4 b i	8.5%
1 A 4 b i	9.6%	2 D 2	7.3%	4 B 8	6.9%	1 A 3 b iii	7.2%
2 C 5 e	6.9%	2 G	6.0%	2 G	6.4%	7 A	7.0%
1 A 4 b ii	5.2%	1 A 3 b i	5.9%	1 A 3 b ii	5.4%	4 B 9 a	5.8%
1 A 3 d ii	4.3%	4 B 8	5.9%	1 A 4 b i	5.0%	1 A 1 b	4.9%
1 A 2 c	3.4%	2 B 5 a	4.8%	1 A 3 b vi	4.1%	2 C 1	4.8%
1 A 4 a ii	2.5%	1 A 3 b ii	4.5%	2 C 1	4.1%	1 A 4 c ii	3.6%
1 A 3 b iii	1.8%	1 A 3 b vi	3.5%	1 A 3 b iii	3.8%	2 G	3.5%
1 A 3 b ii	1.6%	1 A 1 b	3.4%	7 A	3.7%	1 A 3 d i (ii)	3.3%
1 A 2 f ii	1.5%	1 A 3 b iii	3.3%	1 A 1 b	3.5%	2 B 5 a	3.2%
1 A 2 e	0.8%	7 A	3.1%	3 D 3	3.5%	4 B 8	2.6%
1 A 2 b	0.7%	3 D 3	2.9%	2 A 7 d	3.3%	1 A 2 f ii	2.5%
1 A 1 b	0.7%	2 A 7 d	2.8%	1 A 3 b vii	3.1%	2 A 7 d	2.5%
1 A 3 d i (ii)	0.7%	1 A 3 b vii	2.7%	4 B 1 a	2.4%	1 A 3 d ii	2.4%
1 A 4 c ii	0.7%	4 B 1 a	2.0%	2 B 5 a	2.3%	2 D 2	2.3%
		1 A 4 c ii	1.7%	1 A 4 c ii	2.0%	3 D 3	2.2%
		1 A 3 d i (ii)	1.6%	1 A 3 d i (ii)	1.9%	1 A 3 b vi	1.4%
		1 A 1 a	1.3%	1 A 2 f ii	1.4%	2 C 5 e	1.2%
		1 A 2 f ii	1.2%	1 A 3 d ii	1.3%	1 A 4 c iii	1.2%
		1 A 3 d ii	1.1%	2 D 1	1.0%	1 A 1 a	1.1%
		2 C 5 e	1.1%	4 D 2 a	1.0%	4 B 1 a	0.9%
	95.6%		95.5%		95.7%		95.1%

Key source categories for Pb, Hg, Cd, DIOX and PAH — Table 1.1c

Pb		Hg		Cd		DIOX		PAH	
2 C 1	64.3%	2 C 1	31.9%	2 C 1	53.6%	3 D 3	65.1%	1 A 4 b i	56.1%
1 A 3 b vi	14.3%	1 A 1 a	18.9%	2 B 5 a	33.7%	1 A 4 b i	17.2%	2 C 5 e	19.6%
1 A 4 b i	5.6%	6 C c	12.7%	1 A 4 b i	3.6%	1 A 2 a	9.2%	2 C 1	5.0%
1 A 3 a ii (i)	5.3%	2 A 1	11.5%	6 C c	3.3%	6 C c	2.4%	1 A 3 b i	4.5%
2 A 7 d	3.9%	6 C d	8.4%	2 C 5 e	2.4%	1 A 3 b i	1.1%	1 A 3 b iii	3.1%
2 B 5 a	3.7%	2 A 7 d	6.1%			1 A 3 b iv	0.9%	1 A 2 f i	2.8%
		1 A 2 f i	4.3%					1 A 3 b iv	1.9%
		2 B 5 a	3.0%					2 G	1.3%
								1 A 3 b ii	1.2%
	97.1%		96.8%		96.6%		95.9%		95.5%

1.6 Reporting, QA/QC and archiving

Reporting

The Informative Inventory Report is prepared by PBL, with contributions by experts from the PRTR task forces.

QA/QC

The PBL and therefore the PRTR have been ISO 9001:2000 certified for many years. However on 1 January 2009, PBL did not renew its certification, because of a merger with another assessment agency. Instead, the PBL decided to introduce the EFQM-based (Dutch) INK model (see http://ww1.efqm.org/en/ and http://www.ink.nl). As of 1 January 2010, the PRTR is a project belonging to the Centre for Environmental Monitoring (RIVM-CMM). RIVM-CMM has an ISO 9001:2000 AQ/QC system in place, and documentation and archiving will be done according to procedures of the quality manual. Arrangements and procedures for the contributing institutes are described in an annual project plan (PBL, 2009).

In general, the following QA/QC activities are performed:

Quality assurance (QA)

QA activities can be summarised as follows:

- For the energy, industry and waste sectors, emission calculation in the PRTR is based mainly on AERs by companies (facilities). The companies themselves are responsible for the data quality; the competent authorities (in the Netherlands, mainly provinces and local authorities) are responsible for checking and approving the reported data, as part of the annual quality assurance.
- As part of the evaluation process of the previous cycle, internal audits are performed within PBL as part of the ISO certification.
- Furthermore, there are annual external QA checks on selected areas of the PRTR system.

QC checks. A number of general QC checks have been introduced as part of the annual work plan of the PRTR. The

QC checks built into the work plan aim at covering such issues as consistency, completeness and accuracy of the NFR data.

The general QC for the inventory is largely performed within the PRTR as an integrated part of the working processes. For the 2010 inventory the PRTR task forces filled in a standard-format database with emission data from 1990 to 2008. After a first check of the emission files, by the PBL for completeness, the data becomes available to the specific task force for checking consistency and trend (comparability, accuracy). The task forces access information on all emissions in the database, by means of a web-based emission reporter, and are facilitated by the ER-team with comparison information on trends and time series. Several weeks before the data set is fixed, a trend verification workshop will be organised by the PBL (see Text box 1.1).

Archiving and documentation

Internal procedures are agreed on (for example, in the PRTR work plan) for general data collection and the storage of fixed data sets in the PRTR database at PBL, including the documentation/archiving of QC checks. Moreover, updating of monitoring protocols for substances under the Convention for Long Range Transboundary Air Pollution is one of the priorities within the PRTR system. Emphasis is put on documentation of methodologies for calculating SO_x, NO_x , NMVOC, NH_3 and PM_{10} ($PM_{2,5}$). Methodologies/ protocols, emission data (including the emissions of Large Point Sources on the basis of Annual Environmental Reports), as well as such emission reports as the National Inventory Report (UNFCCC) and the Informative Inventory Report (CLRTAP), are made available on the website of the PRTR: www.prtr.nl or www.emissieregistratie.nl (Dutch version). Each institution involved in the PRTR is responsible for QA/QC aspects related to reports based on the annually fixed database.

1.7 Uncertainties

Uncertainty assessments constitute a means to either provide the inventory users with a quantitative assessment of the inventory quality or to direct the inventory preparation team to priority areas, where improvements are warranted and can be made cost-effective. For these purposes, quantitative uncertainty assessments have been carried out for these purposes since 1999. However, awareness of uncertainties in emission figures was expressed earlier in the PRTR in so-called quality indices and in several studies on industrial emissions and generic emission factors for industrial processes and diffuse sources. To date, the Dutch PRTR gives only one value for emissions (calculation result, rounded off to three significant digits).

The information on the quality of emission figures presented here is based on the TNO report 'Uncertainty assessment of NO_x, SO_2 and NH_3 emissions in the Netherlands' (Van Gijlswijk *et al.*, 2004), which presents the results of a Tier-2 'Monte Carlo' uncertainty assessment.

1.7.1 Quantitative uncertainty

Uncertainty estimates in national total emissions have been reported in the Environmental Balances since 2000 (PBL, 2009a). These estimates were based on uncertainties by source category using simple error propagation calculations (Tier 1). Most uncertainty estimates are based on the judgement of RIVM/PBL emission experts. A preliminary analysis on NMVOC emissions showed an uncertainty range of about 25%. In a recent study (Van Gijlswijk *et al.*, 2004) the uncertainty in the contribution of the various emission sources to total acidification (in acidification equivalents) was assessed according to the Tier-2 methodology (estimation of uncertainties by source category using Monte Carlo analysis). See Table 1.2 for results. A comparison was also made between the Tier-1 and Tier-2 methodologies. This is not straightforward as the two studies use a different knowledge collection. The 2000 Tier-1 analysis used CLRTAP default uncertainties for several NO_x processes, which explains the difference with the 1999 Tier-1 results. For NH_3, the difference between the 2000 Tier-1 and Tier-2 can be explained by taking non-normal distributions and dependencies between individual emission sources for each animal type into account (both are violations of the Tier-1 assumptions: effects

Text box 1.1. Trend verification workshops

Several weeks in advance of a trend analysis meeting, a snapshot from the database is made available by PBL in a web-based application (Emission Explorer, EmEx) for checks by the institutes involved and experts (PRTR task forces). In this way the task forces can check for level errors and consistency in the algorithm/method used for calculations throughout the time series. The task forces perform checks for relevant gases and sectors. The totals for the sectors are then compared with the previous year's data set. Where significant differences are found, the task forces evaluate the emission data in more detail. The results of these checks form the subject of discussion at the trend analysis workshop and are subsequently documented.

Furthermore, the ER-team provides the task forces with time series of emissions per substance for the individual target sectors. The task forces examine these time series. During the trend analysis for this inventory the emission data were checked in two ways: 1) emissions from 1990 to 2007 from the new time series were compared with the time series of last years inventory and 2) the data for 2008 were compared with the trend development per gas since 1990. The checks of outliers are performed on a more detailed level of the sub-sources in all sector background tables:

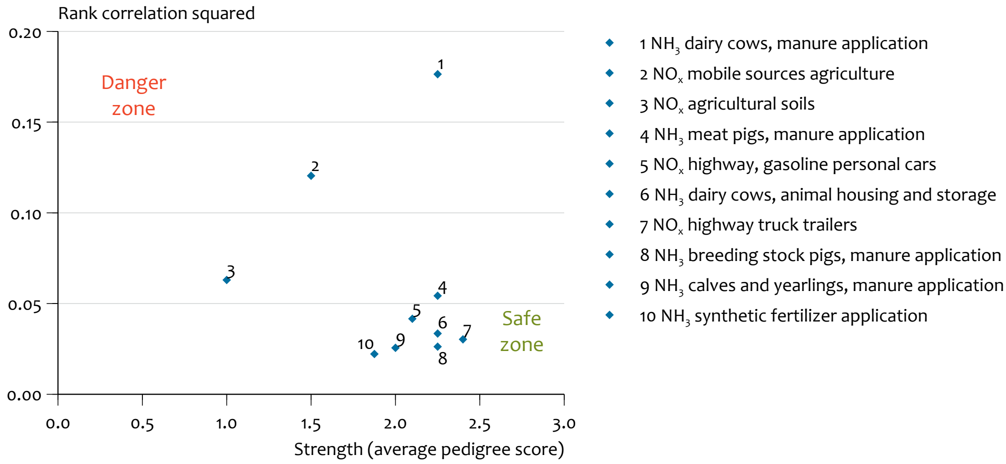
- *annual changes in emissions;*
- *annual changes in activity data;*
- *annual changes in implied emission factors and*
- *level values of implied emission factors.*

Exceptional trend changes and observed outliers are noted and discussed at the trend analysis workshop, resulting in an action list. Items on this list have to be processed within 2 weeks or be dealt with in next year's inventory.

Uncertainty (95% confidence ranges) in acidifying compounds and for total acidifying equivalents for emissions in 1999 (RIVM, 2001) and 2000 (Van Gijlswijk *et al.*, 2004) **Table 1.2**

Component	Tier-1 for 1999	Tier-1 for 2000	Tier-2 for 2000
NH_3	± 17%	± 12%	± 17%
NO_x	± 11%	± 14%	± 15%
SO_2	± 8%	± 6%	± 6%
Total acid equivalents	± 9%	± 8%	± 10%

Diagnostic diagram acidifying equivalents **Figure 1.3**



NUSAP diagnostic diagram indicating strong and weak elements in the available knowledge on acidifying substances.

encapsulated in the 1999 Tier-1 analysis). The differences for SO_2 and total acidifying equivalents are small. The conclusion drawn from this comparison is that focusing on the order of magnitude of the individual uncertainty estimates, as in the RIVM (2001) study, provides a reasonable first assessment of the uncertainty of source categories.

The RIVM (2001) study draws on the results of an earlier study on the quality of nitrogen oxides (NO_x) and sulphur dioxide (SO_2) emissions, as reported by individual companies for point sources under their national reporting requirements. Besides providing quantitative uncertainty estimates, the study yielded important conclusions. One example was that a limited number of facilities showed high uncertainties (e.g. 50% or more for NO_x), which could be reduced with little extra effort, and that companies generally have a lack of knowledge on the uncertainty about the emissions they report.

In the study by Van Gijlswijk (2004), emission experts were systematically interviewed on quantitative uncertainties, which provided simultaneous information on the reliability and quality of the underlying knowledge base. For processes not covered by interviews, standard default uncertainties, derived from the Good Practice Guidance for CLRTAP emission inventories, were used (Pulles and Van Aardenne, 2001). The qualitative knowledge (on data validation, methodological aspects, empirical basis and proximity of data used) has been combined into a score for data strength, based on the so-called NUSAP approach (Van der Sluijs *et al.*, 2003; Van der Sluijs *et al.*, 2005). The qualitative and quantitative uncertainties were combined in so-called diagnostic diagrams that can be used to identify areas for improvement, since the diagrams indicate strong and weak parts of the available knowledge (see Figure 1.3). Sources with a relatively high quantitative uncertainty and weak data strength are thus candidates for improvement. To effectively reduce the uncertainty, the nature of uncertainties must be known (e.g. random, systematic or knowledge uncertainty). A general classification scheme on uncertainty typology is given in Van Asselt (2000).

1.8 Explanation on the use of notation keys

The Dutch emission inventory covers all relevant sources specified in the CLRTAP that determine the emissions to air in the Netherlands. Because of the long history of the inventory it is not always possible to specify all subsectors in detail. This is the reason why notation keys are used in the emission tables (NFR). These notation keys will be explained in tables 1.3 – 1.5.

The Not Estimated (NE) notation key explained

Table 1.3

NFR code	Substance(s)	Reason for reporting NE
1 A 3 a i (ii)	All	Not in PRTR

The Included Elsewhere (IE) notation key explained

Table 1.4

NFR09 code	Substance(s)	Included in NFR code
1 A 3 a ii (ii)	All	1 A 3 a ii (i)
1 B 2 c	All	1 B 2 b, 1 B 2 a iv
4 B 1 b	TSP, PM_{10}, $PM_{2.5}$	4 B 1 a
1 A 3 e	All	1 A 2 f i, 1 A 4 c ii, 1 B 2 b
2 A 2	All	2 A 7 d
2 A 5	NMVOC	2 A 7 d
2 A 6	All	2 A 7 d
2 B 1	NMVOC, NH_3	2 B 5 a
2 B 2	NH_3	2 B 5 a
2 B 4	NMVOC	2 B 5 a
2 C 2	All	2 C 1
2 C 3	All	2 C 5 e
2 C 5 a-d,f	All	2 C 5 e
4 B 3	NH_3	4 B 1 b
4 B 4	NH_3	4 B 1 b
4 B 9 c	NH_3	4 B 9 b
4 B 9 d	NH_3	4 B 9 a

Sub-sources accounted for in reporting 'other' codes, with NO/NA meaning not occurring or not applicable

Table 1.5

NFR09 code	Substance(s) reported	Subsource description
1 A 2 f		Combustion (not reported elsewhere) in industries, machineries, services, product-making activities.
1 A 5 a		combustion gas from landfills
1 A 5 b		NO/NA
1 B 1 c		NO/NA
1 B 3		NO/NA
2 A 7 d		Processes, excl. combustion, in building activities, production of building materials
2 B 5 a		Production of chemicals, paint, pharmaceutics, soap, detergents, glues and other chemical products.
2 B 5 b		NO/NA
2 C 5 e		Production of non-ferrous metals
2 C 5 f		Production of non-ferrous metals
2 G		Production of wooden, plastic, rubber, metal, textile and paper products.
3 A 3		NO/NA
4 B 13	NH_3	pets
4 G	NH_3, TSP, PM_{10}, $PM_{2.5}$	handling agricultural base materials and products
6 D		Handling waste
7 A		smoking tobacco products (All substances, excl NMVOC); perspiration, breathing (NH_3)
7 B		NO/NA
11 C		NO/NA

1.9 Missing sources

The Netherlands emission inventory covers all important sources.

Trends in emissions 2

2.1 Trends in national emissions

The emissions of all substances showed a downward trend in the 1990-2008 period (see Table 2.1). The major overall drivers for this trend are:

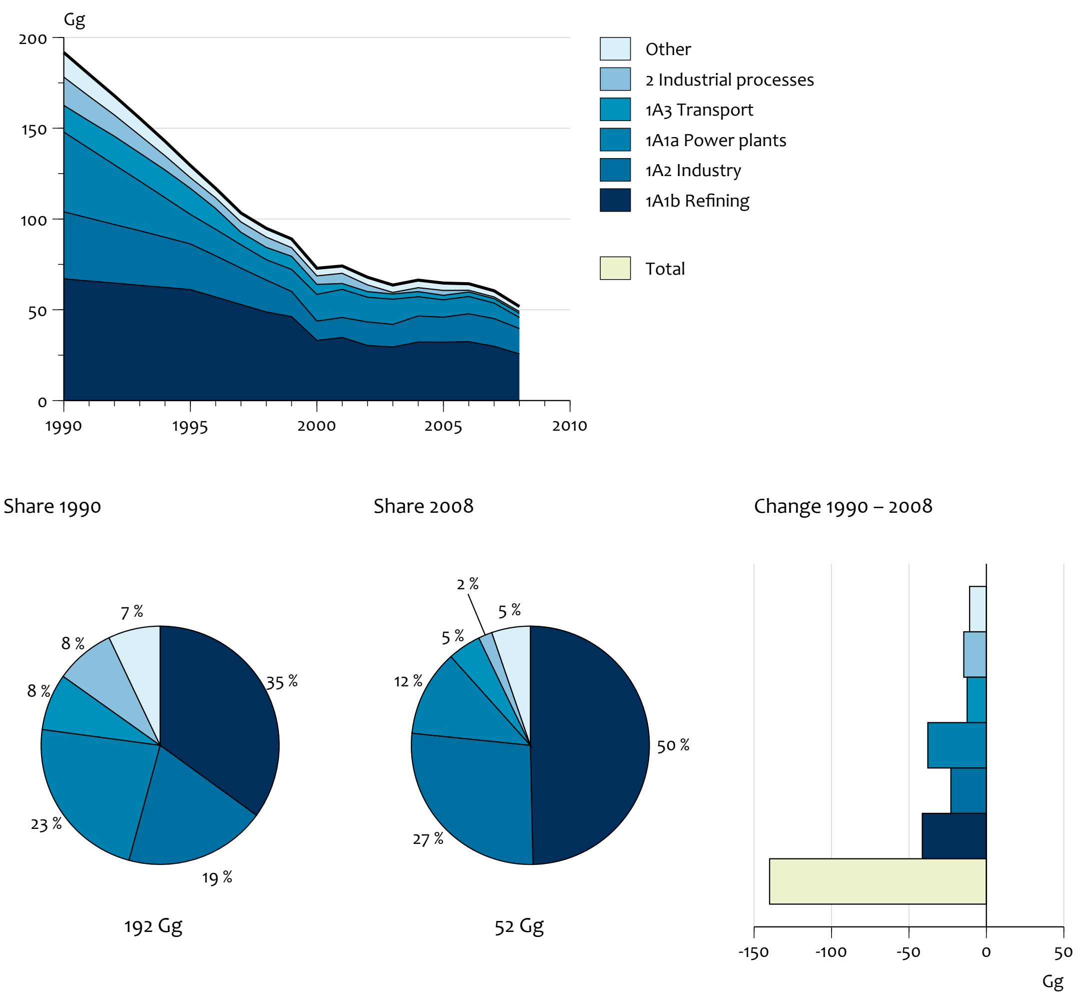
- emission reductions in the industrial sectors,
- cleaner fuels and
- cleaner cars.

European regulations for road traffic emissions have caused a decrease in vehicle emissions of 79% since 1990 for NMVOC, 45% for PM, 54% for NO_x and 98% for SO_2, despite a growth in traffic of 35%. For PM and NO_x, standards have been set for installations by tightening up the extent of emission stocks of heating installations (BEES). In meeting these requirements Dutch industrial plants have realised a reduction of 68% in PM emissions and 50% in NO_x emissions, since 1990. The drivers for the downward emission trend for specific substances will be elaborated in more detail in the next section. Information on sector split and trends for heavy metals and dioxins are not included, as information from the IIR2009 is up to date.

Total national emissions, 1990-2008 — Table 2.1

	Main Pollutants					Particulate Matter			Priority Heavy Metals		
	NO_x	CO	NMVOC	SO_x	NH_3	TSP	PM_{10}	$PM_{2.5}$	Pb	Cd	Hg
Year	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Mg	Mg	Mg
1990	557	1093	461	192	253	96	75	46	338	2.1	3.5
1995	464	845	322	129	196	71	55	34	162	1.1	1.2
2000	390	687	227	73	155	50	44	25	36	1.0	0.9
2005	341	600	175	65	137	44	38	21	39	1.7	0.8
2007	299	567	164	60	137	44	37	20	45	1.7	0.9
2008	293	559	160	52	135	43	37	19	45	1.7	0.9
period 1990-2008, abs	-264	-534	-301	-140	-118	-53	-38	-27	-294	-0.4	-3
period 1990-2008, %1990	-47%	-49%	-65%	-73%	-47%	-55%	-51%	-58%	-87%	-20%	-75%

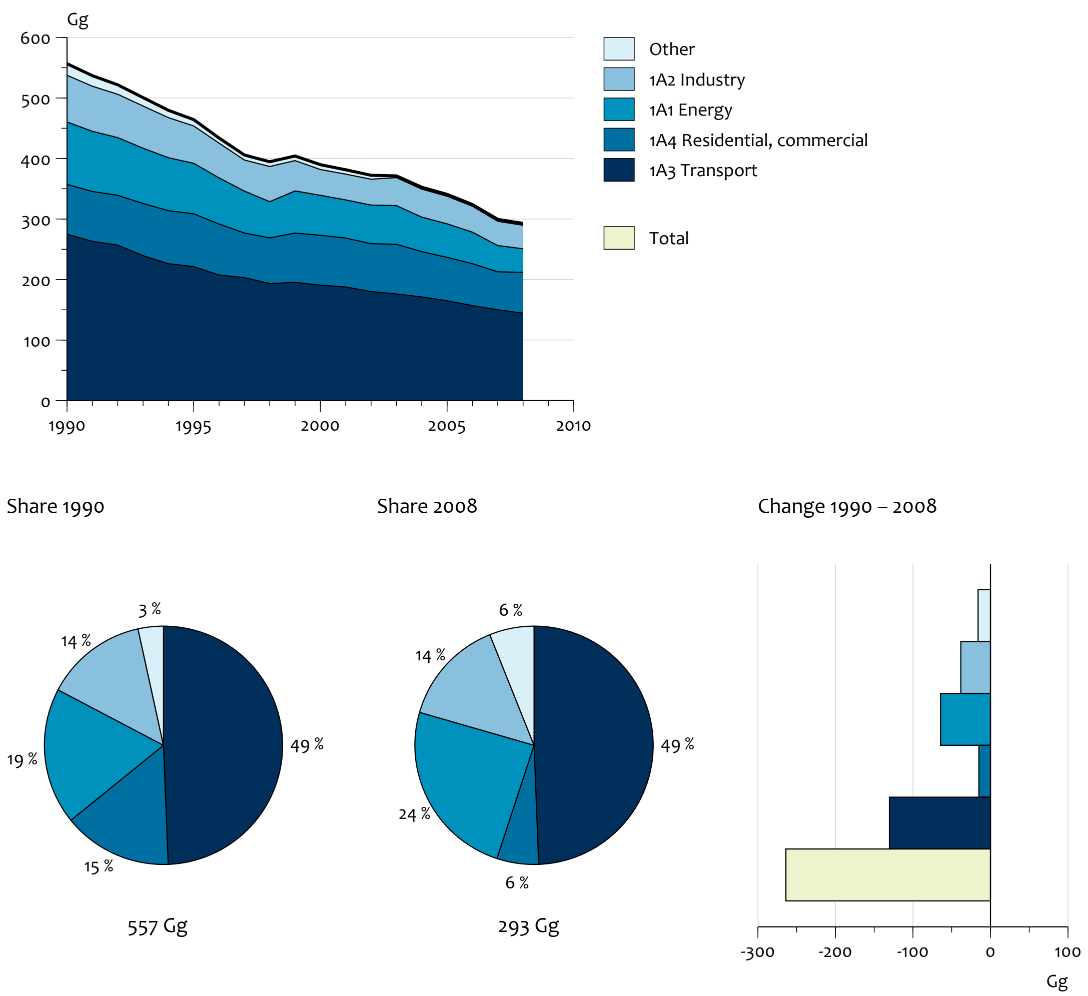
	POPs		Other Heavy Metals					
	DIOX	PAH	As	Cr	Cu	Ni	Se	Zn
Year	g I-Teq	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1990	740	14.7	1.5	9.9	71.5	75.3	0.4	224.8
1995	67	7.7	1.0	6.6	73.6	86.6	0.3	146.1
2000	30	4.8	1.1	3.1	77.1	18.7	0.5	95.8
2005	36	5.1	1.5	2.2	81.9	10.7	2.4	88.9
2007	26	3.8	1.1	2.2	83.9	9.2	1.0	95.0
2008	25	4.0	1.1	2.2	85.3	9.3	1.0	86.8
period 1990-2008, abs	-715	-10.7	-0.4	-7.7	13.8	-65.9	0.6	-138
period 1990-2008, %1990	-97%	-73%	-27%	-77%	19%	-88%	165%	-61%



SO_2, emission trend 1990-2008 and share by sector in 1990 and 2008.

2.2 Trends in sulphur dioxide (SO_2)

The Dutch SO_x emissions (reported as SO_2) decreased by 140 Gg, in the 1990-2008 period, corresponding to 73% of the national total in 1990 (Figure 2.1). Main contributions to this decrease came from the energy, industry and transport sectors. The use of coal declined and major coal-fired electricity producers installed flue-gas desulphurisation plants. The sulphur content in fuels for the (chemical) industry and traffic was also reduced. At present the industry, energy and refining sector (IER) is responsible for 88% of the national SO_2 emissions.

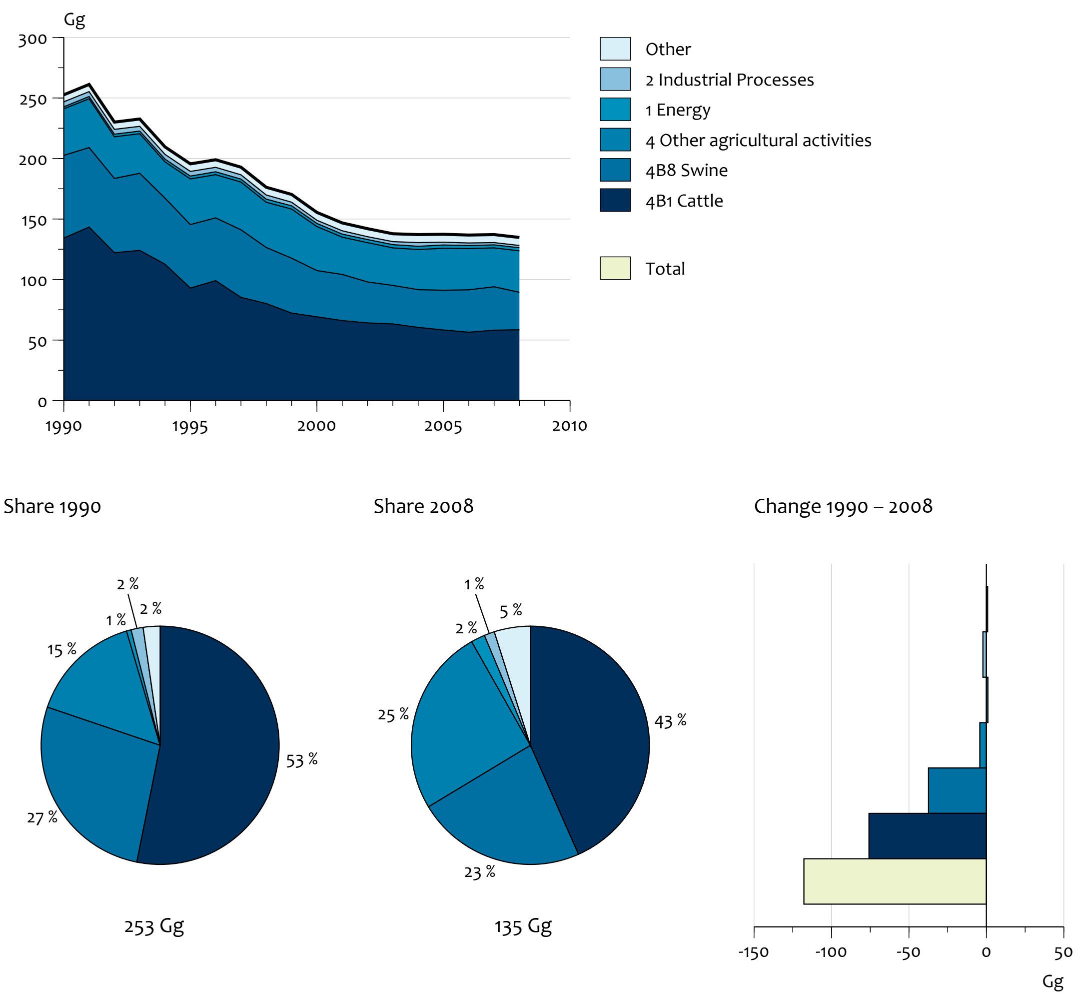


NO_x, emission trend 1990-2008 and share by sector in 1990 and 2008.

2.3 Trends in nitrogen oxides (NO_x)

The Dutch NO_x emissions (NO and NO_2, expressed as NO_2) decreased by 264 Gg, in the 1990-2008 period, corresponding to 47% of the national total in 1990 (Figure 2.2). Main contributors to this decrease were the road-transport and energy sectors. The emissions per vehicle decreased significantly in this period, but the effect on total emissions was partially counterbalanced by an increase in number and mileages of vehicles. The share of the different NFR categories in the national total did not change significantly.

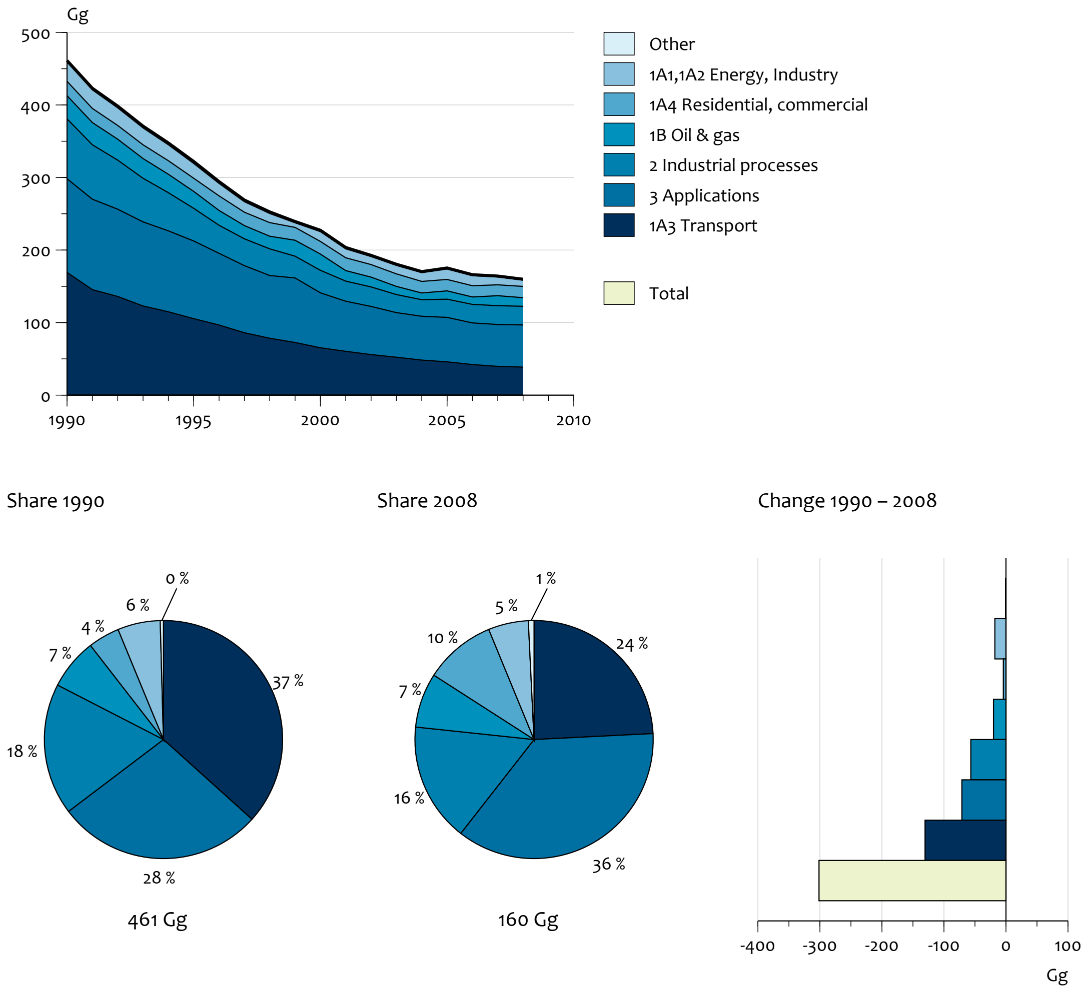
NH_3 emissions Figure 2.3



NH_3, emission trend 1990-2008 and share by sector in 1990 and 2008.

2.4 Trends in ammonia (NH_3)

The Dutch NH_3 emissions decreased by 118 Gg, in the 1990-2008 period, corresponding to 47% of the national total in 1990 (Figure 2.3). This decrease was due to emission reductions from agricultural sources. The direct emissions from animal husbandry decreased slightly as a result of decreasing animal population and measures to reduce emissions from animal houses. Application emissions decreased because of measures taken to reduce the emissions from applying manure to soil and to reduce the total amount of N applied to soil. At present over 90% of Dutch NH_3 emissions come from agricultural sources.

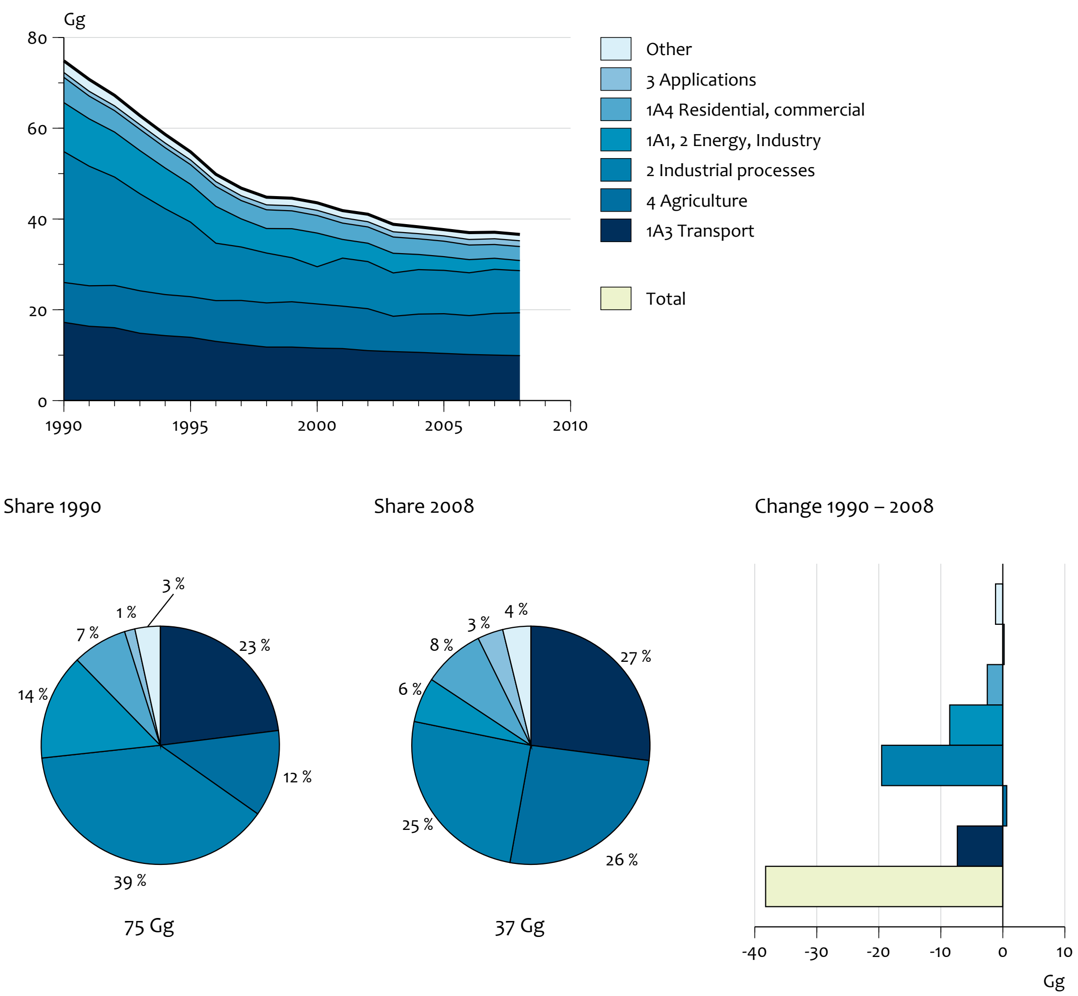


NMVOC, emission trend for 1990-2008 and share by sector in 1990 and 2008

2.5 Trends in non-methane volatile organic compounds (NMVOC)

The Dutch NMVOC emissions decreased by 301 Gg, in the 1990-2008 period, corresponding to 65% of the national total in 1990 (Figure 2.4). All major source categories contributed to this decrease, for example, transport (introduction of catalyst and cleaner engines), product use (intensive programme to reduce NMVOC content in consumer products and paints) and industry (introducing emission abatement specific for NMVOC).

PM_{10} emissions **Figure 2.5**



PM_{10}, emission trend 1990-2008 and share by sector in 1990 and 2008.

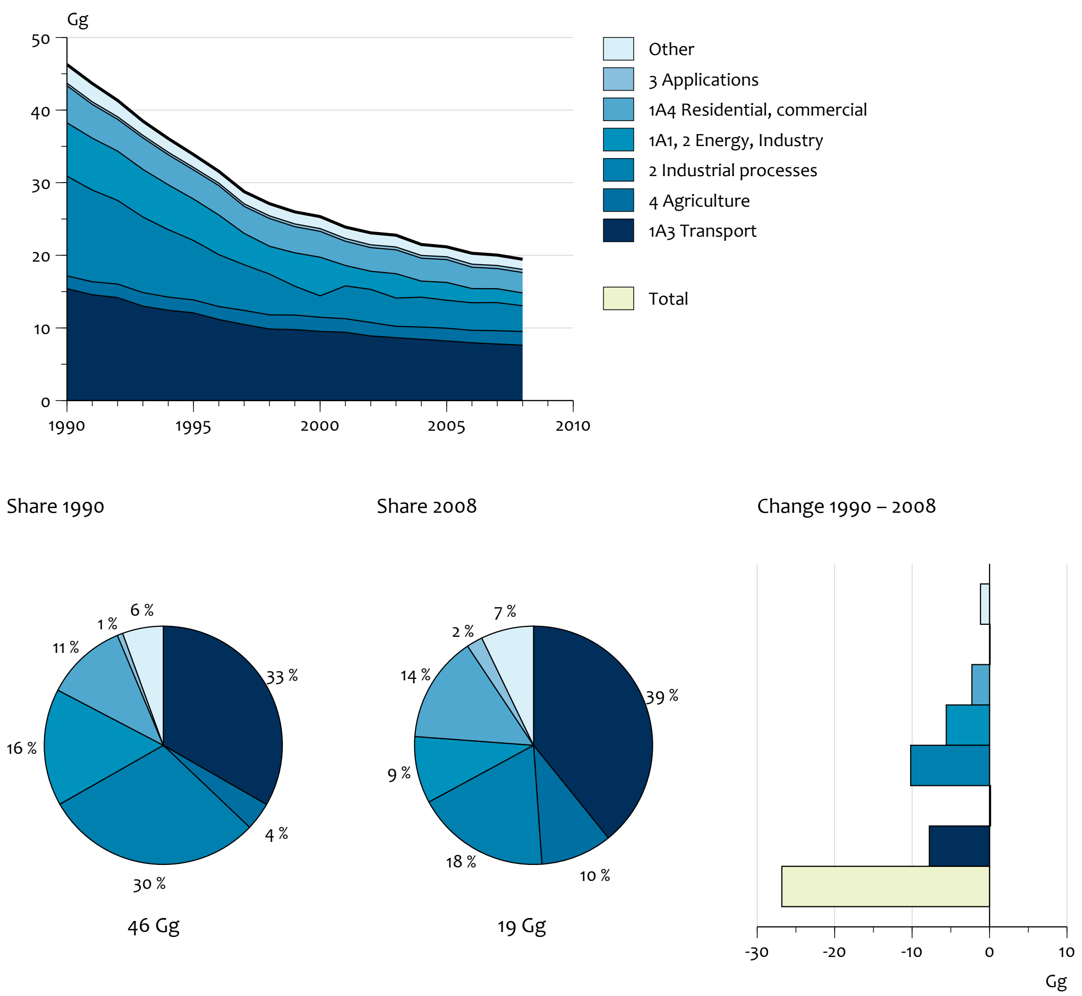
2.6 Trends in PM_{10}

Dutch PM_{10} emissions decreased by 38 Gg, in the 1990-2008 period, corresponding with 51% of the national total in 1990 (Figure 2.5). The major source categories contributing to this decrease are:

- industry (combustion and process emissions), due to cleaner fuels in refineries and the side-effect of emission abatement for SO_2 and NO_x, and
- traffic and transport

The emissions from animal husbandry in agriculture did not change significantly; neither did the emissions from consumers (1A4bi).

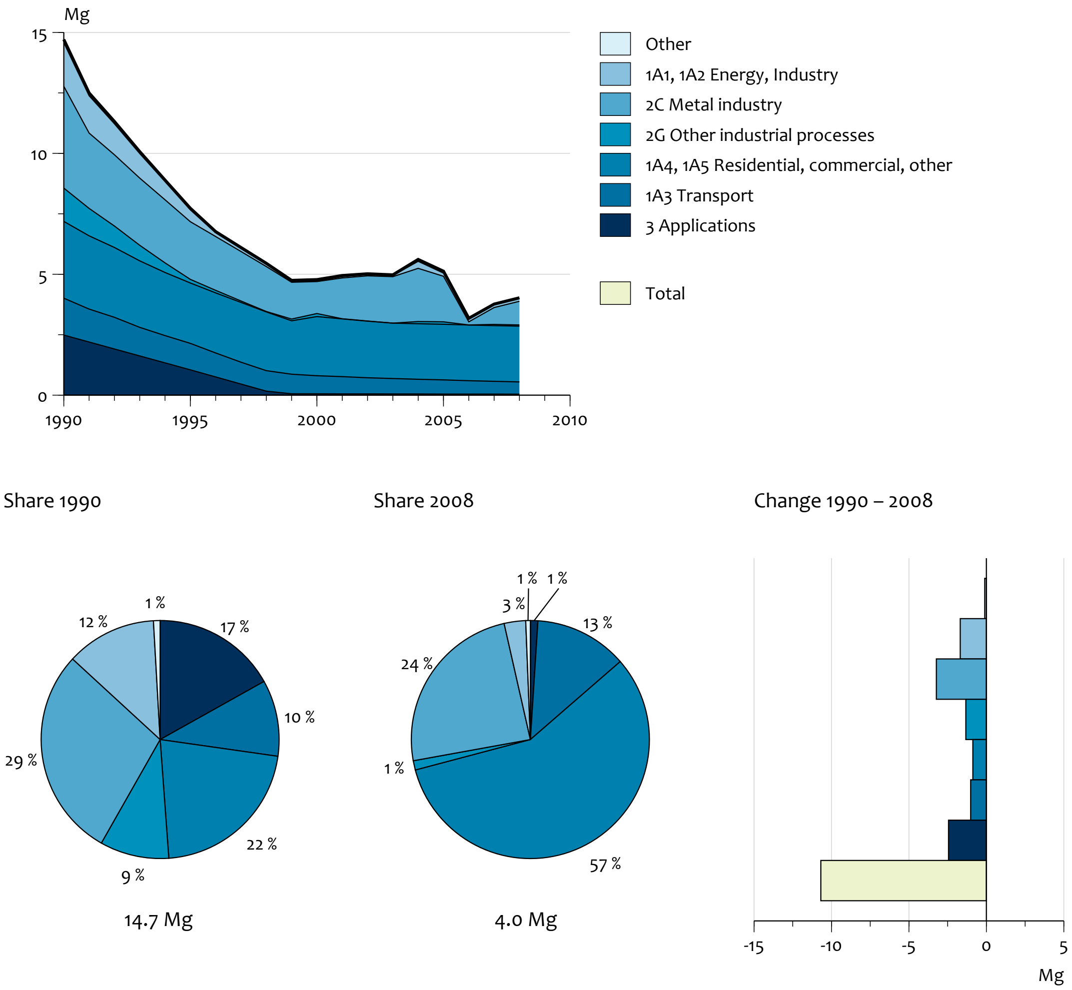
$PM_{2.5}$ emissions Figure 2.6



$PM_{2.5}$ emissions.

2.7 Trends in $PM_{2.5}$

$PM_{2.5}$ emissions are also included in the 2009 submission to UNECE. These emissions are calculated as a specific fraction of PM_{10} by sector (based on Visschedijk *et al.*, 1998). $PM_{2.5}$ emissions in the Netherlands decreased by 27 Gg, in the 1990-2008 period, corresponding with 58% of the national total in 1990 (Figure 2.7). The two major source categories contributing to this decrease were the industrial sector (combustion and process emissions), due to cleaner fuels in refineries and the side-effect of emission abatement for SO_2 and NO_x, and the transport sector.



PAH, emission trend 1990-2008 and share by sector in 1990 and 2008.

2.8 Trends in PAH

Polycyclic aromatic hydrocarbons (PAHs) emissions in the Netherlands decreased by 10.7 Mg, in the 1990-2008 period, corresponding to 73% of the national total in 1990 (Figure 2.8). The major contributors to this decrease are the:

- (metal) industry (general emission reduction) and
- product use (ban on creosoted wood in several applications).

Please note that – unlike in former submissions – the Netherlands now reports PAH emissions according to the NFR template, reporting on the 4 PRTR PAHs individually and in total.

Energy, stationary fuel combustion (1A)

3

About 80-100% of the NO_x, SO_2, PM_{10} and NH_3 emissions from stationary combustion (categories 1A1, 1A2, 1A4 and 1A5) are based on environmental reports of large industrial companies. The emission data in the Annual Environmental Reports (AERs) are based on direct emission measurements (see formula below) or calculations based on fuel input and emission factors. The emission factors used in the calculations are also based on measurements according to this formula.

*Emission = [Concentration]*Flow*Duration of emission*

where:

[Concentration] = Online (semi-)continuous measurement: frequency - seconds to daily
Discontinuous measurement: several times a year, directly in air flow
Off line: sampling and analysis in laboratory

Flow = Flow-speed measurement in air flow; surface of flow channel; calculation based on fuel or raw materials/production quantities; for diffuse emissions: calculation of air flow over source

Duration = Calculation based on process-control data

The emissions and fuel consumption data in the AERs are systematically examined for inaccuracies by checking the resulting implied emission factors. If the environmental report provides data of high enough quality (see Section 1.3 on QA/QC), the information is used to calculate an 'implied emission factor' for a cluster of reporting companies (aggregated by SBI code) and the emission factor ER-I. These emission factors are fuel and sector dependent.

$$EF\ ER\text{-}I_{\text{(SBI category, fuel type)}} = \frac{Emissions\ ER\text{-}I_{\text{(SBI category, fuel type)}}}{Energy\ use\ ER\text{-}I_{\text{(SBI category, fuel type)}}}$$

where:

EF = emission factor

ER-I = Emission Registration database for individual companies

Next, the total combustion emissions in this SBI category are calculated from the energy use NEH, as provided in the Netherlands Energy Statistics (Statistics Netherlands), multiplied by the implied emission factor.

$$ER\text{-}I\_SBI\_emission_{\text{(SBI category, fuel type)}} = EF\ ER\text{-}I_{\text{(SBI category, fuel type)}} * Energy\ NEH_{\text{(SBI category, fuel type)}}$$

For sectors without individual registration of emissions (e.g. residential and agricultural sectors), a set of specific emission factors is used (see Section 3.3).

3.1 Energy industries (1A1)

Public electricity and heat production (1A1a)

Emission data are based on Annual Environmental Reports and collectively estimated industrial sources. For this source category, the percentages of emissions based on annual reports are: 90% for NO_x, 80% for SO_2, 90% for CO and 100% for Hg, Cd and dioxins.

Category 1A1a describes a key source for the following components:

SO_x	(11.7%)
NO_x	(8.4%)
TSP	(1.3%)
$PM_{2.5}$	(1.1%)
Hg	(18.9%)

(% of national total in 2008)

Petroleum refining (1A1b)

All emission data are based on Annual Environmental Reports and registered in the ER-I database.

Category 1A1b describes a key source for the following components:

SO_x	(49.7%)
NO_x	(2.9%)
NMVOC	(3.2%)
CO	(0.7%)
TSP	(3.4%)
PM_{10}	(3.5%)
$PM_{2.5}$	(4.9%)

(% of national total in 2008)

Manufacture of solid fuels and other energy industries (1A1c)

Category 1A1c describes a key source for the following component:

NO_x	(1.9%)

(% of national total in 2008)

3.2 Manufacturing industries and construction (1A2)

Iron and steel (1A2a)

All emission data are based on Annual Environmental Reports and registered in the ER-I database.

Category 1A2a describes a key source for the following components:

SO_x	(6.8%)
NO_x	(1.8%)
CO	(13.3%)
DIOX	(9.2%)

(% of national total in 2008)

Non-ferrous metals (1A2b)

Emission data are based on Annual Environmental Reports and collectively estimated industrial sources. For this source category, the percentage of SO_2 emissions, based on annual reports, is 100%.

Category 1A2b describes a key source for the following components:

SO_x	(7.0%)
CO	(0.7%)

(% of national total in 2008)

Chemicals (1A2c)

Emission data are based on Annual Environmental Reports and collectively estimated industrial sources. For this source category, the percentages of emissions based on annual reports are about 100% for SO_2, 90% for NO_x, 75% for CO and 100% for Pb, Cd and dioxins.

Category 1A2c describes a key source for the following components:

SO_x	(6.4%)
NO_x	(4.3%)
CO	(3.4%)

(% of national total in 2008)

Pulp, paper and print (1A2d)

All emission data are based on Annual Environmental Reports and registered in the ER-I database. No key sources are found in this category.

Food processing, beverages and tobacco (1A2e)

Emission data are based on Annual Environmental Reports and collectively estimated industrial sources.

Category 1A2e describes a key source for the following component:

CO	(0.8%)

(% of national total in 2008)

Other (1A2f)

This sector includes all combustion emissions from the industrial sectors not belonging to the categories 1A2a to 1A2e. Results for stationary (1A2fi) and mobile sources (1A2fii) are separately reported, with emission data being based on Annual Environmental Reports and collectively estimated industrial sources.

Category 1A2fi describes a key source for the following components:

SO_x	(5.0%)
NO_x	(2.6%)
Hg	(4.3%)
PAH	(2.8%)

(% of national total in 2008)

Category 1A2fii describes a key source for the following components:

SO_x	(1.0%)
NO_x	(2.9%)
NMVOC	(0.7%)
CO	(1.5%)
TSP	(1.2%)
PM_{10}	(1.4%)
$PM_{2.5}$	(2.5%)

(% of national total in 2008)

3.3 Other sectors (1A4)

Commercial / institutional (1A4a)

Combustion emissions from the commercial and institutional sector are based on fuel consumption data (Statistics Netherlands) and emission factors (see Table 3.1.). Results for stationary (1A4aii) and mobile sources (1A4ai) are separately reported.

Category 1A4ai describes a key source for the following components:

SO_x	(1.1%)
NO_x	(4.6%)

(% of national total in 2008)

Emission factors for stationary combustion emissions from the services sector and agriculture (g/GJ) **Table 3.1**

	Natural gas	Domestic fuel oil	LPG	Paraffin oil	Coal	Oil fuel
VOC	30	10	2	10	35	10
SO_2	0.22	87	0.22	4.6	460	450
NO_x	1)	50	40	50	300	125
CO	10	10	10	10	100	10
Carbon black		5	10	2		50
Fly ash					100	
PM_{10}	0.15	4.5	2	1.8	2	45
PM coarse		0.5		0.2	80	5

[1)] see table on NO_x emission factors in Van Soest-Vercammen *et al.* (2002)

Emission factors for combustion emissions from households (g/GJ) **Table 3.2**

	Natural gas	Domestic fuel oil	LPG	Paraffin oil	Coal
VOC	6.3	15	2	10	60
SO_2	0.22	87	0.22	4.6	420
NO_x	1)	50	40	50	75
CO	15.8	60	10	10	1500
Carbon black	0.3	5	10	2	
Fly ash					200
PM_{10}	0.3	4.5	2	1.8	120
PM coarse		0.5		0.2	80

[1)] See table on NO_x emission factors in Van Soest-Vercammen *et al.* (2002)

Category 1A4aii describes a key source for the following component:

NO_x (1.7%)
CO (2.5%)
(% of national total in 2008)

Residential (1A4b)

1A4bi Residential plants
Combustion emissions of central heating, hot water and cooking are based on fuel consumption data (Statistics Netherlands) and emission factors (see Table 3.2.). The major fuel used in this category is natural gas. The use of wood in stoves and fireplaces for heating is almost negligible.

Combustion emissions of (wood) stoves and fireplaces are calculated by multiplying the fuel consumption by apparatus type and by fuel type (Statistics Netherlands) with emission factors per house (Hulskotte *et al.*, 1999).

Category 1A4bi describes a key source for the following components:

NO_x (4.4%)
NMVOC (5.4%)
CO (9.6%)
TSP (7.6%)
PM_{10} (5.0%)
$PM_{2.5}$ (8.5%)
Pb (5.6%)
Cd (3.6%)
DIOX (17.2%)
PAH (56.1%)
(% of national total in 2008)

1A4bii Household and gardening (mobile)
Category 1A4bii describes a key source for the following components:

NMVOC (1.0%)
CO (5.2%)
(% of national total in 2008)

Agriculture / forestry / fishing (1A4c)

1A4ci Stationary
Stationary combustion emissions are based on fuel consumption obtained from Statistics Netherlands, which is, in turn, based on data from the Agricultural Economics Research Institute, and emission factors (Table 3.1).

Category 1A4ci describes a key source for the following components:

NO_x (4.3%)
NMVOC (1.1%)
(% of national total in 2008)

1A4cii Off-road vehicles and other machinery
Combustion emissions of CO, NMVOC, NO_x, PM_{10}, SO_2 and heavy metals from off-road vehicles and other machinery are based on fuel consumption and emission factors (g/kg fuel). Fuel consumption data for privately-owned agricultural machinery is provided by the Agricultural Economics Research Institute LEI, while data for agricultural machinery from equipment rental companies is provided by Statistics Netherlands. Fuel consumption in the construction sector is based on production statistics of this sector, provided by Statistics Netherlands. The fuel consumption of other machinery is highly uncertain, as it is based on the difference between the total amount of gas oil used according to

Netherlands energy statistics (NEH) minus the gas oil use in the agricultural and construction sectors. Combustion emissions of NH_3 are based on emission factors (Ntziachristos and Samaras, 2000) and total fuel consumption by off-road vehicles and other machinery. NMVOC and PAH combustion emissions are calculated by using NMVOC profiles (VROM, 1993; Shareef *et al.*, 1988).

Category 1A4cii describes a key source for the following components:

SO_x	(1.4%)
NO_x	(4.5%)
NMVOC	(0.9%)
CO	(0.7%)
TSP	(1.7%)
PM_{10}	(2.0%)
$PM_{2.5}$	(3.6%)

(% of national total in 2008)

1A4ciii National fishing
Combustion emissions are based on fuel sales to cutters operating within national waters, and on fuel-specific emission factors. Since fuel sales to cutters are not recorded separately by Netherlands energy statistics (these are included in the bunker fuel sales), an estimate of fuel use is made on the basis of vessel movements. Emission factors for CO, NO_x, (NM)VOC, CH_4, SO_2, and PM_{10} are derived from national research (Hulskotte and Koch, 2000; Van der Tak, 2000). NH_3 emission factors are derived from Ntziachristos and Samaras (2000). It is assumed that all four-stroke engines use diesel oil, while all two-stroke engines use heavy fuel oil. NMVOC and PAH combustion emissions are calculated by using NMVOC profiles (VROM, 1993; Shareef *et al.*, 1988).

Category 1A4ciii describes a key source for the following components:

NO_x	(3.5%)
$PM_{2.5}$	(1.2%)

(% of national total in 2008)

3.4 Other (1A5)

Other, stationary (including military) (1A5a)
Emissions in this category are from the combustion of waste gas at dumping sites.

Other, mobile (including military) (1A5b)
For military vessels and aircraft only emissions of CO_2, N_2O and CH_4 are calculated. Other compounds relating to NEC ceilings can not be calculated, since it is unknown where fuel is used. The Ministry of Defence regards information on the location of military activity as classified.

No key sources are found in this category.

3.5 Mobile combustion (1A3)

Road transportation (1A3b)
Exhaust emissions of CO, NMVOC, NO_x, NH_3 and PM in these source categories are dependent on vehicle type, fuel type, emission reduction technology, and driving behaviour. These emissions are calculated on the basis of vehicle kilometres and specific emission factors for a variation of different vehicle classes and for three different road types. The vehicle classes are defined by the vehicle category (such as passenger cars, vans, trucks), fuel type, weight class, emission legislation class and in some instances the engine type and/or the emission reduction technology. The emission factors for passenger cars are based on a yearly vehicle emission monitoring programme by TNO (Science and Industry). The VERSIT+ model (Smit *et al.*, 2006) is used to calculate emission factors from the emission measurement database. The specific emission factors per vehicle class are aggregated to emission factors by year of construction (in grams per vehicle kilometre). The emission factors by year of construction are published in Statline, the central database of Statistics Netherlands. The method is described in detail in Klein *et al.* (2009).

Traffic volume data is based on the following data by Statistics Netherlands:
- The Dutch Mobility Behaviour Survey (CBS, 2009). Since 2004, this study has been conducted by the Transport Research Centre of the Directorate for Public Works and Water Management; the current Dutch name is *MobiliteitsOnderzoek Nederland*. (MON)
- Mileage data is compiled by the *Stichting Nationale Autopas (NAP)* (Dutch national vehicle information foundation). From its database the average annual mileage (Dutch vehicles) can be derived per vehicle, according to year of construction and fuel type. The data include kilometres driven abroad.
- The recent data on ownership and use of commercial vehicles have been based on the *Statistiek Wegvervoer* (Road Transport Survey) (CBS, 1994) combined with NAP-data. The data from 1990 to 1994 were derived from the *BedrijfsVoertuigenEnquête* (Commercial vehicle survey).
- A survey in 1993 on the use of motorcycles in the Netherlands (CBS, 1993). Currently, there are no plans for repeating this survey.

The characteristics of the Dutch vehicle fleet are based on CBS (1999), which in turn is based on data provided by the Dutch road traffic department (RDW). Passenger car movements by non-residents are based on the following data by Statistics Netherlands: 'Statistics on registered overnight stays', commuter traffic by foreign workers and number of day trips. Foreign freight transport kilometres are based on 'Statistics on road freight transport' and similar statistics from other EU countries provided by Eurostat.

Emissions of SO_2 and heavy metals (and CO_2) are dependent on fuel consumption and fuel type. These emissions are calculated by multiplying fuel use by emission factors (gram per litre fuel consumed). The emission factors are based on the sulphur, carbon and heavy metal contents of the fuels. It is assumed that 75% of the lead is emitted as particles and 95%

Basis for estimating emissions from mobile sources — Table 3.3

NFR code	Description	Fuel sold	Fuel used
1A3ai(i)	International Aviation (LTO)		X
1A3ai(ii)	International Aviation (Cruise)		X
1A3aii(i)	1A3a2 Civil Aviation (Domestic, LTO)		X
1A3aii(ii)	1A3a2 Civil Aviation (Domestic, Cruise)		X
1A3b	Road transport		X
1A3c	Railways	X	
1A3di(i)	International maritime Navigation		X
1A3di(ii)	International inland waterways		X
1A3dii	National Navigation		X
1A4ci	Agriculture	X	
1A4cii	Off-road Vehicles and Other Machinery	X	
1A4ciii	National Fishing		X
1A5b	Other, Mobile (Including military)	X	

of the sulphur is transformed to sulphur dioxide. The data on fuel consumption by mobile sources is collected by Statistics Netherlands.

Emissions of NMVOC components (alkanes, alkenes, aromates, such as benzene and formaldehyde, polycyclic aromatic hydrocarbons PAHs and chlorinated hydrocarbons) are calculated by multiplying the total NMVOC emission by a NMVOC speciation profile.

1A3bi Road transport, passenger cars

Category 1A3bi describes a key source for the following components:

NO_x	(11.8%)
NH_3	(1.8%)
NMVOC	(10.2%)
CO	(32.0%)
TSP	(5.9%)
PM_{10}	(6.9%)
$PM_{2.5}$	(13.0%)
DIOX	(1.1%)
PAH	(4.5%)

(% of national total in 2008)

1A3bii Road transport, light-duty vehicles

Category 1A3bii describes a key source for the following components:

NO_x	(5.4%)
NMVOC	(0.9%)
CO	(1.6%)
TSP	(4.5%)
PM_{10}	(5.4%)
$PM_{2.5}$	(10.1%)
PAH	(1.2%)

(% of national total in 2008)

1A3biii Road transport, heavy-duty vehicles

Category 1A3biii describes a key source for the following components:

NO_x	(20.7%)
NMVOC	(1.9%)
CO	(1.8%)
TSP	(3.3%)
PM_{10}	(3.8%)
$PM_{2.5}$	(7.2%)
PAH	(3.1%)

(% of national total in 2008)

1A3biv Road transport, mopeds and motorcycles

Category 1A3biv describes a key source for the following components:

NMVOC	(5.7%)
CO	(10.0%)
DIOX	(0.9%)
PAH	(1.9%)

(% of national total in 2008)

1A3a Civil aviation

Combustion emissions – Amsterdam Airport Schiphol

Combustion emissions of CO, NMVOC, NO_x, PM_{10}, SO_2 and heavy metals from aviation are calculated with the EMASA model on a yearly basis (TNO Built Environment and Geosciences). This model is derived from the widely used method of the US Environmental Protection Agency for calculating aviation emissions.

The Landing and Take-off cycle (LTO) can be divided into four LTO cycle phases: idle, take-off, climb-out and approach from 3000 feet. The four modes in the LTO cycle correspond to different power settings of the engines: idle 7%, take-off 100%, climb-out 85% and approach 30%. The equation for calculating the emissions is presented next:

$$emission = SUM_{p,m,f} (LTO_{p,m} * N_p * FUEL_{m,f} * TIM_{p,f} * EF_{m,f})$$

where:

emission = emission (kg/yr)

$LTO_{p,m}$ = number of LTO cycles per aircraft with jet engine type (m) per year

N_p = number of engines per aircraft

$FUEL_{m,f}$ = fuel consumption of jet engine type (m) in LTO cycle phase (f)

$TIM_{p,f}$ = time in mode in LTO cycle (f) for aircraft (p)

$EF_{m,f}$ = emission factor of jet engine type (m) in LTO cycle (f) (kg/kg)

The EMASA model takes into account about 100 types of aircraft, as reported in the Statistical Annual Review of Amsterdam Airport Schiphol. The engine types of these aircrafts are based on the aircraft/engine combinations of the so-called home-carriers (e.g. KLM, Martinair and Transavia). The emission factors are derived from various sources, including the DERA database (DERA, 1999) and the Federal Aviation Agency Engine Emission Database of the EPA (FAA, 1996); for smaller engines emission factors are based on EPA publication AP42 (EPA, 1985). Emissions from military use of aviation fuel are reported under the source category Other mobile sources (NFR 1A5b).

Emissions from auxiliary power units and general power units for aircraft at Schiphol are based on an estimated fuel consumption of 500 gram per passenger multiplied with emission factors.

Combustion emissions other airports
Emissions by civil aviation from other airports are calculated similarly to the method described above, now taking into account the number of flights per regional airport. The aircraft types were derived from their ICAO codes and assigned to the most appropriate type present in the EMASA model. If no aircraft types are available for a certain year, the movements were indexed with the total number of flight movements as published by Statistics Netherlands. Furthermore, emissions in the 1995-1999 period are calculated by indexing the 1994 emissions with the flights per airport in this period.

NH_3 emissions are based on emission factors from EEA (Ntziachristos and Samaras, 2000) and total fuel consumption during the LTO cycle at Dutch airports.

VOC and PAH combustion emissions
First, the NMVOC emissions are calculated as described above. Second, the NMVOC and PAH components are calculated using NMVOC profiles (VROM, 1993; Shareef *et al.*, 1988).

1A3aii(i) Civil aviation (domestic, LTO)
Category 1A3aii describes a key source for the following component:

Pb	(5.3%)
(% of national total in 2008)	

1A3ai(i) International aviation (LTO)
No key sources are found for category 1A3ai(ii).

Railways (1A3c)
Combustion emissions of CO, NMVOC, NO_x, PM_{10}, SO_2 and heavy metals from railways are based on diesel fuel consumption and emission factors. Fuel consumption data is provided by NS Reizigers (Dutch rail passenger organisation). Emission factors for CO, NMVOC, NO_x and PM_{10} were derived by PBL (The Netherlands Environmental Assessment Agency) in consultation with the NS (Railways Netherlands). Combustion emissions of NH_3 are based on EEA emission factors (Ntziachristos and Samaras, 2000). NMVOC and PAH combustion emissions are calculated using NMVOC profiles (VROM, 1993; Shareef *et al.*, 1988).

No key sources are found in this category.

International inland waterways (1A3di(ii))
For inland waterways, emission factors are dependent on year of construction of the engine and on maximum RPM for recently built engines. Energy consumption data is calculated by using data on ship movements from Statistics Netherlands. This is calculated with the EMS model, which is managed by the Netherlands Organisation for Applied Scientific Research (TNO) (Hulskotte *et al.*, 2003).

Category 1A3di(ii) describes a key source for the following components:

SO_x	(2.4%)
NO_x	(5.8%)
NMVOC	(0.5%)
CO	(0.7%)
TSP	(1.6%)
PM_{10}	(1.9%)
$PM_{2.5}$	(3.3%)
(% of national total in 2008)	

National navigation (1A3dii)
For inland navigation energy consumption for 28 different vessel classes is calculated for the various inland waterway types and rivers in the Netherlands, based on the load factor of the vessels and the speed of the vessels relative to the water. Emission factors dependent on energy consumption were derived by Oonk *et al.* (2003). Emission factors are dependent on year of construction of the engine and on maximum RPM for recently built engines. Energy consumption data is calculated using ship movements and divided into inland shipping and international shipping using the data of Statistics Netherlands. The above calculation is done with the EMS model, which is managed by TNO (Hulskotte *et al.*, 2003).

Combustion emissions of leisure boats are based on fuel consumption data, which are estimated by multiplying boat numbers by specific yearly fuel consumption per boat type. Specific fuel consumption was determined by means of a questionnaire. The calculation procedure is described in a fact sheet (Hulskotte *et al.*, 2005). Some of the emissions of some substances (e.g. PAH and NMVOC species) are specified as waterborne emissions.

Category 1A3dii describes a key source for the following components:

NMVOC profile for gasoline and gasoline evaporation (mass %) **Table 3.4**

	Gasoline		Gasoline vapour	
	1999 and before	2000 and after	1999 and before	2000 and after
Benzene	2.5	0.8	1	0.3
Toluene	15	12.5	3	2.5
Xylene	-	-	0.5	0.5
Aliphatic hydrocarbons (non-halogenated)	35	60	95	97
Aromatic hydrocarbons (non-halogenated)	65	40	5	3

SO_x	(1.2%)
NO_x	(3.8%)
NMVOC	(2.3%)
CO	(4.3%)
TSP	(1.1%)
PM_{10}	(1.3%)
$PM_{2.5}$	(2.4%)

(% of national total in 2008)

Other (1A3e)

No emissions are reported in this category and the subcategories 1A3e1 *Pipeline compressors* and 1A3e2 *Other mobile sources and machinery*.

3.6 Evaporation, tyre and brake wear, road abrasion (1A3b)

Road transport: gasoline evaporation (1A3bv)

VOC emissions from gasoline evaporation originate from diurnal losses, hot soak losses and running losses. The calculation of evaporative emissions is based on the simpler (Tier 2) methodology from the Emission Inventory Guidebook 2007 (EEA, 2007). The Guidebook provides specific emission factors for different vehicle size classes, temperature ranges in winter and summer and fuel vapour pressures. Data on vehicle numbers and vehicle use are derived from Statistics Netherlands. The emissions of NMVOC components are calculated on the basis of NMVOC speciation profiles. The evaporation NMVOC profile has, since 2000, been adjusted for the change in benzene and aromatics content of gasoline since 2000, due to stricter EU legislation (see Table 3.4).

Category 1A3bv describes a key source for the following component:

NMVOC	(2.5%)

(% of national total in 2008)

Road transport, automobile tyre and brake wear (1A3bvi)

TSP emissions from tyre wear and brake wear are based on vehicle kilometres and emission factors. The fraction PM_{10} in total PM for tyre wear is assumed to be 5% (highly uncertain) and for brake wear 49%. Heavy metal emissions are calculated using a speciation profile on total particulate emissions.

Category 1A3bvi describes a key source for the following components:

TSP	(3.5%)
PM_{10}	(4.1%)
$PM_{2.5}$	(1.4%)
Pb	(14.3%)

(% of national total in 2008)

Road transport, automobile road abrasion (1A3bvii)

The same method is applied as for category 1A3bvi Tyre and brake wear. The fraction PM_{10} in TSP for road abrasion is assumed to be 5%. Heavy metal emissions are calculated using a speciation profile on total particulate emissions.

Category 1A3bvii describes a key source for the following components:

TSP	(2.7%)
PM_{10}	(3.1%)

(% of national total in 2008)

3.7 Energy, fugitive emissions from fuels (1B)

The fugitive NMVOC emissions from category 1B2ai comprise process emissions from oil and gas production and are derived from the environmental reports of the companies, which cover 100% of the emissions.

Category 1B2ai describes a key source for the following components:

NMVOC	(4.0%)

(% of national total in 2008)

The fugitive NMVOC emissions from category 1B2aiv comprise dissipation losses from gasoline service stations, leaking losses during vehicle/aeroplane refuelling and refinery processes.

Category 1B2aiv describes a key source for the following components:

NMVOC	(2.5%)

(% of national total in 2008)

The fugitive NMVOC emissions from category 1B2b comprise emissions from gas transport (compressor stations) and gas distribution networks (pipelines for local transport).

The NMVOC emissions from gas transport are derived from the environmental reports of the companies, which cover 100% of the emissions. The NMVOC emissions from gas distribution are calculated on the basis of a NMVOC profile with the CH_4 emission from annual reports of the sector as input.

Category 1B2b describes a key source for the following component:

NMVOC	(1.0%)
(% of national total in 2008)	

Industry (2)

4

4.1 Overview of the sector

Emissions in this sector include all non-energy-related emissions from industrial activities. Emissions from fuel combustion in industrial activities are included in data on the energy sector. Fugitive emissions in the energy sector (i.e. not relating to fuel combustion) are included in NFR sector 1B Fugitive emissions.

Industrial process emissions are based on environmental reports of large industries and extrapolations to total emissions per SBI category, using implied emission factors and production data (method 1), or they are based on sector reports on emissions (method 2) or they are based on specific emission factors and production statistics from CBS and branch organisations(method 3).

Method 1 Extrapolation from emission data of individual companies

$$\textit{Emission factor ER-I}_{\text{(SBI category)}} = \textit{Emissions ER-I}_{\text{(SBI category)}} / \textit{Production ER-I}_{\text{(SBI category)}})$$

where

ER-I = Emission Registration database for individual companies

Production ER-I = activity data or proxy for the production process

Next, the total process emissions in this SBI category are calculated from the production data, as provided in the Production Statistics (Statistics Netherlands), multiplied by the implied emission factor.

$$\textit{ERI\_SBI\_Emission}_{\text{(SBI category)}} = \textit{Emission factor ER-I}_{\text{(SBI category)}} * \textit{Production}_{\text{(SBI category)}}$$

Note: Companies do not provide specific information to the PRTR on their measurement systems or emission model or which emission factors are used in the calculation model. Therefore, in some cases the PRTR can not use the data from the environmental reports in the extrapolation to the total emissions of a sector.

Method 2 Sectoral emission reports

Some branch organisations provide emission reports as part of their agreements in covenants with the government; see http://www.fo-industrie.nl (Dutch only). Total emissions for the sectors are obtained from these annual reports.

Method 3 Sources for which there is no individual or sectoral registration

A set of specific emission factors is used for the calculation of emissions such as PAHs from 2C1 and 2C5e. These emission factors are obtained from specific studies. The emission factors are combined with production statistics from CBS or activity data reported by specific branch organisations.

The main categories (2A–G) in the NFR sector 2 'Industrial processes' are discussed in the following sections. Because the priority heavy metals (Pb, Hg and Cd) time series of most categories (2A1, 2B, 2C) are incomplete they will not be discussed in the following sections. In subsequent submissions, incomplete time series will be repaired, as far as possible.

4.2 Mineral production (2A)

This category comprises emissions related to the production and use of non-metallic minerals in:

- 2A1 Cement clinker production;
- 2A3 Limestone and dolomite use;
- 2A4 Soda ash production and use;
- 2A7 Other (the production of glass and other mineral production and use).

Emissions from 2A2 Lime production are included in 2D2; those from 2A5 Asphalt roofing and 2A6 Road paving with asphalt are not estimated since no methodology is available.

Due to allocation problems, total emissions from mineral products (2A) are reported in category 2A7. Only emissions in the category 2A1 Cement production could be reported separately, because emissions in this category are derived from the environmental reports of the corresponding companies.

Cement clinker production (2A1)

Category 2A1 describes a key source for the following component:

Hg	(11.5%)
(% of national total in 2008)	

Other mineral products (2A7d)

Category 2A7d describes a key source for the following components:

SO_x	(1.8%)
TSP	(2.8%)
PM_{10}	(3.3%)
$PM_{2.5}$	(2.5%)
Pb	(3.9%)

(% of national total in 2008)

The SO_2 emissions reported in this category originate in glass production and production of roof tiles. The SO_2 and lead emissions from glass production are calculated with the extrapolation method (1), see Section 4.1, based on m^2 glass produced by individual companies and total glass production, as reported by the CBS. The SO_2 emission from the production of roof tiles is based on production statistics and a specific emission factor (method 3). Because of a lower sulphur content in fuels, SO_2 emissions decreased from 10.1 in 1990 to 3.1 Gg in 2008. Pb emissions in this category are from glass production only.

4.3 Chemical industry (2B)

The PRTR comprises emissions related to three source categories belonging to this category:

- 2B1 Ammonia production (SBI 24.15 'Manufacture of artificial fertilisers')
- 2B2 Nitric acid production (included in SBI 24.1 'Manufacture of basic organic chemicals')
- 2B5a Emissions from 'Other chemical product manufacture':
- Manufacture of chemicals for agricultural use;
- Manufacture of other chemical products (glue, photo chemicals, pharmaceuticals, fibres, paint and ink, soap and detergents).

Adapic acid (2B3) and calcium carbide (included in 2B4) are not produced in the Netherlands. Emissions are not reported under 2B1 and 2B2 (only the greenhouse gases CO_2 and N_2O are reported here). Due to allocation problems, all emissions from the chemical industry (2B) are reported in category 2B5a.

Other chemical industry (2B5a)

Category 2B5a describes a key source for the following components:

NMVOC	(4.5%)
TSP	(4.8%)
PM_{10}	(2.3%)
$PM_{2.5}$	(3.2%)
Pb	(3.7%)
Hg	(3.0%)
Cd	(33.7%)

(% of national total in 2008)

All emissions are calculated by extrapolation of activity data and emissions of the individual companies to totals in the subsectors, using production volume or production value as a proxy.

From 1990 to 2008, NMVOC emissions decreased from 33.82 to 7.56 Gg and PM_{10} emissions from 4.42 to 0.84 Gg. These reductions were mainly caused by the implementation of technical measures.

4.4 Metal production (2C)

The national inventory of the Netherlands comprises emissions from iron and steel production (2C1) and other metal production (2C5). As announced in the 2009 submission, the current submission also includes emissions of the four individual PAHs (Benzo(a)pyrene, Benzo(b) fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene) as well as the total for those four substances.

2C1 Iron and steel production

Category 2C1 describes a key source for the following components:

TSP	(8.9%)
PM_{10}	(4.1%)
$PM_{2.5}$	(4.8%)
Pb	(64.3%)
Hg	(31.9%)
Cd	(53.6%)
PAH	(5.0%)

(% of national total in 2008)

The Netherlands has one integrated iron and steel plant (Corus, formerly known as Hoogovens). Integrated steelworks convert iron ores into steel by means of sintering, producing pig iron in blast furnaces and converting pig iron to steel in basic oxygen furnaces. For the purpose of the inventory, emissions from integrated steelworks are estimated for these three processes, as well as for some other minor processes. Emissions from sintering are included in 1A. A portion of the coke oven gas and blast/oxygen furnace gas produced during these processes is sold to a nearby power plant to be used as fuel. These emissions are reported by Corus in AERs and are included in category 1B. The emissions are calculated by using the extrapolation method. Extrapolations to total emissions from this sector are very small.

The PM_{10} emissions decreased from 10.27 Gg in 1990 to 1.86 Gg in 2008 and the PAH emissions from 1.641 Mg in 1990 to 0.199 Mg in 2008. These reductions were mainly caused by the implementation of technical measures.

2C5e Other metal production

Category 2C5e describes a key source for the following components:

CO	(6.9%)
TSP	(1.1%)
$PM_{2.5}$	(1.2%)
Cd	(2.4%)
PAH	(19.6%)

(% of national total in 2008)

The other metal production (2C5) category covers the production of aluminium, copper, lead, nickel and zinc. Aluminium production is the most important sector in this category. Aluminium is produced at two primary aluminium smelters and they report their emissions in AERs. The emissions are calculated by using the extrapolation method.

Between 1990 and 2008 the CO emissions remained rather constant. PM_{10} emissions decreased from 1.046 Gg in 1990 to 0.357 Gg in 2008 and PAH emissions from 2.567 Mg in 1990 to 0.779 Mg in 2008. These reductions were mainly caused by the implementation of technical measures.

4.5 Pulp and paper (2D1)

Category 2D1 describes a key source for the following component:

PM_{10}	(1.0%)

(% of national total in 2008)

PM emissions in this category are derived from the environmental reports of the companies and completed with calculations using implied emission factors and production data (method 1). The PM_{10} emissions from this sector remained rather constant between 1990 and 2008.

4.6 Food and drink production (2D2)

Category 2D2 describes a key source for the following components:

NMVOC	(3.2%)
TSP	(7.3%)
PM_{10}	(7.3%)
$PM_{2.5}$	(2.3%)

(% of national total in 2008)

NMVOC and PM emissions in this category are derived from the environmental reports of the companies and completed with calculations using implied emission factors and production data (method 1). From 1990 to 2008, the NMVOC emissions decreased from 7.56 to 5.67 Gg and the PM_{10} emissions from 7.17 to 2.77 Gg. These reductions were mainly caused by the implementation of technical measures.

4.7 Other production (2G)

Category 2G describes a key source for the following components:

NMVOC	(7.7%)
TSP	(6.0%)
PM_{10}	(6.4%)
$PM_{2.5}$	(3.5%)
PAH	(1.3%)

(% of national total in 2008)

Most of PAH emissions are emitted in the electrical engineering sector. The emission figures are derived from the environmental reports of the companies and completed with calculations using implied emission factors and production data (method 1). NMVOC emissions decreased from 37.9 Gg in 1990 to 12.35 Gg in 2008 and PM_{10} emissions from 4.91 Gg in 1990 to 2.34 Gg in 2008. These reductions were mainly caused by the implementation of technical measures.

PAH emissions remained rather constant between 1990 and 2008.

Solvents and product use (3)

5

5.1 Overview of the sector

Emissions in this sector include emissions from the use of paints (3A), degreasing and dry-cleaning(3B), the printing industry (3D1), domestic solvent use (3D2) and other product use (3D3). Most emissions are based on activity data from (statistical) annual reports from branch organisations and NMVOC contents and emission factors from studies. Emissions from chemical products, manufacturing and processing (3C) are included in 2B (chemical industry).

NMVOC emissions from solvent use have decreased since 1990 because of a reduction in the solvent content in consumer products and paints. The PRTR works in good cooperation with industrial branch organisations.

In the paint application sector, annual statistics on sales are provided by the Dutch branch organisation for paint producers (VVVF). Also for products containing solvent (in the domestic sector and other product use), sales data are obtained from the branch organisations. The fraction NMVOC emitted to the atmosphere is available from other studies. The printing industry has an agreement with the government from which data become available for the PRTR.

The main categories (3A, 3B and 3D) in the NFR sector 3 'Solvent and product use' are discussed in the following sections.

5.2 Paint application (3A)

This is the most important category in this sector.

3A1 Decorative coating application

Category 3A1 'Decorative coating application' describes a key source for the following component:

NMVOC (2.3%)
(% of national total in 2008)

3A2 Industrial coating application

Category 3A2 'Industrial coating application' describes a key source for the following component:

NMVOC (11.4%)
(% of national total in 2008)

VOC emissions from paint use are calculated from annual national paint sales statistics (containing data on paint that is both produced and sold in the Netherlands), provided by the Dutch branch organisation for paint producers (VVVF), including data on paint imports, estimated by the VVVF (2004). The VVVF (through its members) directly monitors VOC in paint, while an assumption by the VVVF is used for the VOC in imported paints. Estimates have also been made for paint-related thinner use and the (reduction) effect of afterburners. For more information, see the protocol 'Calculation of VOC emissions from paint in the Netherlands' (Peek, 2010).

NMVOC emissions from paint use decreased from 80.74 Gg in 1990 to 21.8 Gg in 2008, mainly due to the lower average NMVOC content.

5.3 Degreasing and dry cleaning (3B)

3B1 Degreasing

Category 3B1 'Degreasing' describes a key source for the following component:

NMVOC (1.4%)
(% of national total in 2008)

Up-to-date information on activity data is not available and emissions (2.9 Gg) have been assumed constant for the 2000-2008 period. For the next submission the PRTR will investigate this problem.

3B2 Dry-cleaning

No key sources in the category 3B2 'Dry-cleaning'.

5.4 Other, including products containing HMs and POPs (3D)

3D1 Printing

Category 3D1 'Printing' describes a key source for the following component:

NMVOC	(3.0%)
(% of national total in 2008)	

Some branch organisations provide emission reports as part of their agreements in covenants with the government. Emissions from total category are subtracted from these annual evaluation reports.

NMVOC emissions decreased from 14.36 Gg in 1990 to 4.79 Gg in 2008. These reductions were mainly caused by the implementation of technical measures (afterburners).

3D2 Domestic solvent use including fungicides

Category 3D2 'Domestic solvent use including fungicides' describes a key source for the following component:

NMVOC	(11.9%)
(% of national total in 2008)	

The most important sources are cosmetics (and personal care), cleaning agents and car products.

Total NMVOC-emissions per product are calculated by multiplying them by the number of products sold. NMVOC emissions per product are calculated by multiplying the fraction of the NMVOC content that is emitted to the atmosphere by the content of the product.

Sales data are obtained from annual reports of branch organisations. The NMVOC content of the products and the fraction of the NMVOC content that is emitted to the atmosphere are obtained from studies.

The NMVOC emissions increased from 11.3 Gg in 1990 to 19.1 Gg in 2008. These extra emissions were caused by the increased consumption of cosmetics, cleaning agents and car products during the 1990-2008 period.

3D3 Other product use

Category 3D3 describes a key source for the following components:

NMVOC	(5.8%)
TSP	(2.9%)
PM_{10}	(3.5%)
$PM_{2.5}$	(2.2%)
DIOX	(65.1%)
(% of national total in 2008)	

Category 3D3 also includes the emissions from the use of creosoted wood products (PAH) and dioxin emissions from PCP treated wood. The emission is estimated by using a specific Dutch method.

Dioxin emissions from timber frames used in housing are determined for 1990 based on Bremmer et al (1993). As PCP has been banned since 1989, a linear reduction in dioxin emissions has been assumed around 25 g I-TEQ in 1990 to around 16 g I-TEQ in 2000.

Emissions of the other components remained rather constant between 1990 and 2008.

Agriculture (4)

6

The sector Agriculture is a major source category for ammonia and particulate matter (PM) emissions. See section 5.2.3 on emission trends. For ammonia emission from agriculture two different sources are distinguished: animal manure and synthetic fertiliser. The main source of agricultural PM emissions is formed by animal housing systems. A description of the calculation method is provided in Van der Hoek (2002).

Ammonia emissions from animal manure

Ammonia emissions from animal manure are calculated using the Manure and Ammonia model developed by the Dutch Agricultural Economics Research Institute (LEI). Input data for this model are divided into general and specific. General input data are animal numbers taken from the annual agricultural census. Specific input data concern the nitrogen and phosphate excretion by different animal categories and the ammonia volatilisation rates from animal housing systems and soil application systems for animal manure. The average nitrogen excretion per animal category is calculated annually as the difference between absorbed nitrogen from feeding and the capture in animal products. This so-called 'balance' method takes into account annual changes in food consumption, food nitrogen content, etc. The excreted nitrogen partly volatilises as ammonia in animal houses, in pasture, during storage and during application to the soil. The share of housing and manure application systems with low ammonia volatilisation rates is taken into account. The rate of volatilisation of ammonia from animal manure depends on such aspects as the nitrogen content of the manure, the chemical balance between ammonia and ammonium in the manure and, finally, the contact surface manure – air and the exposure time.

Ammonia emissions from synthetic fertiliser

Ammonia emissions from synthetic fertiliser are calculated using data on the amounts of applied nitrogen fertiliser. These data are recorded by LEI and reported in Landbouwcijfers (Agricultural Data); these are also available via www.lei.wur.nl. Several types of nitrogen – each with their own specific ammonia emission factor fertiliser – are distinguished.

PM emissions from Agriculture

The main source for PM emissions from agriculture are animal housing systems. Some other smaller sources include application of synthetic fertiliser, application of pesticides, supply of concentrates, hay making and harvesting of arable crops. The general input data for calculating the emissions from animal housing systems are animal numbers taken from the annual agricultural census. The share of poultry in free range housing systems with relative high emission factors is taken into account in these calculations. For several sources country-specific emission factors are available (Chardon and Van der Hoek, 2002).

6.1 Dairy cattle (4B1A)

Ammonia emission from dairy cattle (adult female cows) is calculated by multiplying the activity number with the emission factor. For dairy cattle the activity number is based on the animal number count from the annual agricultural census. Emission factors are calculated from the excretion and volatilisation rates for dairy cows.

Excretion rate

The excretion rate depends on feed intake and milk yield. Distinction is made between type of feed in two regions in the Netherlands and for two periods (summer and winter period).

Volatilisation rate

There are four different sources for ammonia emissions from animal manure: animal housing (manure production and storage), outside storage facilities (manure storage), meadow (manure production) and soils (manure application). For this reason also four different volatilisation rates are distinguished. Approximately 40% of dairy cattle ammonia emissions are derived from application of manure to the soil. Another 50% derives from animal houses and the rest is from animals grazing and from storage of manure.

Category 4B1a describes a key source for the following components:

NH_3	(29.0%)
TSP	(2.0%)
PM_{10}	(2.4%)
$PM_{2.5}$	(0.9%)

(% of national total in 2008)

6.2 Non-dairy cattle (4B1b)

Emission data for non-dairy cattle is based on the non-dairy cattle number count from the agricultural census and on emission factors calculated from excretion and volatilisation rates for these specific cows. There is, however, no distinction made between young and full-grown animals. Young dairy cattle are also included in this category.

Category 4B1b describes a key source for the following component:

NH_3	(14.4%)

(% of national total in 2008)

6.3 Swine (4B8)

Emission data is based on agricultural data from the agricultural census and on emission factors calculated from excretion and volatilisation rates for two specific types of pigs. Distinction is made between animals for meat production (fattening pigs) and animals used for breeding (breeding sows). Three types of volatilisation rates are distinguished for the two swine categories: the animal house, manure storage and soil application. Housing systems with high and low ammonia emission are also distinguished.

Emission of particulates comes mainly from skin, manure, feed and mulch particles ventilated from animal housing and have been calculated using an average emission factor per pig, deducted from the PM_5 (respirable fraction of PM) emission factor.

Category 4B8 describes a key source for the following components:

NH_3	(23.0%)
TSP	(5.9%)
PM_{10}	(6.9%)
$PM_{2.5}$	(2.6%)

(% of national total in 2008)

6.4 Poultry (4B9)

Ammonia emission data is based on agricultural data from the agricultural census and on emission factors calculated from excretion and volatilisation rates for two specific types of poultry. Distinction is made between animals for meat production (broilers) and animals for egg production (laying hens). For both poultry categories, three types of volatilisation rates are distinguished: for the animal house, manure storage and soil application. Five different housing systems are distinguished for laying hens.

Emission of particulates comes mainly from skin, manure, feed and mulch particles ventilated from animal housing; these have been calculated using an average emission factor per chick, deducted from the PM_5 (respirable fraction of PM) emission factor. A distinction is made between free-range housing systems (with high PM emission factors) and housing systems based on cages (with a low PM emission factor).

Category 4B9 describes a key source for the following components:

TSP	(13.0%)
PM_{10}	(15.4%)
$PM_{2.5}$	(5.8%)

(% of national total in 2008)

Laying hens

Category 4B9a describes a key source for the following component:

NH_3	(7.5%)

(% of national total in 2008)

4B9b Other poultry

Category 4B9b describes a key source for the following component:

NH_3	(4.6%)

(% of national total in 2008)

6.5 Synthetic N-fertilisers (4D1a)

Emission data is based on amounts of different types of synthetic fertiliser and specific emission factors.

Category 4D1a describes a key source for the following component:

NH_3	(8.9%)

(% of national total in 2008)

6.6 Farm-level agricultural operations including storage, handling and transport of agricultural products (4D2a)

Emission data are based on amounts of agricultural product stored, handled, transported and used, and on specific emission factors (Chardon and Van der Hoek, 2002).

Category 4D2a describes a key source for the following component:

PM_{10}	(1.0%)

(% of national total in 2008)

7 Waste (6)

7.1 Waste incineration (6C)

The combustion emissions from waste incineration are included in the category 1A1a because nearly all the energy from waste incineration is converted into electricity. The emissions from crematoria are reported in this category. Mercury (Hg) emissions are estimated on the basis of the number of corpses cremated and an average amalgam content.

6Cc Municipal waste incineration

Category 6Cc describes a key source for the following components :

Hg	(12.7%)
Cd	(3.3%)
DIOX	(2.4%)

(% of national total in 2008)

6Cd Cremation

Category 6Cd describes a key source for the following components :

Hg	(8.4%)

(% of national total in 2008)

7.2 Other waste (6D)

The emissions from the waste sector are reported in this category and coded as process emissions in the database. For historical reasons this category used to contain some of the emissions from waste incineration. This has been corrected in the latest submission, and emissions have been transferred to the 1A1a category.

No key sources in this category.

8

Other (7)

The emissions from burning candles, smoking of cigarettes and lighting of fireworks are reported in this category. This also includes the emissions of NH_3 from human perspiration. Please note that the Netherlands include this NH_3 sources in the national total, whereas other parties do not. There is no clear guidance yet whether or not these emissions should be included in the national total for NH_3.

Category 7A describes a key source for the following components:

NH_3	(3.8%)
TSP	(3.1%)
PM_{10}	(3.7%)
$PM_{2.5}$	(7.0%)

(% of national total in 2008)

Recalculations and other changes

9

9.1 Recalculations of the 2010 submission

Compared to the 2009 submission (Jimmink et al, 2009), only one methodological change was implemented in the PRTR system. A new method for calculating the emission from off-road vehicles was implemented which is described on the website of Statistics Netherlands, see http://www.cbs.nl/en-GB/menu/themas/natuur-milieu/methoden/dataverzameling/overige-dataverzameling/2006-11-methoden-rapport-verkeer-eng1.htm. This new method is based on sales data and average annual use, energy consumption and average life span of different types of mobile machinery (Hulskotte *et al.*, 2009). Total energy consumption by non-road mobile machinery as applied in this method, was obtained from Statistics Netherlands. The new method has led to a decrease in the calculated PM_{10} emissions of 0.7 to 0.9 Gg (25-30%) for the 2000-2006 period. The drop in NO_x emissions was small (1-2%).

9.2 Improvements

Improvements included in the 2010 submission and the IIR 2010:

New information on total kilometres driven by heavy-duty vehicles (excluding buses) became available from Statistics Netherlands, based on the *Statistiek Wegvervoer* (Road Transport Survey) combined with data from the NAP (Dutch national vehicle information foundation). The NAP registers odometer data from all vehicles that enter a garage for maintenance or repair. This data has been used by Statistics Netherlands to calculate the average annual mileage for different vehicle types. Combined with data on the number of vehicles in the Dutch car fleet and kilometres driven by foreign vehicles, this has led to new data on total annual mileage of different types of heavy-duty vehicles on the Dutch road network for the 2001-2007 period. Applying this new data has led to lower annual NO_x emissions from heavy-duty vehicles by approximately 1to 6 Gg in the 2000-2006 period.

NAP-data has also been used by Statistics Netherlands for recalculating the total annual number of kilometres driven by light commercial vehicles (N1 vehicles) within the Netherlands in the 2001-2007 period. This resulted in a downward adjustment of approximately 10 to 20%, subsequently resulting in a downward adjustment of total emissions from LCVs.

Furthermore, the Netherlands now also report on the individual PAHs, instead of formerly only reporting on the sum parameter for total PAHs. This methodological change explains the drastic reduction in reported PAHs emissions.

The Dutch inventory now also holds data on estimates of ammonia emissions from horses. The emissions of ammonia have now increased with 3 to 4 Gg compared to the last submission.

Because of recoding of emission sources in the PRTR system some emission figures were reallocated, compared to the 2009 submission (Table 9.1).

As before, for the Netherlands, emissions from road transportation were calculated on the basis of 'fuel consumed'. More accurate activity data have become available on the amount of kilometres driven within the Netherlands, including a subdivision which distinguishes kilometres driven on motorways, regional and local roads.

For the subsector 'Commercial', 'Riding Horses' are recognised as a new emission source. A calculation for the complete reporting period has been added to the inventory.

For agricultural sources PM_{10} and $PM_{2.5}$ emission series have been recalculated.

Planned improvements:

The share of kilometres driven annually, on urban roads, rural roads and motorways by different vehicle types will be re-evaluated.

The NMVOC and PAH profiles used for calculating emissions of different NMVOC and PAH components from light and heavy-duty vehicles (excluding motorcycles and mopeds) will be re-evaluated.

The emission model VERSIT+, used for calculating emission factors for different types of road vehicles, will be re-estimated by using new measurement data on new light

Re-allocation of emission sources in the PRTR system in 2010 **Table 9.1**

Source	Allocation in 2009 submission	Allocation in 2010 submission	Compounds	Rationale
Waste incineration	1 A 1 a	6 C c	All	Former allocation was based on IPCC guidelines
Cokes production	1 A 1 c	1 B 1 b	All	Error correction
Refineries and petro-chemical operations	1 B 2 a i	1 A 1 b And 1 A 1 c	All	Improved allocation
Oil and Gas	1 B 2 b	1 A 1 c	Combustion emissions	Error correction
Oil and Gas	1 B 2 b	1 B 2 a i	NMVOC	Error correction
Soda Ash production	2 A 4	1 A 2 c	NO_x, SO_2	These emission should be reported under combustion
Printing industry	2 G	3 D 1	NMVOC	Improved allocation

Please note that the above reallocations do not change the national emission total.

and heavy-duty vehicle types (Euro-4 LD, Euro-IV and Euro-V HD).

Recalculations of agricultural NH_3 emissions for the whole time series will become available. As outlined in the newest EMEP guidelines the total acid number (TAN) fraction will be included in the nitrogen flow. The method still follows a Tier-3 approach.

Projections

10

The chapter on projections consists of a description (per source sector) of general methods (models), data sources and assumptions used for estimating projected emissions reported in Annex IV Table 2a. Where available, references to detailed documentation are included.

The updated reference scenario is the Global Economy variant (GE) of the Reference Scenario from 2005 (Daniëls and Van der Maas, 2009). This GE-scenario offers a future based on a consistent set of assumptions on long-term demographic, economic and technological trends. The scenario used for emission projections includes the effects of the current economic crisis, the implementation of the European climate and energy measures as well as the proposed Industrial Emissions Directive and the recent IMO-agreement on a lower sulphur content in fuels for sea-going vessels. Based on the assumed CO_2-prices and energy prices estimates were made for the number of additional power plants and CHP installations in industry and glasshouse horticulture in the coming decade, as well as the share of renewable energy in electricity production.

The pace at which economic growth will recover after 2010 still remains unclear. The average annual economic growth between 2011 and 2020 is assumed to be 2.7%. Clearly, the economic crisis leads to a decline in environmental investments.

The economic crisis reduces emissions by an extra 5 to 10% in 2010 compared to the projection last year (See Table 10.1). NH_3 emissions are not expected to change because of the crisis.

As a consequence of the recession especially freight transport, industrial production and construction decline considerably, in turn reducing emissions. Lower investments in cleaner technology, however, have a negative effect on emissions (i.e. raising them).

10.1 Energy

10.1.1 Stationary combustion

Emissions are linked to energy use, which, in turn, is connected to fuel and CO_2-prices. In the GE-scenario oil prices are assumed to increase from 53 USD per barrel in 2009 to 68 USD per barrel in 2020. The CO_2-price is assumed to be 35 euros per tonne CO_2 in 2020. The direct impact from higher energy and CO_2 prices on final and primary energy use turns out to be relatively low. In 2008 the Energy research Centre of the Netherlands (ECN) concluded, on the basis of an analysis of the electricity market, that in the coming decade strong climate policies and high CO_2 prices are likely to improve the international competitiveness of Dutch electricity generation (See ECN report http://www.ecn.nl/docs/library/report/2008/e08026.pdf). Higher CO_2 prices will paradoxically increase the share of coal in Dutch electricity generation and limit the share of renewable energy in electricity production. The capacity of wind power is assumed to increase from 2000 MW in 2005 to the government target of 15400 MW by 2020. This includes the realisation of a wind park of 6000 MW in the North Sea. However, restricted available and appointed budgets have, until now, limited the growth in wind energy for 2020 on land to 3600 MW and to 2100 MW at sea.

New policy measures

For NO_x-trading in industry, the performance standard rate of 40 g/GJ has been sharpened to 37 g/GJ. Moreover emission standards for medium-sized heating systems (BEMS) have been sharpened.

Historical and projected emissions from the Netherlands (PBL, 2009a) — **Table 10.1**

Pollutant:		1990	2000	2007	NEC-2010	2010	2020
SO_2	Gg	192	73	60	50	40	48
NO_x	Gg	557	390	299	260	244	206
NH_3	Gg	253	155	137	128	129	131
NMVOC	Gg	463	229	164	185	143	165
PM_{10}	Gg	75	44	37	NA	33	34
$PM_{2.5}$	Gg	46	25	20	NA	17	15

10.1.2 Mobile combustion

The transport sector's projections were updated with available new insights into transport volumes and emission factors. The assumed growth of diesel use by passenger cars has been adjusted downwards, based on recent developments in car sales in the Netherlands combined with new policy measures relating to the registration tax for passenger cars. In the new projections, the share of diesel in total fuel used is assumed to increase from approximately 23% in 2000 to 36% in 2020.

Policy measures

NO_x emissions by road traffic are reduced by renewal of the fleet of vehicles, combined with the stricter Euro-standards for light and heavy-duty vehicles (e.g. the Euro-6 standards). These Euro standards also lead to a reduction in PM and NMVOC emissions from road traffic. There has been agreement within the EU on stricter NO_x and PM_{10} standards for heavy-duty vehicles (Euro-VI). The Euro-VI standard applies to new vehicle types from 1-1-2013 and to all new sales from 1-1-2014. These standards are incorporated in the new NO_x emission projections and lead to a decrease in NO_x emission of approximately 13 kton in 2020. Emission standards for non-road transport (i.e. non-road mobile machinery, diesel trains and inland shipping) also contribute to the projected decrease in NO_x emissions from the transport sector.

Since 2007 the North Sea is a Sulphur Emission Control Area (SECA), meaning sea-going vessels have to use fuel oil with a maximum sulphur content of 1.5%. The International Maritime Organisation (IMO) has sharpened this standard to 1% from 2010, and 0.1% from 2015 onwards.

At the end of 2008, the EU agreed on the revision of the fuel quality directive, which constrains the sulphur content for inland shipping, rail transport and mobile machinery to a maximum of 10 ppm. As a consequence of the sharpening of the standard, the entire transport sector (except for sea shipping) will use virtually sulphur-free fuels from 2011 onwards. Combined, these two measures lead to a sharp decrease in the projected SO_2-emissions by the transport sector.

Additional policies that have not been decided upon and which, therefore, are not incorporated in the projections, are the introduction of road pricing and a limitation put on the growth of Schiphol Amsterdam Airport of 255000 landing and take-off (LTO) cycles (in 2000 the number of cycles was 215000). The Dutch Government plans to introduce a so-called 'kilometre price' for passenger vehicles, vans and heavy-duty vehicles, from 2011 onwards. The price per kilometre will depend on vehicle type, fuel type, fuel efficiency and emission performance. The average price per kilometre for passenger vehicles would be € 0.07. It is expected that the introduction of road pricing would lead to a decrease in vehicle kilometres travelled, resulting in lower emissions. The faster renewal rate of the national fleet of vehicles would also lead to a decrease in emissions.

10.2 Industrial processes

In the GE-scenario, industrial revenues grow by 2.4% per annum. The growth is relatively high in chemical industry (4.1%) and food and beverages industry (3.6%). Iron and steel production has a smaller growth with (0.9%).

Policy measures

The refinery sector has agreed to an emission cap of 16 Gg for SO_2. Additional policy envisages a sharpening of this cap to 14.5 Gg.

10.3 Agriculture

NH_3 emissions from agriculture are not expected to change because of the economic crisis. Prices of agricultural products are expected to drop, in the short term, but this will not affect agricultural production levels.

Animal numbers have been derived from the GE-scenario in the long-term scenario study 'Welfare, Prosperity and Quality of the Living Environment' by CPB, MNP and RPB (CPB *et al.*, 2006) and adjusted according to recent data from the Statistics Netherlands (CBS). Cattle stocks are assumed to decrease from 3.7 million cows in 2008 to 3.5 million in 2020. The number of pigs is assumed to decrease from 12 million in 2008 to 11 million in 2020 and for poultry an increase is expected from 99 million in 2008 to 109 million in 2020. The use of N fertilizer is expected to decrease from an annual 258 Gg in 2008 to 236 Gg per year in 2020.

Policy measures

As an additional measure, the introduction of air scrubbers has been assumed for NH_3 and $PM_{2.5}$ emissions from very large animal houses.

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Colophon

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Report prepared for submission in accordance with The UN Framework Convention on Long Range Transboundary Air Pollution including electronic Excel spreadsheet files containing Nomenclature for Reporting (NFR) data for 1990 to 2008.

Emissions from the Netherlands: “How are we doing?”

The Netherlands Informative Inventory Report (IIR) contains information on emission inventories in the Netherlands up to 2008, describing methods, data sources, QA/QC activities carried out and a trend analysis.

Its aim is to provide a better view on applicability (transparency between countries, modeled air quality) and accountability (transparency, completeness, consistency, strengths and weaknesses in methods, uncertainties) of emission data.

So basically, it’s useful for inventory reviewers, modelers and emission experts in general.

In the 1990–2008 period, emissions of all gases presented in this report showed a downward trend. Major overall drivers for this trend are emission reductions in industry, cleaner fuels and cleaner cars.

Netherlands Environmental Assessment Agency, March 2010