Greenhouse Gas Emissions in the Netherlands 1990-2007

National Inventory Report 2009

Planbureau voor de Leefomgeving

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Report prepared for submission in accordance with The UN Framework Convention on Climate Change (UNFCCC) and the European Union's Greenhouse Gas Monitoring Mechanism [Including electronic Excel spreadsheet files containing the Common Reporting Format (CRF) data for 1990 to 2007]

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Subsequently, the emissions and activity data of the Netherlands' inventory is converted into the IPCC source categories contained in the CRF files, which form a supplement to this report.

The description of sources, analysis of trends and uncertainty estimates in emissions (see Chapters 3 to 8) of the various sources has been made in cooperation with the following emission experts: Mr Guus van den Berghe (SenterNovem) (waste), Mr Gert-Jan van der Born (land use), Mr Gerben Geilenkirchen (transport), Mr Romuald te Molder (trends, key sources), Mr Durk Nijdam (small combustion, solvent and product use), Mr Jos Olivier (energy), Mr Kees Peek (fugitive, industrial processes, other waste), Mr Kees Baas (CBS) (wastewater handling), Mrs Marian van Schijndel and Ms Sietske van der Sluis (agriculture). In addition, Mr Bas Guis of CBS has provided pivotal information on CO_2 related to energy use. This group has also provided activity data and additional information for the CRF files in cases where these were not included in the data sheets submitted by the ER Task Forces. We are particularly grateful to Mr Jack Pesik, Mr Dirk Wever and Mr Jeroen Peters, for their contribution to data processing and quality control.

We greatly appreciate the contributions of each of these groups and individuals to this National Inventory Report and supplemental CRF files, as well as the external reviewers that provided comments on the draft report.

Rapport in het kort

Broeikasgasemissies in Nederland 1990-2007

Dit rapport over de Nederlandse inventarisatie van broeikasgasemissies is op verzoek van het Ministerie van VROM opgesteld om te voldoen aan de nationale rapportageverplichtingen in 2008 van het Klimaatverdrag van de Verenigde Naties (UNFCCC) en van het Bewakingsmechanisme Broeikasgassen van de Europese Unie. Dit rapport bevat de volgende informatie:

- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2007;
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van het IPCC-rapport over Good Practice guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- een overzicht van het kwaliteitssysteem en de validatie van de emissiecijfers voor de Nederlandse Emissieregistratie.

Geconcludeerd wordt dat de emissies van de zes broeikasgassen, uitgedrukt in CO_2 equivalenten, in 2007 in totaal met bijna 3% gedaald zijn ten opzichte van het basisjaar [1990 voor CO_2 , CH_4, N_2O en 1995 voor HFK's, PFK's en SF_6 (F-gassen); exclusief de bos- en landgebruik (LULUCF)]. Emissie van CO_2 exclusief LULUCF is in de periode 1990-2007 met 8% gestegen, terwijl de emissies van CH_4 en N_2O met respectievelijk 34% en 23% zijn gedaald over dezelfde periode. De emissies van F-gassen zijn in de periode 1995-2007 met gemiddeld 72% afgenomen. De emissies van HFK's en PFK's daalden in die periode met respectievelijk 71% en 83%. De SF_6 emissies daalden met 29%.

Ten opzichte van 2006 zijn in 2007 zowel de CO_2-emissies als de totale broeikasgasemissies vrijwel gelijk gebleven (minder dan 0,5% gedaald).

Trefwoorden: broeikasgassen, emissies, trends, methodiek, klimaat

Inhoud

Samenvatting

Inleiding

Het National Inventory Report (NIR) 2009 bevat de rapportage van broeikasgasemissies (CO_2, N_2O, CH_4 en de F-gassen) over de periode 1990 tot en met 2007.

De emissiecijfers in de NIR 2009 zijn berekend volgens de protocollen behorend bij het 'National System' dat is voorgeschreven in het Kyoto Protocol. In de protocollen zijn de methoden vastgelegd voor zowel het basisjaar (1990 voor CO_2, CH_4 en N_2O en 1995 voor de F-gassen) als voor de emissies in de periode tot en met 2012. De protocollen staan op de website www.broeikasgassen.nl. Alle emissiecijfers en bijbehorende documentatie worden ook, met een vertraging van enkele maanden, gepubliceerd op www.emissieregistratie.nl.

National Inventory Report (NIR)

Dit rapport over de Nederlandse inventarisatie van broeikasgasemissies is op verzoek van het ministerie van VROM opgesteld om te voldoen aan de nationale rapportageverplichtingen in 2009 van het Klimaatverdrag van de Verenigde Naties (UNFCCC) het Kyotoprotocol en het Bewakingsmechanisme Broeikasgassen van de Europese Unie. Dit rapport bevat de volgende informatie:

- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2007
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van het IPCC-rapport over Good Practice guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- een overzicht van het kwaliteitssysteem en de validatie van de emissiecijfers voor de Nederlandse Emissieregistratie;
- de wijzigingen die in de methoden voor het berekenen van broeikasgasemissies zijn aangebracht na de review van het Nationaal Systeem broeikasgassen vanuit het Klimaatverdrag. Op basis van de methoden die in de NIR en de Nederlands protocollen broeikasgassen zijn vastgelegd is de basisjaaremissie bepaald, en de hoeveelheid broeikasgassen die Nederland in de periode 2008 t/m 2012 (volgens het Kyoto Protocol) mag uitstoten.

Een aparte annex bij dit rapport bevat elektronische data over emissies en activiteitsdata in het zogenaamde Common Reporting Format (CRF), waar door het secretariaat van het VN-Klimaatverdrag om wordt verzocht. In de bijlagen bij dit rapport zijn de samenvattende emissie - en trendtabellen '7A' en 10 op basis van het CRF opgenomen voor 1990-2007. Daarnaast bevatten de bijlagen ondermeer een overzicht van sleutelbronnen en onzekerheden.

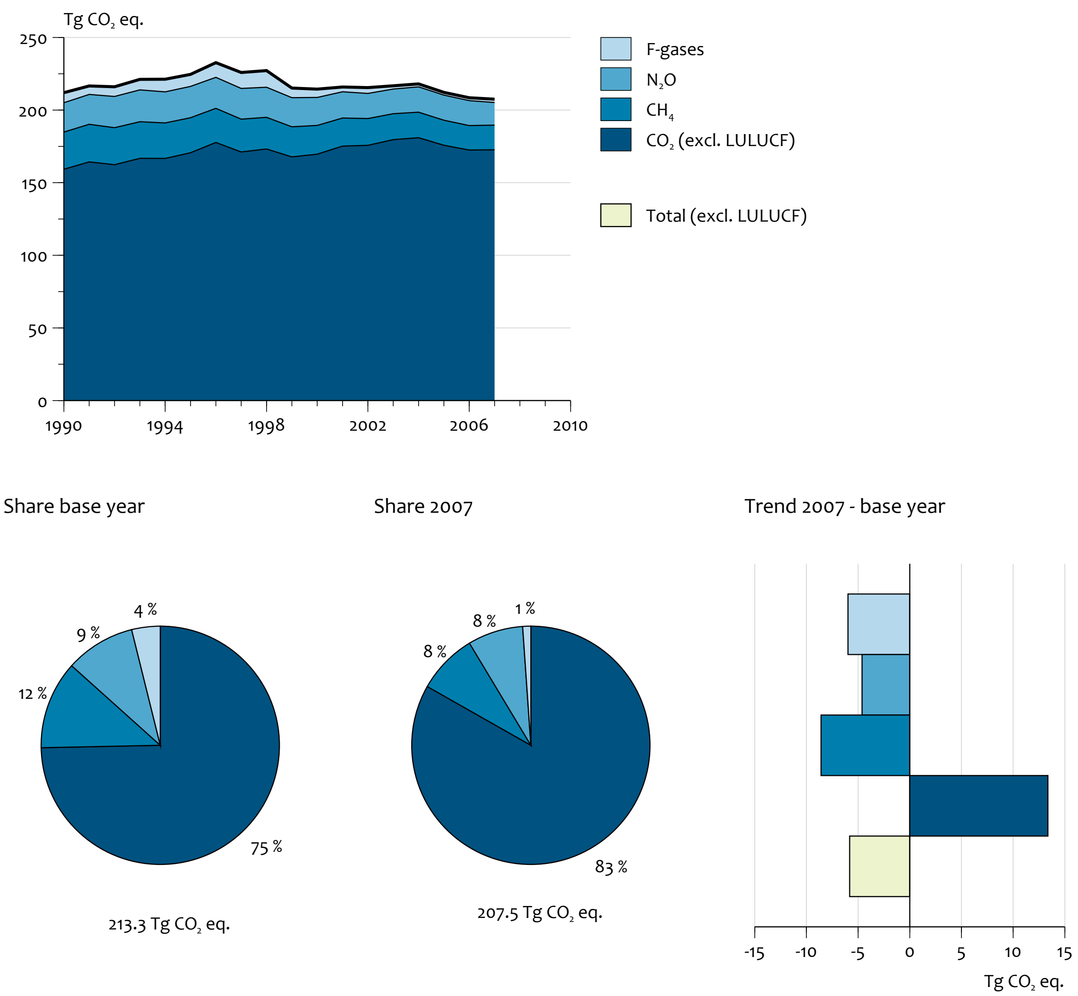
De NIR gaat niet specifiek in op de invloed van het gevoerde overheidsbeleid met betrekking tot emissies van broeikasgassen; meer informatie hierover is te vinden in de jaarlijkse Milieubalans en de vierde Nationale Communicatie onder het Klimaatverdrag, die eind 2005 is verschenen.

Ontwikkeling van de broeikasgasemissies

De emissieontwikkeling in Nederland wordt beschreven en toegelicht in dit National Inventory Report (NIR 2009). Figuur ES.1 geeft het emissieverloop over de periode 1990-2007 weer. De totale emissies bedroegen in 2007 circa 207,5 Tg (Mton ofwel miljard kg) CO_2 equivalenten en waren daarmee bijna drie procent lager (Box ES.1) dan de emissies in het basisjaar (213,3 Tg CO_2 eq). De hier gepresenteerde emissies zijn exclusief de emissies van landgebruik en bossen (LULUCF); deze emissies tellen pas mee vanaf het emissiejaar 2008 (waarover wordt gerapporteerd in 2010) onder het Kyoto Protocol. De emissie van CO_2 is sinds 1990 met circa 8% toegenomen, terwijl de emissies van de andere broeikasgassen met circa 36% zijn afgenomen ten opzichte van het basisjaar.

De daling in 2007 is vooral toe te schrijven aan de vermindering van de N_2O emissie. In 2007 bedroeg de N_2O emissie 15,6 miljard kg. Dit is veel minder dan in 2006, toen de uitstoot 17,1 miljard kg bedroeg. De belangrijkste reden voor de daling is de emissiereductie bij de salpeterzuurproductie. De uitstoot van methaan nam toe in 2007 door de emissies van gasmotoren. In het afgelopen jaar zijn deze emissies opnieuw berekend voor de gehele tijdreeks op basis van voortschrijdende inzichten. De uitstoot van koolstofdioxide steeg beperkt en bleef op het niveau van 2006.

Greenhouse gas emissions (excl. LULUCF) **Figure ES.1**



Methoden

De methoden die Nederland hanteert voor de berekening van de broeikasgasemissies zijn vastgelegd in protocollen, te vinden op www.broeikasgassen.nl. De protocollen zijn opgesteld door SenterNovem, in nauwe samenwerking met deskundigen van de Emissieregistratie (voor wat betreft de beschrijving en documentatie van de berekeningsmethoden). Na vaststelling van deze protocollen in de Stuurgroep ER (december 2005), zijn de protocollen vastgelegd in een wettelijke regeling door het ministerie van VROM. De methoden maken onderdeel uit van het Nationaal Systeem (artikel 5.1 van het Kyoto Protocol) en zijn bedoeld voor de vaststelling van de emissies in zowel het basisjaar als in de jaren in de budgetperiode. Naar aanleiding van de review van het zogenaamde 'Initial Report' zijn de methoden en protocollen aangepast. Deze zijn daarmee in overeenstemming met de IPCC Good Practice guidance and Uncertainty Management, dat als belangrijkste voorwaarde is gesteld aan de te hanteren methoden voor de berekening van broeikasgassen. Deze methoden zullen de komende jaren (tot 2014) worden gehanteerd; tenzij er grote veranderingen plaatsvinden in bijvoor-

Box ES.1 onzekerheden

De emissies van broeikasgassen kunnen niet exact worden gemeten of berekend. Onzekerheden zijn daarom onvermijdelijk. Het PBL schat de onzekerheid in de jaarlijkse totale broeikasgasemissies op circa 5%. Dit is geschat op basis van informatie van emissie-experts in een eenvoudige analyse van de onzekerheid (volgens IPCC Tier 1). De totale uitstoot van broeikasgassen ligt daarmee met 95% betrouwbaarheid tussen de 197 en 218 Tg (Mton). De onzekerheid in de emissietrend tussen het basisjaar (1990/1995) en 2007 is geschat op circa 3%-punt; dat wil zeggen dat de emissietrend in die periode met 95% betrouwbaarheid ligt tussen de -6 tot +0%.

In het verrekeningssysteem onder het Kyoto Protocol worden emissies bepaald op een van tevoren afgesproken wijze (vastgelegd in protocollen) en wordt een Partij daarop uiteindelijk ook afgerekend.

beeld de beschikbaarheid van basisdata of de implementatie van beleidsmaatregelen aanleiding geeft de methoden aan te passen.

Belangrijkste methodische wijzigingen ten opzichte van de NIR 2008

In deze NIR zijn de volgende methodologische wijzigingen doorgevoerd:

- Nieuwe methode voor de berekening van de methaan-emissies uit gasmotoren voor de gehele tijdreeks
- Herberekening van de emissies van landgebruik en bossen (LULUCF) naar aanleiding van de UNFCCC review in 2007
- Door toepassing van meer gedetailleerde basisdata kon de kwaliteit van de emissiecijfers van CH_4 en N_2O uit de landbouw worden verbeterd. Het zelfde geldt voor de emissies van N_2O uit de waterzuiveringen.

Executive Summary

ES.1 Background information on greenhouse gas inventories and climate change

This report documents the 2009 Netherlands' annual submission of its greenhouse gas emission inventory in accordance with the guidelines provided by the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism. These guidelines, which also refer to Revised 1996 IPCC Guidelines and IPCC Good Practice guidance and Uncertainty Management reports, provide a format for the definition of source categories and for calculation, documentation and reporting of emissions. The guidelines aim at facilitating verification, technical assessment and expert review of the inventory information by independent Expert Review Teams of the UNFCCC. Therefore, the inventories should be transparent, consistent, comparable, complete and accurate as elaborated in the UNFCCC Guidelines for reporting and be prepared using good practice as described in the IPCC Good Practice Guidance. This National Inventory Report (NIR) 2009 therefore provides explanations of the trends in greenhouse gas emissions, activity data and (implied) emission factors for the period 1990-2007. It also summarises descriptions of methods and data sources of Tier 1 assessments of the uncertainty in annual emissions and in emission trends; it presents an assessment of key sources following the Tier 1 and Tier 2 approaches of the IPCC Good Practice Guidance; and describes Quality Assurance and Quality Control activities. This report provides no specific information on the effectiveness of government policies for reducing greenhouse gas emissions. This information can be found in the annual Environmental Balance (in Dutch: 'Milieubalans') prepared by the Netherlands Environmental Assessment Agency (PBL) and the 4th National Communication (NC4) prepared by the government of the Netherlands.

So-called Common Reporting Format (CRF) spreadsheet files, containing data on emissions, activity data and implied emission factors, accompany this report. The complete set of CRF files as well as the NIR in pdf format can be found at the website www.greenhousegases.nl. From July 2009 the emissions and documentation can also be found on www.prtr.nl.

Climate Convention and Kyoto Protocol

Although this NIR 2009 is prepared as a commitment under the UNFCCC, it is also an important report in the context of the Kyoto Protocol. Because the Protocol has entered into force, ratifying Parties will have to start fulfilling commitments under the Protocol. One of the commitments is the development of a National System for greenhouse gas emissions (art. 5.1 of the Protocol). This National System shall comply with the IPCC guidelines as mentioned earlier. This NIR 2009 is based upon the methodologies included in the National System of the Netherlands under article 5.1 of the Protocol, as developed in the period 2000-2005 and was reviewed by an Expert Review Team of the UNFCCC in April 2007.

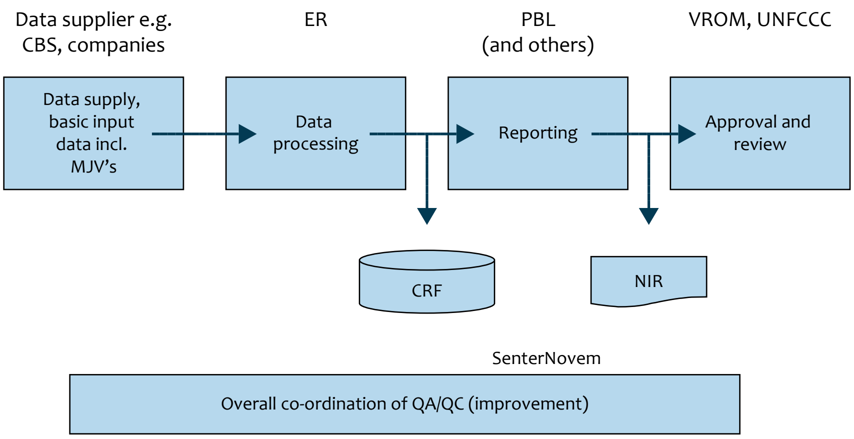
Key categories

For identification of so-called 'key categories' according to the IPCC Good Practice approach the national emissions are allocated according to the IPCC potential key category list wherever possible. The IPCC Tier 1 method consists of ranking this list of source category-gas combinations, for the contribution to both the national total annual emissions and the national total trend. The results of these listings are presented in Annex 1: the largest sources, the total of which ads up to 95% of the national total, are 32 sources for annual level assessment and 30 sources for the trend assessment, out of a total of 70 sources. Both lists can be combined to get an overview of sources, which meet any of these two criteria. Next, the IPCC Tier 2 method for identification of key sources is used, which requires the incorporation of the uncertainty to each of these sources before ordering the list of shares. The result is a list of 43 source categories out of a total of 70 that could be identified as 'key sources' according to the definition of the IPCC Good Practice Guidance report. Finally, four key categories are found in the LULUCF sector (Sector 5), after inclusion of 9 LULUCF subcategories in the key category analysis.

Institutional arrangements for inventory preparation

The greenhouse gas inventory of the Netherlands is based on the national Pollutant Release & Transfer Register (PRTR). The general process of inventory preparation exists many years and is organised as a project with an annual cycle. In 2000, an improvement programme was initiated (under the lead of SenterNovem) to transform the general process of the greenhouse gas inventory of the PRTR into a National System,

The greenhouse gas inventory process **Figure ES.1**



according to the requirements under article 5.1 of the Kyoto Protocol.

The Netherlands Environmental Assessment Agency (PBL) has been contracted by the Ministry of Housing, Spatial Planning and the Environment (VROM) to compile and maintain the PRTR and to co-ordinate the preparation of the NIR and filling the CRF (see Figure ES.2). SenterNovem is designated by law as the National Inventory Entity (NIE). SenterNovem co-ordinates the overall QA/QC activities and the support/response to the UNFCCC review process.

Monitoring protocols

As part of the improvement programme, the methodologies for calculating greenhouse gas emission in the Netherlands were reassessed and compared with UNFCCC and IPCC requirements. For the key sources and for sinks, the methodologies and processes are elaborated, re-assessed and revised where needed. The final revision took place after review of the National System (including the protocols). The present CRF/NIR is based on methodologies approved during/after the review of the National System and the calculation of the Assigned Amount of the Netherlands. Monitoring protocols describing methodologies, data sources and the rationale for their selection are available at www.greenhousegases.nl.

Organisation of the report

This report is in line with the prescribed format for the NIR, starting with an introductory Chapter 1, containing background information on the Netherlands' process of inventory preparation and reporting; key categories and their uncertainties; a description of methods, data sources and emission factors, and a description of the quality assurance system, along with verification activities applied to the data. Chapter 2 provides a summary of trends for aggregated greenhouse gas emissions by gas and by main source. Chapters 3 to 9 present detailed explanations for the emissions in different sectors. Chapter 10 presents information on recalculations, improvements and response to issues raised in external reviews on the NIR 2008 and on the draft version of the NIR 2009. In addition, the report provides more detailed information on key categories, methodologies, other relevant reports and summary emission tables selected from the CRF files (IPCC Tables 7A and 10) in 12 Annexes.

New this year is Annex 12, showing the Emission Factors and Activity Data from the Agricultural sector.

ES.2 Summary of national emission and removal related trends

In 2007, total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands are estimated at 207.5 Tg CO_2 equivalents (CO_2 eq). This is three percent below the emissions in the base year (213.3 Tg CO_2 eq). In the Netherlands the base year emissions are 1990 for CO_2, CH_4 and N_2O and 1995 for fluorinated gases. CO_2 emissions (excluding LULUCF) increased by about 8% from 1990 to 2007, mainly due to the increase in the emissions in the 1A1a Public electricity sector and 1A3 Transport sector. CH_4 emissions decreased by 34% in 2007 compared to the 1990 level, mainly due to decrease in the waste sector, the agricultural sector and fugitive emissions in the energy sector. N_2O emissions decreased by about 23% in 2007 compared to 1990, mainly due to the decrease in the emissions from agriculture and from industrial processes, which partly compensated increases of emissions from fossil fuel combustion (mainly from transport). Of the fluorinated greenhouse gases, emissions of HFCs and PFCs decreased in 2007 by about 71% and 83%, respectively, while SF_6 emissions decreased by 29%. Total emissions of all F-gases decreased by about 72% compared to the 1995 level (chosen as the base year).

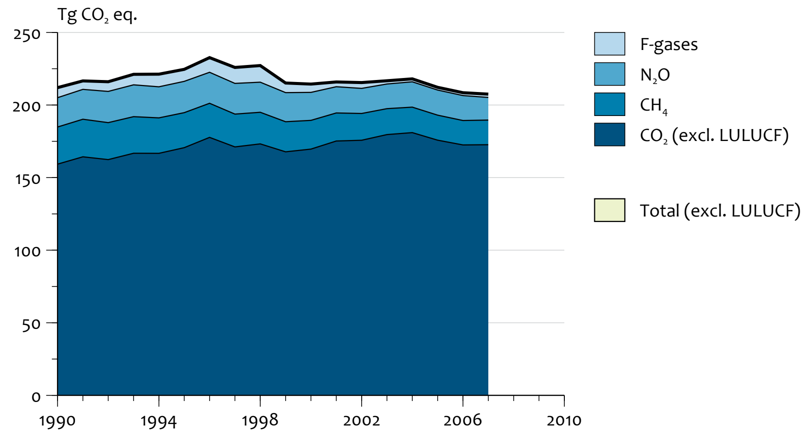
Between 2006 and 2007, total greenhouse gas emissions (excluding LULUCF) dropped by about 0.4% (-1.0 Tg CO_2 eq). CO_2 emissions increased by 0.2 Tg. Major contributor to the decrease in greenhouse gas emission is the nitric acid production which decreased by approximately 1.3 Tg N_2O in the period 2006-2007.

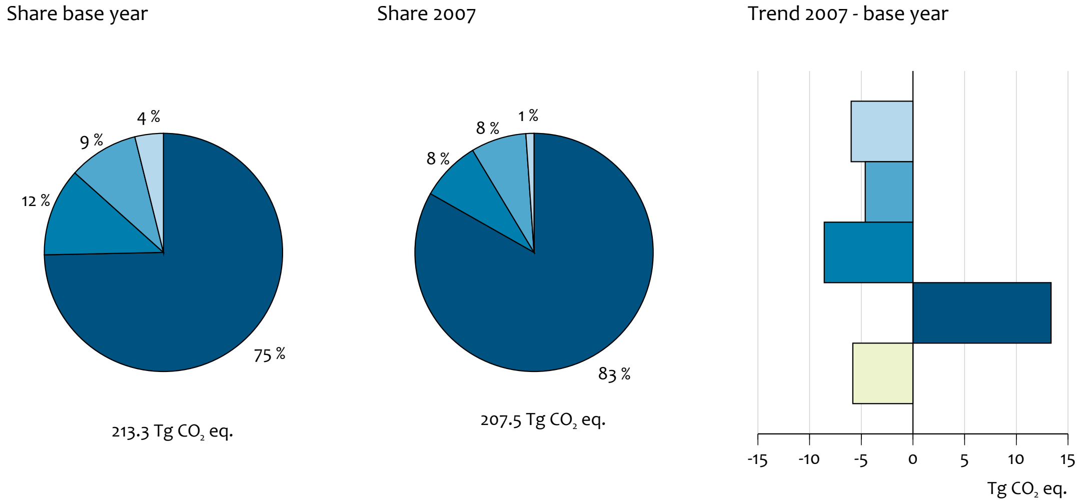
ES.3 Overview of source and sink category emission estimates and trends

Tables ES.1 and ES.2 provide an overview of the emission trends (in CO_2 equivalents) per gas and per IPCC source category. The Energy sector (category 1) is by far the largest contributor to national total greenhouse gas emissions. The

Greenhouse gas emissions (excl. LULUCF)

Figure ES.2





Summary of emission trend per gas (unit: Tg CO_2 equivalents).

Table ES.1

	CO_2 incl. LULUCF	CO_2 excl. LULUCF	CH_4	N_2O	HFCs	PFCs	SF_6	Total (incl LULUCF)	Total (excl LULUCF) [1]
Base yr	161.9	159.3	25.5	20.2	6.0	1.9	0.3	215.9	213.3
1990	161.9	159.3	25.5	20.2	4.4	2.3	0.2	214.6	212.0
1991	166.5	164.3	25.9	20.6	3.5	2.2	0.1	218.8	216.6
1992	164.8	162.4	25.5	21.5	4.4	2.0	0.1	218.5	216.0
1993	169.0	166.8	25.2	21.9	5.0	2.1	0.1	223.4	221.1
1994	168.9	166.7	24.4	21.4	6.5	2.0	0.2	223.4	221.2
1995	172.9	170.6	24.2	21.5	6.0	1.9	0.3	226.9	224.6
1996	179.8	177.7	23.5	21.4	7.7	2.2	0.3	234.8	232.7
1997	173.5	171.1	22.6	21.1	8.3	2.3	0.3	228.3	225.9
1998	175.6	173.2	21.7	20.7	9.3	1.8	0.3	229.5	227.2
1999	170.1	167.8	20.7	20.0	4.9	1.5	0.3	217.5	215.2
2000	172.1	169.6	19.8	19.3	3.8	1.6	0.3	216.9	214.4
2001	177.6	175.2	19.3	18.1	1.5	1.5	0.3	218.3	215.9
2002	178.1	175.7	18.4	17.3	1.5	2.2	0.3	217.8	215.5
2003	182.0	179.6	17.9	16.9	1.4	0.6	0.2	219.0	216.7
2004	183.3	181.0	17.6	17.4	1.5	0.3	0.2	220.4	218.0
2005	178.2	175.8	17.2	17.3	1.4	0.3	0.2	214.6	212.2
2006	174.9	172.5	16.8	17.1	1.6	0.3	0.2	210.9	208.5
2007	175.2	172.7	17.0	15.6	1.7	0.3	0.2	210.0	207.5

Summary of emission trend per source category (unit: Tg CO_2 equivalents). **Table ES.2**

	1. Energy	2. Ind. Proc.	3. Solvents	4. Agri-culture	5. LULUCF	6. Waste	7. Other	Total (in. LULUCF)	Total (ex. LULUCF)
Base yr	154.0	22.1	0.5	22.5	2.6	12.8	NA	215.9	213.3
1990	154.0	22.1	0.5	22.5	2.6	12.8	NA	214.6	212.0
1991	159.1	21.2	0.5	23.0	2.2	12.9	NA	218.8	216.6
1992	157.8	21.5	0.4	23.6	2.5	12.7	NA	218.5	216.0
1993	162.6	22.3	0.4	23.5	2.2	12.3	NA	223.4	221.1
1994	161.8	24.3	0.4	22.8	2.2	11.9	NA	223.4	221.2
1995	165.8	23.5	0.4	23.5	2.3	11.3	NA	226.9	224.6
1996	173.7	24.7	0.4	22.9	2.2	10.9	NA	234.8	232.7
1997	166.1	26.1	0.3	22.8	2.4	10.6	NA	228.3	225.9
1998	168.2	26.4	0.4	22.0	2.3	10.2	NA	229.5	227.2
1999	162.6	21.2	0.4	21.6	2.4	9.4	NA	217.5	215.2
2000	164.6	20.2	0.3	20.4	2.5	8.9	NA	216.9	214.4
2001	170.7	16.6	0.3	19.9	2.4	8.4	NA	218.3	215.9
2002	171.3	17.0	0.2	18.9	2.3	8.0	NA	217.8	215.5
2003	175.1	15.4	0.2	18.4	2.3	7.5	NA	219.0	216.7
2004	176.3	15.8	0.2	18.5	2.3	7.2	NA	220.4	218.0
2005	171.2	15.5	0.2	18.5	2.4	6.8	NA	214.6	212.2
2006	167.9	15.6	0.2	18.4	2.4	6.4	NA	210.9	208.5
2007	168.3	14.5	0.2	18.4	2.5	6.0	NA	210.0	207.5

emissions of this sector increased substantially compared to 1990. In contrast, emissions of the other sectors decreased compared to the base year, the largest being those of Industrial Processes, Waste and Agriculture.Summary of emission trend per gas (unit: Tg CO_2 equivalents).

Sectors showing the largest growth in CO_2 equivalent emissions since 1990 are Transport (1A3) and Energy industries (1A1) (+35% and +25%, respectively). Note that half of the marked increase in the Public electricity sector of almost 30% between 1990 and 1998 is caused by a shift of cogeneration plants from Manufacturing industries to the Public electricity and heat production sector due to a change of ownership (joint-ventures), simultaneously causing a 15% decrease in industry emissions in the early 1990's (1A2).

ES.4 Other information

General uncertainty evaluation

The results of the uncertainty estimation according to the IPCC Tier 1 uncertainty approach are summarised in Annex 1 of this report. The Tier 1 estimation of *annual uncertainty* in CO_2 eq emissions results in an overall uncertainty of 4%, based on calculated uncertainties of 2%, 16%, 46% and 33% for CO_2 (excluding LULUCF), CH_4, N_2O and F-gases, respectively. However, these figures do not include the correlation between source categories (e.g. cattle numbers for enteric fermentation and animal manure production) or a correction for not-reported sources. Therefore, the actual uncertainty of total annual emissions per compound and of the total will be somewhat higher; it is currently estimated by PBL at:

CO_2	±3%	HFCs	±50%
CH_4	±25%	PFCs	±50%
N_2O	±50%	SF_6	±50%
	Total greenhouse gas emissions		±5%

Table A1.4 of Annex 1 summarises the estimate of the trend uncertainty 1990-2005 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in the total CO_2 eq emissions (including LULUCF) for 1990 -2007 (1995 for F-gases) of ±3% points. This means that the decrease in total CO_2 eq emissions between 1990 and 2007 (including LULUCF), which is calculated to be -3%, will be between -6% and 0%. Per individual gas, the trend uncertainty in total emissions of CO_2 , CH_4, N_2O and the total group of F-gases has been calculated at ±2%, ±10%, ±15% and ±9% points, respectively. More details on the level and trend uncertainty assessment can be found in Annex 7.

Completeness of the national inventory

The Netherlands' greenhouse gas emission inventory includes all sources identified by the Revised Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 1996) – with the exception of the following, very minor, sources:

- oil transport (1B2a3), due to missing activity data
- charcoal production (1B2) and use (1A4), due to missing activity data
- CO_2 from lime production (2A2), due to missing activity data
- CO_2 from asphalt roofing (2A5), due to missing activity data
- CO_2 from road paving (2A6), due to missing activity data
- CH_4 from enteric fermentation of poultry (4A9), due to missing emission factors
- N_2O from industrial waste water (6B1), due to negligible amounts
- Precursor emissions (i.e. carbon monoxide (CO), nitrogen oxide (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (2)) from Memo item "International bunkers" (international transport) have not been included.

For more extended information on this issue, see annex 5.

Differences between NIR 2008 and NIR 2009 due to recalculations (Unit: Tg CO_2 eq, F-gases: Gg CO_2 eq). **Table ES.3**

Gas	Source	1990	1995	2000	2001	2002	2003	2004	2005	2006
CO_2 Incl. LUCF	NIR08	162.0	173.1	172.3	177.9	178.4	182.3	183.7	178.5	174.8
	NIR09	161.9	172.9	172.1	177.6	178.1	182.0	183.3	178.2	174.9
	Diff.	-0.1	-0.2	-0.2	-0.2	-0.3	-0.4	-0.4	-0.3	0.1
CO_2 Excl. LUCF	NIR08	159.4	170.6	169.6	175.2	175.8	179.7	181.1	175.9	172.2
	NIR09	159.3	170.6	169.6	175.2	175.7	179.6	181.0	175.8	172.5
	Diff.	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.3
CH_4	NIR08	25.4	23.8	19.2	18.8	18.0	17.5	17.3	16.8	16.3
	NIR09	25.5	24.2	19.8	19.3	18.4	17.9	17.6	17.2	16.8
	Diff.	0.1	0.4	0.6	0.5	0.5	0.3	0.3	0.4	0.6
N_2O	NIR08	19.9	21.3	19.0	17.9	17.1	16.8	17.3	17.1	16.9
	NIR09	20.2	21.5	19.3	18.1	17.3	16.9	17.4	17.3	17.1
	Diff.	0.3	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.2
PFCs Gg	NIR08	2,264	1,938	1,582	1,489	2,187	621	286	266	257
	NIR09	2,264	1,938	1,582	1,489	2,187	621	286	266	257
	Diff.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HFCs Gg	NIR08	4,432	6,020	3,824	1,469	1,541	1,379	1,511	1,353	1,559
	NIR09	4,432	6,020	3,829	1,469	1,541	1,377	1,507	1,358	1,566
	Diff.	0.0	0.0	5.4	-0.1	0.0	-1.6	-3.9	5.0	7.0
SF_6 Gg	NIR08	217	301	320	325	286	248	251	250	215
	NIR09	217	301	319	323	283	243	246	238	202
	Diff.	0.0	0.0	-1.1	-2.1	-3.1	-4.1	-5.1	-11.9	-12.9
Total Excl. LUCF	NIR08	211.7	224.0	213.6	215.3	214.9	216.3	217.7	211.8	207.5
	NIR09	212.0	224.6	214.4	215.9	215.5	216.7	218.0	212.2	208.5
	Diff.	0.3	0.6	0.8	0.6	0.6	0.4	0.3	0.4	1.0
Total Incl. LUCF	NIR08	214.3	226.4	216.3	217.9	217.5	218.9	220.3	214.3	210.1
	NIR09	214.6	226.9	216.9	218.3	217.8	219.0	220.4	214.6	210.9
	Diff.	0.3	0.4	0.6	0.4	0.3	0.1	0.1	0.2	0.9

Methodological changes, recalculations and improvements

This NIR 2009 is based upon the envisaged National System of the Netherlands under article 5.1 of the Kyoto Protocol, as developed in the last decade and finalised by December 2005. In past years the results of various improvement actions have been implemented in the methodologies and processes of the preparation of the greenhouse gas inventory of the Netherlands. Compared to the NIR/CRF 2008 and based on the results of the review of the National System by an Expert Review Team of the UNFCCC, some recalculations were undertaken in the past year. The methodological changes are documented in Chapters 3-8.

Compared to the NIR/CRF 2008, the following methodological changes were made in the greenhouse gas inventory for the base year:

- Recalculation of CH_4 emissions from smaller cogeneration facilities, Category 1A1, +64 Gg CO_2 eq in 1990
- Recalculation of LULUCF as an result of the in country review of 2007 Effect: -70.2Gg CO_2 eq in the base year 1990
- Use of improved feed-data in the emission calculations for agriculture
- Inclusion of horses and ponies in the emission calculations for agriculture
- Inclusion of information of different husbandry systems and manure storage systems in the emission calculations for agriculture . The for mentioned changes resulted in an increase of 45.1 Gg CO_2 eq from CH_4 and 329 Gg CO_2 eq from N_2O for agriculture in 1990
- Use of more detailed data on purification efficiencies in wastewater treatment plants resulted in a decrease of 48 Gg CO_2 eq fron N_2O in category 6B

Table ES.3 provides the results of recalculations in the NIR 2009 compared to the NIR 2008.

Improving the QA/QC system

The QA/QC programme (quality assurance / quality control) is up to date and all procedures and processes are established to meet the National System requirements (as part of the annual activity programme of the Netherlands PRTR). QA/QC activities to be undertaken as part of the National System have been described in Chapter 1. Some actions which remained since the NIR 2007, are now implemented:

- The update of the description of QA/QC of outside agencies;
- Results of a TIER 2 uncertainty analysis are taken into account in the NIR, the QA/QC programme and included in the monitoring protocols.

Emission trends for indirect greenhouse gases and 2

Compared to 1990, the CO and NMVOC emissions were reduced in 2007 by 50% and 66%, respectively. For 2 this is 69%, and for NOx, the 2007 emissions are 47% lower than the 1990 level. Table ES.4 provides trend data.

In contrast with the direct greenhouse gases, emissions of precursors from road transport have not been corrected for fuel sales according to the national energy statistics but are

Emission trends for indirect greenhouse gases and SO_2 (Unit: Gg). **Table ES.4**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total NOx	545	449	386	376	369	366	346	330	317	290
Total CO	1,067	804	647	625	603	582	583	551	544	534
Total NMVOC	456	316	218	198	188	175	168	168	163	156
Total SO_2	190	128	72	73	67	63	63	65	64	60

directly related to transport statistics on vehicle-km, which differs to some extent from the IPCC approach.

Recalculations (due to changing methodologies), have only been performed for 1990, 1995, 2000, 2005, 2006 and 2007 for all sources. For that reason the precursor gas emissions in other years are interpolated (not the whole time series is presented in Table ES.4).

1 Introduction

1.1 Background information on greenhouse gas inventories and climate change

1.1.1 General issues

The United Nations Framework Convention on Climate Change (UNFCCC) was ratified by the Netherlands in 1994 and entered into force in March of 1994. One of the commitments made by the ratifying Parties under the Convention is to develop, publish and regularly update national emission inventories of greenhouse gases.

This national inventory report documents the 2008 Greenhouse Gas Emission Inventory for the Netherlands under the UNFCCC and under the Kyoto Protocol. The estimates provided in the report are consistent with the Intergovernmental Panel on Climate Change (IPCC) 1996 Guidelines for National Greenhouse Gas Inventories (IPCC, 1997) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2001) and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (LULUCF). The methodologies applied for the Netherlands' inventory are also consistent with the guidelines under the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism.

For detailed assessments of the extent to which changes in emissions are due to the implementation of policy measures, the reader is referred to the annual Environmental Balance (PBL 2008, in Dutch), the Fourth Netherlands' National Communication under the United Nations Framework Convention on Climate Change (VROM, 2005) and the Netherlands' Report on Demonstrable Progress under Article 3.2 of the Kyoto Protocol (VROM, 2006b).

The Netherlands also reports emissions under other international agreements, such as the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Transboundary Air Pollutants (CLRTAP) and the European Union's National Emission Ceilings (NEC) Directive. All these estimates are provided by the Netherlands' Pollutant Release and Transfer Register, PRTR, which is compiled by the Environmental Assessment Agency. The greenhouse gas inventory and the PRTR share the same underlying data, which ensures consistency between the inventories and the internationally reported data. Several institutes are involved in the process of compiling the greenhouse gas inventory (see also Section 1.3).

The National Inventory Report (NIR) covers the six direct greenhouse gases included in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) (the F-gases). The emissions of the following indirect greenhouse gases are also reported: nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC), as well as sulphur oxides (SOx).

This report provides explanations of the trends in greenhouse gas emissions per gas and per sector for the 1990–2007 period and summarizes descriptions of methods and data sources for: (a) Tier 1 assessments of the uncertainty in annual emissions and in emission trends; (b) key source assessments following the Tier 1 and Tier 2 approaches of the IPCC Good Practice Guidance (IPCC, 2001); (c) quality assurance and quality control (QA/QC) activities.

Under the National System under Article 5.1 of the Kyoto Protocol, methodologies were established (and documented) in monitoring protocols. These protocols are annually re-assessed and revised, if needed, e.g. based on recommendations of UN reviews. The monitoring protocols and the general description of the National System are available on the website www.greenhousegases.nl. The emissions reported in the NIR 2009 are based on these methodologies, which have been incorporated in the National System for greenhouse gases. The emissions and all the documentation are, with a delay of some months, available on the website www.prtr.nl.

In 2007 the UN performed an in-country review of the NIR 2006 and the initial review under the Kyoto Protocol. The review concluded that the Netherlands' National System has been established in accordance with the guidelines and that it meets the requirements. The National System remained unchanged.

The structure of this report complies with the format required by the UNFCCC (FCCC/SBSTA/2004/8). It also includes supplementary information under Article 7 of the Kyoto Protocol; Annex 11 gives an overview of this information.

Emissions of greenhouse gases presented in this report are given in gigagrammes (Gg) and teragrammes (Tg), and both the units and conversion factors used are given in Annex 9. Global warming potential (GWP) weighed emissions of the greenhouse gases are also provided (in CO2 equivalents). In accordance with the Kyoto Protocol, the IPCC GWP for a time horizon of 100 years is used. The GWP of each individual greenhouse gas is provided individually in Annex 9.

1.1.2 CRF files: greenhouse gas emissions and background data

The Common Reporting Format (CRF) spreadsheet files accompany this report as electronic annexes (the CRF files are compressed into four zip files for this submission: CRF-NLD-2009-v-1.2-90-93.zip; CRF-NLD-2009-v-1.2-94-97.zip; CRF-NLD-2009-v-1.2-98-01.zip; CRF-NLD-2009-v-1.2-02-07.zip). The CRF files contain detailed information on greenhouse gas emissions, activity data and (implied) emission factors specified by sector, source category and greenhouse gas. Please note that the results of the key category analysis are included in the year 2004 instead of 2007 due to a minor bug in the CRF reporter. The complete set of CRF files as well as this report comprise the National Inventory Report (NIR) and are published on the website www.greenhousegases.nl.

In addition, trend tables and check tables compiled from CRF data as well as other information, such as protocols of the methods used to estimate emissions, are available on this website. Some summary tables are included in Annex 8 of this report:

- IPCC summary Table 7A for 1990, 1995, 2000, 2005 and 2007 (CRF Summaries 1);
- trend Table 10 for each gas individually, and for all gases and sources in CO_2 equivalents.
- Section 10.4 provides details on the extent to which the CRF data files for 1990–2007 have been completed.

1.1.3 Geographical coverage of the Netherlands' inventory

The reported emissions have to be allocated to the legal territory of the Netherlands. This includes a 12-mile zone from the coastline and also inland water bodies. It excludes Aruba and the Netherlands Antilles, which are self-governing dependencies of the Royal Kingdom of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included as are emissions from all electricity-generating activities in the Netherlands, including the electricity fraction that is exported. The Netherlands imported about 10% of its electricity up to 1999, but following the liberalization of the European electricity markets in that year, the net import in 2007 amounted to about 14% of the national electricity use. Emissions from the fishing fleet registered in the Netherlands, but sailing outside Dutch coastal waters for the most part, are included in the national total.

1.2 Institutional arrangements for inventory preparation

1.2.1 Overall responsibility

The Ministry of Housing, Spatial Planning and the Environment (VROM) has overall responsibility for climate change policy issues.

1.2.2 Responsibility for "the National System"

In August 2004, the Ministry of VROM assigned SenterNovem executive tasks bearing on the National Inventory Entity (NIE), the single national entity required under the Kyoto Protocol. In December 2005, SenterNovem was designated by law as the NIE. In addition to coordinating the establishment of a National System, the tasks of SenterNovem include the overall coordination of (improved) QA/QC activities as part of the National System and coordination of the support/response to the UNFCCC review process. The National System is described in more detail in SenterNovem et al. (2005c).

1.2.3 Responsibility for emission estimates

The Netherlands Environmental Assessment Agency (PBL, previously MNP) has been contracted by the Ministry of VROM to compile and maintain the pollutants emission register/inventory (PRTR system) and to coordinate the preparation of the NIR and filling the CRF.

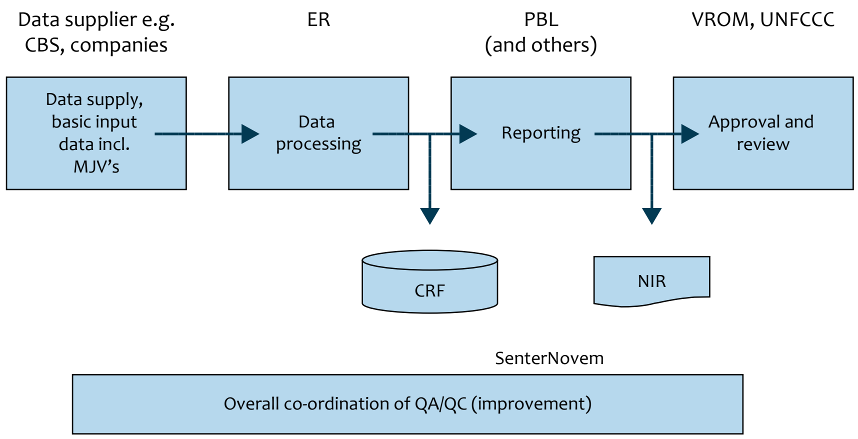
A Pollutant Emission Register (PRTR) has been in operation in the Netherlands since 1974. This system encompasses the process of data collection, data processing and the registering and reporting of emission data for some 170 policy-relevant compounds and compound groups that are present in the air, water and soil. The emission data is produced in an annual (project) cycle (MNP, 2006). This system is also the basis for the national greenhouse gas inventory. In April 2004 full coordination of the PRTR was outsourced by the Ministry of VROM to the PBL (previously named MNP). This has resulted in a clearer definition and separation of responsibilities as well as a clustering of tasks.

The main objective of the PRTR is to produce an annual set of unequivocal emission data that is up-to-date, complete, transparent, comparable, consistent and accurate. In addition to PBL, various external agencies contribute to the PRTR by performing calculations or submitting activity data (see following Section), these include: CBS (Statistics Netherlands), TNO (Netherlands Organization for Applied Scientific Research), SenterNovem, Centre for Water Management, Deltares and several institutes related to the Wageningen University and Research Centre (WUR).

1.2.4 Responsibility for reporting

The NIR is prepared by PBL. Since mid-2005, the NIR has been part of the PRTR project. Most institutes involved in the PRTR also contribute to the NIR (including CBS and TNO, among others). In addition, SenterNovem is involved in its role as NIE.

The greenhouse gas inventory process **Figure 1.1**



1.3 A brief description of how the inventory is prepared

1.3.1 Introduction

The primary process of preparing the greenhouse gas inventory in the Netherlands is summarized in Figure 1.1. This process includes three major steps that are described in more detail in the following Sections.

1.3.2 Data supply and collection

Various data suppliers provide the basic input data needed for emission estimates. The most important data sources for greenhouse gas emissions include:

Statistical data

Statistical data are provided under various (i.e. not specifically greenhouse-gas related) obligations and legal arrangements. These include national statistics from Statistics Netherlands (CBS) and a number of other sources of data on sinks, water and waste. The provision of relevant data for greenhouse gases is guaranteed through covenants and an Order in Decree, the latter of which is under preparation by the Ministry of VROM. For greenhouse gases, relevant agreements with respect to waste management are in place with CBS and SenterNovem. An agreement with the Ministry of Agriculture, Nature and Food Quality (LNV) and related institutions was established in 2005.

Data from individual companies

Data from individual companies are provided in the form of annual environmental reports (MJVs). A large number of companies have a legal obligation to submit an MJV that includes – in addition to other pertinent information – emission data validated by the competent authorities (usually provincial and occasionally local authorities that also issue permits to these companies). A number of companies with large combustion plants are also required to report information under the so-called BEES/A regulation. Some companies provide data voluntarily, within the framework of environmental covenants. The data in these MJVs are used for verifying the calculated CO_2 emissions from energy statistics for industry, energy sector and refineries. If reports from major industries contain plant-specific information on activity data and emission factors of sufficient quality and transparency, this data is used in the calculation of CO_2 emission estimates for specific sectors.

The MJVs from individual companies provide essential information for calculating the emissions of substances other than CO_2. The calculations of industrial process emissions of non-CO_2 greenhouse gases (e.g. N_2O, HFC-23 and PFCs released as by-products) are mainly based on information from these MJVs, as are the calculated emissions from precursor gases (CO, NOx, NMVOC) and SO_2. As reported in previous NIRs, only those MJVs with high-quality and transparent data are used as a basis for calculating total source emissions in the Netherlands.

Additional greenhouse-gas-related data

Additional greenhouse gas related data are provided by other institutes and consultants that are specifically contracted to provide information on sectors not sufficiently covered by the above-mentioned data sources. For greenhouse gases, contracts and financial arrangements are made (by PBL) with, for example, various agricultural institutes and TNO. In addition, SenterNovem contracts out various tasks to consultants (collecting information on F-gas emissions from cooling and product use, on improvement actions, etc.). During 2004, the Ministry of LNV also issued contracts to a number of agricultural institutes; these consisted of, in particular, contracts for developing a monitoring system and protocols for the LULUCF data set. Based on a written agreement between LNV and PBL, these activities are also part of the PRTR.

1.3.3 Data processing and storage

Data processing and storage are coordinated by PBL; these processes consist most notably of the elaboration of emission estimates and data preparation in the emissions data base and the CRF. The emission data are stored in a central database, thereby satisfying – in an efficient and effective manner – national and international criteria on emission reporting. This year PBL automated the process to fill the CRF with emissions from the central database.

The actual emission calculations and estimates that are made using the input data are implemented in five task forces, each dealing with specific sectors:

CRF Summary Table 3 with methods and emission factors applied. **Table 1.1**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	**CS,T2,T3**	**CS,D,PS**	**CS,T1,T1b, T2,T3**	**CS,D,PS**	**CS,T1,T2**	**CS,D**						
A. Fuel Combustion	CS,T2	CS,D	CS,T1,T2,T3	CS,D	CS,T1,T2	CS,D						
1. Energy Industries	T2	CS	T2	CS	T1,T2	CS,D						
2. Manufacturing Industries and Construction	T2	CS	T2	CS	T1	CS,D						
3. Transport	CS,T2	CS	CS,T2,T3	CS,D	CS,T2	CS,D						
4. Other Sectors	T2	CS,D	T1,T2	CS,D	T1	D						
5. Other	T2	D	T2	CS	T2	CS						
B. Fugitive Emissions from Fuels	CS,T2,T3	CS,PS	T1b,T2,T3	CS,D,PS	NA	NA						
1. Solid Fuels	T2	CS	T1b	D	NA	NA						
2. Oil and Natural Gas	CS,T2,T3	CS,PS	T1b,T2,T3	CS,D,PS	NA	NA						
2. Industrial Processes	**CS,T1,T1a,T1b ,T2**	**CS,D,PS**	**CS,T1,T2**	**CS,D**	**CS,T2**	**CS,PS**	**T1,T2**	**CS,PS**	**CS,T2**	**PS**	**CS,T2**	**D,PS**
A. Mineral Products	CS	CS,D,PS	NA	NA	NA	NA						
B. Chemical Industry	CS,T1,T1b	CS,D,PS	T1,T2	D	T2	PS	NA	NA	NA	NA	NA	NA
C. Metal Production	T1a,T2	CS	NA	NA	NA	NA	NA	NA	T2	PS	NA	NA
D. Other Production	T1b	CS										
E. Production of Halocarbons and SF_6							T1,T2	PS	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6							T2	CS	CS,T2	PS	CS,T2	D,PS
G. Other	CS,T1b	CS,D	CS	CS	CS	CS	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**CS**	**CS**			**CS**	**CS**						
4. Agriculture			**T1,T2**	**CS,D**	**T1,T1b,T2, T3**	**CS,D**						
A. Enteric Fermentation			T1,T2	CS,D								
B. Manure Management			T2	CS	T2	D						
C. Rice Cultivation			NA	NA								
D. Agricultural Soils			NA	NA	T1,T1b,T2, T3	CS,D						
E. Prescribed Burning of Savannas			NA	NA	NA	NA						
F. Field Burning of Agricultural Residues			NA	NA	NA	NA						
G. Other			NA	NA	NA	NA						
5. Land Use, Land-Use Change and Forestry	**CS,D**	**CS,D**	**NA**	**NA**	**NA**	**NA**						
A. Forest Land	CS	CS	NA	NA	NA	NA						
B. Cropland			NA	NA	NA	NA						
C. Grassland			NA	NA	NA	NA						
D. Wetlands			NA	NA	NA	NA						
E. Settlements			NA	NA	NA	NA						
F. Other Land			NA	NA	NA	NA						
G. Other	D	D	NA	NA	NA	NA						
6. Waste	**NA**	**NA**	**T2**	**CS**	**T2**	**CS,D**						
A. Solid Waste Disposal on Land	NA	NA	T2	CS								
B. Waste-water Handling			T2	CS	T2	D						
C. Waste Incineration	NA	NA	NA	NA	NA	NA						
D. Other	NA	NA	T2	CS	T2	CS						
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

- energy, industry and waste (combustion, process emissions, waste handling)
- agriculture (agriculture, sinks)
- consumers and services (non-industrial use of products)
- transport (including bunker emissions)
- water (less relevant for greenhouse gas emissions)

The task forces consist of experts from several institutes. In 2008, in addition to the PBL, these included TNO, CBS, Centre for Water Management, Deltares, FO-I (the Facilitating Organization for Industry, which co-ordinates annual environmental reporting by companies), SenterNovem (Waste Management division) and various agricultural research institutes: Alterra (sinks) and LEI. The task forces are responsible for assessing emission estimates based on the input data and emission factors provided. PBL commissioned TNO to assist compiling the CRF.

1.3.4 Reporting, QA/QC, archiving and overall coordination

The NIR is prepared by PBL with input from the experts in the relevant PRTR task forces and from SenterNovem. This step includes documentation and archiving. The Ministry of VROM formally approves the NIR before it is submitted; in some cases approval follows consultation with other ministries. SenterNovem is responsible for coordinating QA/QC and responses to the EU and for providing additional information requested by the UNFCCC after the NIR and the CRF have been submitted. SenterNovem is also responsible (in collaboration with PBL) for coordinating the submission of supporting data to the UNFCCC review process.

1.4 Brief description of methodologies and data sources used

1.4.1 Methodologies

Table 1.1 provides an overview of the methods used to estimate greenhouse gas emissions. Monitoring protocols documenting the methodologies and data sources used in the greenhouse gas inventory of the Netherlands as well as other key documents are listed in Annex 6. The protocols were elaborated, together with relevant experts and institutes, as part of the monitoring improvement program.

Explanation of notation keys used:

- Method applied: D, IPCC default; RA, reference approach; T, IPCC Tier; C, CORINAIR; CS, country-specific; M, model.
- Emission factor used: D, IPCC default; C, CORINAIR; CS, country-specific; PS, plant-specific; M, model.
- Other keys: NA, not applicable, NO, not occurring; NE, not estimated; IE, included elsewhere.

All key documents are electronically available in PDF-format at www.greenhousegases.nl. The monitoring protocols describe methodologies, data sources and QA/QC procedures for estimating greenhouse gas emissions in the Netherlands. The sector-specific chapters provide a brief description per key source of the methodologies applied for estimating the emissions.

1.4.2 Data sources

The monitoring protocols provide detailed information on activity data used for the inventory. In general, the following primary data sources supply the annual activity data used in the emission calculations:

- fossil fuel data: (1) national energy statistics from CBS (National Energy Statistics; Energy Monitor); (2) natural gas and diesel consumption in the agricultural sector (Agricultural Economics Institute, LEI)
- residential biofuel data: (1) annual survey of residential woodstove and fireplace penetration from the Association for Comfortable Living (Vereniging Comfortabel Wonen); (2) a 1996 survey on wood consumption by owners of residential woodstoves and fireplaces from the Stove and Stack Association (Vereniging van Haard en Rookkanaal, VHR)
- transport statistics: monthly statistics for traffic and transportation
- industrial production statistics: (1) annual inventory reports from individual companies; (2) national statistics
- consumption of HFCs: annual reports from the accountancy firm, PriceWaterhouseCoopers (only HFC data are used due to inconsistencies for PFCs and SF_6 with emissions reported elsewhere)
- consumption/emissions of PFCs and SF_6: reported by individual firms
- anesthetic gas: data provided by Hoekloos, the major supplier of this gas
- spray cans containing N2O: the Dutch Association of Aerosol Producers (Nederlandse Aerosol Vereniging, NAV)
- animal numbers: from the CBS/LEI agricultural database, plus data from the annual agricultural census
- manure production and handling: from the CBS/LEI national statistics
- fertilizer statistics: from the LEI agricultural statistics
- forest and wood statistics: (1) harvest data: FAO harvest statistics; (2) stem-volume, annual growth and fellings: Dirkse et al, (2003) (3) carbon balance: National Forestry Inventory data based on two inventories: HOSP (1988-1992) and MFV (2001-2005)
- land use and land use change: based on digitized and digital topographical maps of 1990and 2004 (Kramer et al, 2009, in preparation)
- area of organic soils: De Vries (2004)
- soil maps: De Groot et al. (2005)
- waste production and handling: Working Group on Waste Registration (WAR), SenterNovem and CBS
- CH_4 recovery from landfills: Association of Waste Handling Companies (VVAV)

Many recent statistics are available on the internet at CBS's statistical website Statline and in the CBS/PBL environmental data compendium. However, it should be noted that the units and definitions used for domestic purposes on those websites occasionally differ from those used in this report (for instance: temperature corrected CO_2 emissions versus actual emissions in this report; in other cases, emissions are presented with or without the inclusion of organic CO_2 and with or without LULUCF sinks and sources).

1.5 A brief description of the key categories

The analysis of key sources is performed in accordance with the IPCC Good Practice Guidance (IPCC, 2001). To facilitate the identification of key sources, the contribution of source categories to emissions per gas are classified based on the IPCC potential key source list as presented in Table 7.1, Chapter 7 of the Good Practice Guidance.

A detailed description of the key source analysis is provided in Annex 1 of this report. Per sector, the key sources are also listed in the first Section of each of Chapters 3–8.

Compared to the key source analysis for the NIR 2008, the key categories have changed as follows:

- N_2O emissions from 1A3 Mobile combustion: road vehicles: now non-key;
- CO_2 emissions from 2A7 Other minerals: now non-key;
- N_2O emissions from 2B5 Caprolactam production now non-key;
- CO_2 emissions from 5C2 Land converted to Grassland now key;
- CO_2 emissions from 5F2 Land converted to other land now non-key;
- N_2O emissions from 6B waste water handling now key

1.6 Information on the QA/QC plan

As one of the results of a comprehensive *inventory improvement program*, a National System fully in line with the Kyoto requirements was finalized and established by the end of 2005. As part of this system also an Act on the Monitoring of Greenhouse Gases also became effective in December 2005. This Act determines the establishment of the National System for monitoring of greenhouse gases and empowers the Minister of Housing, Spatial Planning and the Environment (VROM) to appoint an authority responsible for the National System and the National Inventory. The Act also determines that the National Inventory be based on methodologies and processes as laid down in the monitoring protocols. In a subsequent regulation the Minister has appointed SenterNovem as NIE (National Inventory Entity) and published a list of the protocols. Adjustments to the protocols will require official publication of the new protocols and announcement of publication in the official Government Gazette (Staatscourant).

As part of its National System, the Netherlands has developed and implemented a QA/QC program. This program is yearly assessed and updated, if needed. The key elements of the current program (SenterNovem, 2008) are briefly summarized in this chapter, notably those related to the current NIR.

1.6.1 QA/QC activities for the CRF/NIR 2009

The *Monitoring Protocols* were elaborated and implemented in order to improve the transparency of the inventory (including methodologies, procedures, tasks, roles and responsibilities with regard to inventories of greenhouse gases). Transparent descriptions and procedures of these different aspects are described in the protocols for each gas and sector and in process descriptions for other relevant tasks in the National System. The protocols are assessed annually and updated if needed.

- Various QC issues
  - Inconsistencies in the key category analysis between CRF and NIR were analyzed and removed. The key category analysis is updated in the NIR (Annex 1) as well as the CRF files
  - The Expert Review Team (ERT) recommended providing more information in the NIR report and protocols, that was until now only included in background information. The Netherlands is preparing an update of the protocols; for various sectors this implies that more information will be included in the protocols, as requested by the ERT. This update will be finalized before the NIR 2010
  - In 2008 a quantitative assessment was made of the possible (in)consistencies in CO_2 emissions between data from ETS, NIR and National Energy Statistics. The figures that were analyse concerned about 40% of the CO_2 emissions in the Netherlands in 2006 and 2007. The differences could reasonably be explained (e.g. different scope) within the given time available for this action [Guis et al, 2009]. Recommendations were elaborated for future improvements. One of these implies an annual update comparison as a sectorspecific QA/QC action, when new annual data become available.
  - The ERT recommended providing more specific information on sector specific QC activities. A start has been made; this will be further expanded in the NIR 2010
  - Finally, the Netherlands continues its efforts to include the correct notation keys in the CRF files
- For the NIR 2009 changes were incorporated to and references were updated in the National System website (www.greenhousegases.nl), providing additional information on the protocols and relevant background documents;
- *General* QC *checks* were performed. To facilitate these general QC checks, a checklist was developed and implemented. A number of general QC checks have been introduced as part of the annual work plan of the PRTR and are also mentioned in the monitoring protocols. The QC checks included in the work plan, aim at covering issues such as consistency, completeness and correctness of the CRF data, among others.
  The general QC for the present inventory is largely performed in the PRTR, as an integrated part of the working processes. The PRTR task forces fill in a standard-format database with emission data for 1990–2007. After a first check of the emission files by PBL and TNO for completeness, the (corrected) data are available to the specific task force for checking consistency checks and trend analysis (comparability, accuracy). The task forces have access to information about the relevant emissions in the database. Several weeks before the dataset is fixed, a trend verification workshop is organized by PBL (see Box 1.1).
- *Quality Assurance* for the current NIR includes the following activities:
  - A peer and public review on the basis of the draft NIR in January/February 2009. Results of this review are summarised in Chapter 10 and have been dealt with as far as possible in the present NIR.
  - In preparing this NIR, the results of former UNFCCC reviews, including the results of the initial review in 2007 and the review of the NIR 2007 and NIR 2008 in September 2008 have been taken into account in Chapters 3–8 whereever possible (see also Chapter 10.4.2 for an overview).
  - As part of the evaluation process of the previous cycle, internal audits were carried out by SenterNovem on

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 webbased application (so-called Emission Explorer, EmEx) for checks by the involved institutes and experts (PRTR task forces). This allows 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 CO2, CH4 and N2O emissions, among others, from all 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 are then subject to discussion at the trend analysis workshop and subsequently documented.

Furthermore, the task forces were provided with the CRF Reporter software to check the time series of emissions per substance and the CRF. The task forces examine these time series. During the trend analysis the greenhouse gas emissions for all years between 1990 and 2007 were checked in two ways: (1) emissions from 1990 – 2006 should (with some exceptions) be identical to those reported last year; (2) the data for 2007 were compared with the trend development for each gas since 1990. Checks of outliers were carried out at a more detailed level for the sub-sources of all sector background tables:

- *annual changes in emissions of all greenhouse gasses*
- *annual changes in activity data*
- *annual changes in implied emission factors*
- *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 must either be processed within 2 weeks or be dealt with in next year's inventory.

the use of the protocols and the implementation of QC checks. This year protocols in the "waste sector" were given special attention and some recommendations on improving transparency and background information were provided.

The trend verification workshop held on 3 March 2009, showed a.o. the following results:

Issues per source category:

- Reallocation of CO_2 emissions from cat. 1.AA.2 Manufacturing Industries to 2.B Chemical Industry for some years. Caused by new automated import procedure for CRF. Reallocation has to be turned back.
- Explanation of changed CH_4 emissions (whole time series) in cat. 1A Energy should be explained in Chapter 3.
- Reallocation from part of emissions from cat 1.AA.4.C Agriculture/forestry/Fishery to cat. 1AA.2.F Machinery should be explained in Chapter 3.
- Changes emissions N_2O and CH_4 from cat. 4. Agriculture (whole time series) should be explained in detail in Chapters 6.
- Changes emissions CO_2 from cat. 5. LULUCF (whole time series) should be explained in detail in Chapter 7.
- Changes emissions N_2O from cat. 6.B.2.1 Waste water (whole time series) should be explained in detail in Chapters 8.
- Minor changes in emission figures of all gasses in all categories, caused by the new improved automated import procedure of data to the CRF Reporter, should be explained in Chapter 10.

1.6.2 QA/QC plan as part of the National System

The QA/QC activities generally aim at a high-quality output of the emissions inventory and the National System; these are in line with international QA/QC requirements (IPCC Good Practice Guidance).

The QA/QC system should operate within the available means (capacity, finances). Within those boundaries, the main focal points of the QA/QC activities are:

- The QA/QC *programme* (SenterNovem, 2008), that has been developed and implemented as part of the National System. This program includes quality objectives for the National System, the QA/QC plan and a time schedule for implementation of the activities. It is updated annually as part of a yearly 'evaluation and improvement cycle' for the inventory and National System and held available for review.
- Up to and including 2008, PBL held ISO 9001/2000 certification. After 31 December 2008 PBL will no longer apply for extension of this certificate, but use its own quality management system, following the guidelines of the Dutch Institute for Quality Management (INK, a Dutch variety of the European Foundation for Quality Management (EFQM) Business Model). In practice this will not have much impact on the quality checks and quality assurance within PBL. As part of this system, PBL will periodically contract consultants to assess the implementation of its quality system and the INK guidelines.
- The *annual activity program* of the PRTR (PBL, 2008). The work plan describes tasks and responsibilities of the parties involved in the PRTR process, such as products, time schedules (planning) and emission estimation methods – including the monitoring protocols for the greenhouse gases – as well as those of the members of several task forces. The annual work plan also describes the general QC activities to be performed by the task forces before the annual database is fixed (see Section 1.6.1)
- The responsibility for the quality of data in *annual environmental reports* (MJVs) lies with the companies themselves, while validation of the data is the responsibility of the competent authorities. It is the responsibility of the institutes involved in the PRTR to judge whether or not to use the validated data of individual companies to assess the national total emissions (CO_2 emissions, however, are based on energy statistics and standard emission factors, and only qualified specific emission factor from environmental reports are used).
- *Agreements/covenants* between PBL and other institutes involved in the annual PRTR process. The general agreement is that by accepting the annual work plan, the involved institutes commit themselves to deliver capacity for the products specified in that work plan. The role and responsibility of each institute have been described (and agreed upon) within the framework of the PRTR work plan.
- *Specific procedures* that have been established to fulfill the QA/QC requirements as prescribed by the UNFCCC and Kyoto Protocol. General agreements on these procedures are described in the QA/QC program as part of the National System. The following specific procedures and agreements have been set out and described in the QA/QC plan and the annual PRTR work plan:
  - QC on data input and data processing, as part of the annual process towards trend analysis and fixation of the database following approval of the involved institutions.
  - Documentation of consistency, completeness and correctness of the CRF data (see also 1.6.1). Documentation is required for changes in the historical data set or in the emission trend that exceeds 5% at the sector level and 0.5% at the national total level.
  - Peer reviews of CRF and NIR by the SenterNovem (assigned as NIE) and institutions not fundamentally involved in the PRTR process.
  - Public review of the draft NIR: SenterNovem organizes every year a public review (by means of internet). Relevant comments are incorporated in the final NIR.
  - Audits: in the context of the annual work plan, it has been agreed upon that the involved institutions of the PRTR inform PBL concerning possible internal audits. Furthermore, SenterNovem is assigned the task of organizing audits, if needed, of relevant processes or organizational issues within the National System. In 2008 such an audit was performed for the emission estimates in the waste sector (see the previous Section)
  - Archiving and documentation: internal procedures are agreed upon (amongst others in the PRTR annual activity program) for general data collection and the storage of fixed datasets in the PBL database, including

the documentation/archiving of QC checks. The improved monitoring s have been documented and will be published on the website www.greenhousegases.nl. To improve transparency, the implemented checklists for QC checks have been documented and archived. As part of the QA/QC plan the documentation and archiving system has been further upgraded. SenterNovem (NIE) maintains the National System website and a central archive of relevant National System documents

– Each institution is responsible for QA/QC aspects related to reports based on the annually fixed database

- *Evaluation and improvement:* those persons involved in the annual inventory tasks are invited once a year to evaluate the process. In this evaluation, the results of any internal and external review and evaluation are taken into account. The results are used for the annual update of the QA/QC program (including the improvement program) and the annual work plan. The (monitoring) improvement plan is described in the previous sub-section;
- *Source-specific QC*: comparison of emissions with independent data sources was one of the study topics in the inventory improvement program. Because it did not seem possible to considerably reduce uncertainties through independent verification (measurements) – at least not on a national scale – this issue has received less priority. In the context of a longer term programme (including a large research program on climate change in the Netherlands [NOP-MLK, ROB]), the issue is currently being studied once again. To some extent (for example, in the transport sector) comparisons can be made on the basis of independent data sets (see Section 3.4.4.). It is expected that the NIR 2010 will include results of the update of source specific QA/QC.

1.7 Evaluating general uncertainty

The IPCC Tier 1 methodology for estimating uncertainty in annual emissions and trends has been applied to the list of possible key sources (see Annex 1) in order to obtain an estimate of the uncertainties in the annual emissions as well as in the trends. These uncertainty estimates have also been used for a first Tier 2 analysis to assess error propagation and to identify key sources as defined in the IPCC Good Practice Guidance (IPCC, 2001).

1.7.1 Data

The following information sources were used for estimating the uncertainty in activity data and emission factors (Olivier et al., 2009):

- estimates used for reporting uncertainty in greenhouse gas emissions in the Netherlands that were discussed at a national workshop in 1999 (Van Amstel et al., 2000a)
- default uncertainty estimates provided in the IPCC Good Practice Guidance report (IPCC 2000)
- RIVM fact sheets on calculation methodology and data uncertainty (RIVM, 1999)
- other recent information on the quality of data (Boonekamp et al., 2001)
- a comparison with uncertainty ranges reported by other European countries have led to a number of improvements in (and increased underpinning of) the Netherlands' assumptions for the present Tier 1 (Ramirez et al., 2006)

These data sources were supplemented with expert judgments from PBL and CBS emission experts (also for new key sources). This was followed by an estimation of the uncertainty in the emissions in 1990 and 2007 according to the IPCC Tier 1 methodology – for both the annual emissions and the emission trend for the Netherlands. All uncertainty figures should be interpreted as corresponding to a confidence interval of 2 standard deviations (2σ), or 95%. In cases where asymmetric uncertainty ranges were assumed, the largest percentage was used in the calculation.

1.7.2 Results

The results of the uncertainty calculation according to the IPCC Tier 1 uncertainty approach are summarized in Annex 7 of this report. The Tier 1 calculation of *annual uncertainty* in CO_2 equivalent emissions results in an overall uncertainty of about 4% in 2007, based on calculated uncertainties of 2%, 16%, 46% and 33% for CO_2 (excluding LULUCF), CH_4, N_2O and F-gases, respectively. The uncertainty in CO_2 equivalent emissions including emissions from LULUCF is calculated to be 5%.

However, these figures do not include the correlation between source categories (e.g. cattle numbers for enteric fermentation and animal manure production) or a correction for not-reported sources. Therefore, the *uncertainty of total annual emissions* per compound and of the total will be somewhat higher; see Table 1.2 for the currently estimated values.

Table 1.3 shows the top ten sources (excluding LULUCF) contributing most to total *annual uncertainty* in 2007, after ranking the sources according to their calculated contribution to the uncertainty in total national emissions (using the column 'Combined uncertainty as a percentage of total national emissions in 2007' in Table A7.1).

Table A7.1 of Annex 7 summarizes the estimate of the *trend uncertainty* 1990–2007 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in the total CO_2equivalent emissions (excluding LULUCF) for 1990–2007 (1995 for F-gases) of ±3% points. This means that the increase in total CO_2 eq emissions between 1990 and 2007, which is calculated to be -3%, will be between -6% and +0%.

Per individual gas, the *trend uncertainty* in total emissions of CO_2, CH_4, N_2O and the total group of F-gases has been calculated to be ±2%, ±10%, ±15% and ±9% points respectively. More details on the level and trend uncertainty assessment can be found in Annex 7. Table 1.4 shows the top ten sources (excluding LULUCF)contributing most to *trend uncertainty* (calculated) in the national total (using the column 'Uncertainty introduced into the trend in total national emissions' in Table A7.1).

Uncertainty of total annual emissions.

Table 1.2

CO_2	**±3%**	**HFCs**	**±50%**
CH_4	±25%	PFCs	±50%
N_2O	±50%	SF_6	±50%
Total greenhouse gases			±5%

Top ten sources contributing most to total annual uncertainty in 2007

Table 1.3

IPCC category	Category	Gas	Combined uncertainty as a percentage of total national emissions in 2007
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3.1% [1)]
4D1	Direct N_2O emissions from agricultural soils	N_2O	1.4%
1A4a	Stationary combustion : Other sectors: Commercial/Institutional, gases	CO_2	1.0%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	0.8%
4B1	Emissions from manure management : cattle	CH_4	0.7%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	0.6%
4B8	Emissions from manure management : swine	CH_4	0.5%
1A3b	Mobile combustion: road vehicles:diesel oil	CO_2	0.5%
2B2	Nitric acid production	N_2O	0.5%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	0.4%

1) calculated uncertainties, for ranking purposes not rounded off

Top ten sources contributing most to trend uncertainty in the national total

Table 1.4

IPCC cat.	Category	Gas	Uncertainty introduced into the trend in total national emissions
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1.9%
1A4a	Stationary combustion : Other sectors: Commercial/Institutional, gases	CO_2	1.3%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	1.1%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	0.7%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	0.6%
1A4b	Stationary combustion : Other sectors, Residential, gases	CO_2	0.5%
1A4c	Stationary combustion : Other sectors, Agriculture/Forestry/Fisheries, gases	CO_2	0.4%
4D2	Animal production on agricultural soils	N_2O	0.4%
2B2	Nitric Acid production	N_2O	0.3%
4D1	Direct N_2O emissions from agricultural soils	N_2O	0.3%

Seven of these key sources are included in both the list presented above and the list of the largest contributors to annual uncertainty.

1.7.3 Limitations

The propagation of uncertainty in the emission calculations was assessed using the IPCC Tier 1 approach. In this method, uncertainty ranges are combined for all sectors or gases using the standard equations for error propagation: if sources are added, total error is the root of the sum of squares of the error in the underlying sources. Strictly speaking, this is only valid if the uncertainties meet the following conditions: (a) standard normal distribution ("Gaussian"); (b) 2σ smaller than 60%; (c) independent (not-correlated) sector-to-sector and substance-to-substance. It is clear however for some sources that activity data or emission factors are correlated, which may change the overall uncertainty of the sum to an unknown extent. It is also known for some sources, that the uncertainty is not distributed normally; in particular, when uncertainties are very high (on an order of 100%) it is clear that the distribution will be positively skewed.

Even more important is the fact that although the uncertainty estimates have been based on the documented uncertainties mentioned above, uncertainty estimates are unavoidably – and ultimately – based on the judgment of the expert. On occasion there is only limited reference to actual data for the Netherlands possible as support for these estimates. By focusing on the order of magnitude of the individual uncertainty estimates, it is expected that this data set provides a reasonable first assessment of the uncertainty of key source categories.

Furthermore, in 2006 a Tier 2 uncertainty assessment was carried out (Ramirez et al., 2006). This study used the same uncertainty assumption as the Tier 1 study but accounted for

Effects of simplifying Tier 1 assumptions on the uncertainties of 2004 emissions (without LULUCF). **Table 1.5**

Greenhouse gas	Tier 1 annual uncertainty [1)]	Tier 2 annual uncertainty [2)]
Carbon dioxide	1.9%	1.5%
Methane	18%	15%
Nitrous oxide	45%	42%
F-gases	27%	28%
Total	4.3%	3.9%

1) Calculated in NIR 2006. 2) Source: Ramirez-Ramírez et al. (2006).

Effects of simplifying Tier 1 assumptions on the uncertainty in the emission trend for 1990–2004 (without LULUCF) **Table 1.6**

Greenhouse gas	Emission trend 1990-2004	Tier 1 trend uncertainty [1)]	Tier 2 trend uncertainty [2)]
Carbon dioxide	+13%	2. 7%	2.1%
Methane	-32%	11%	15%
Nitrous oxide	-16%	15%	28%
F-gases	-75%	7.0%	9.1%
Total	+1.6%	3.2%	4.5%

1) Calculated in NIR 2006. 2) Source: Ramirez et al. (2006).

correlations and non-Gaussian distributions. Results reveal that the Tier 2 uncertainty in total Netherlands CO_2 equivalent emissions is in the same order of magnitude as that in the Tier 1 results, although a higher trend uncertainty is found (see Tables 1.5 and 1.6). Furthermore, the Tier 2 uncertainty for 1990 emissions is slightly higher (about 1.5%-) than the uncertainty for the 2004 emissions. Finally, the resulting distribution for total Netherlands' CO_2 equivalent emissions turns out to be clearly positively skewed.

As part of the above mentioned study, the expert judgments and assumptions made for uncertainty ranges in emission factors and activity data for the Netherlands have been compared to the uncertainty assumptions (and their underpinnings) used in Tier 2 studies carried out by other European countries, such as Finland, the United Kingdom, Norway, Austria and Flanders (Belgium) in particular. The correlations that have been assumed in the various European Tier 2 studies have also been mapped and compared. The comparisons of assumed uncertainty ranges have already led to a number of improvements in (and increased underpinning of) the Netherlands' assumptions for the present Tier 1 approach. Although a straightforward comparison is somewhat blurred due to differences in the aggregation level at which the assumptions have been made, results show that for CO_2 the uncertainty estimates of the Netherlands are well within the range of European studies. For non-CO_2 gases, especially N_2O from agriculture and soils, the Netherlands uses IPCC defaults which are on the high side compared to the assumptions used in some of the other European studies, but this seems quite realistic in view of the state of knowledge on the processes that lead to N_2O emission. Another finding is that correlations (covariance and dependencies in the emission calculation) seem somewhat under-addressed in most present-day European Tier 2 studies and may require more systematic attention in future Tier 2 studies.

In the assessments made above only random errors have been estimated, assuming that the methodology used for the calculation does not include systematic errors. It is well known that, in practice, this may well be the case. Therefore, a more independent verification of the emission level and emission trends using, for example, comparisons with atmospheric concentration measurements is encouraged by the IPCC Good Practice Guidance. In the Netherlands, these approaches have been studied for several years, funded by the National Research Program on Global Air Pollution and Climate Change (NOP-MLK) or by the Dutch Reduction Program on Other Greenhouse Gases (ROB). The results of these studies can be found in Berdowski et al. (2001), Roemer and Tarasova (2002) and Roemer et al. (2003). In 2006, the research program *'Climate changes spatial planning'* started aiming to strengthen the knowledge on the relationship between greenhouse gas emissions and land-use and spatial planning.

1.8 General assessment of the completeness

At present, the greenhouse gas emission inventory for the Netherlands includes all of the sources identified by the Revised IPCC Guidelines (IPCC, 1997), with the exception of a number of (very) minor sources Annex 5 presents the assessment of completeness and sources, potential sources and sinks for this submission of the NIR and the CRF.

Trends in greenhouse gas emissions

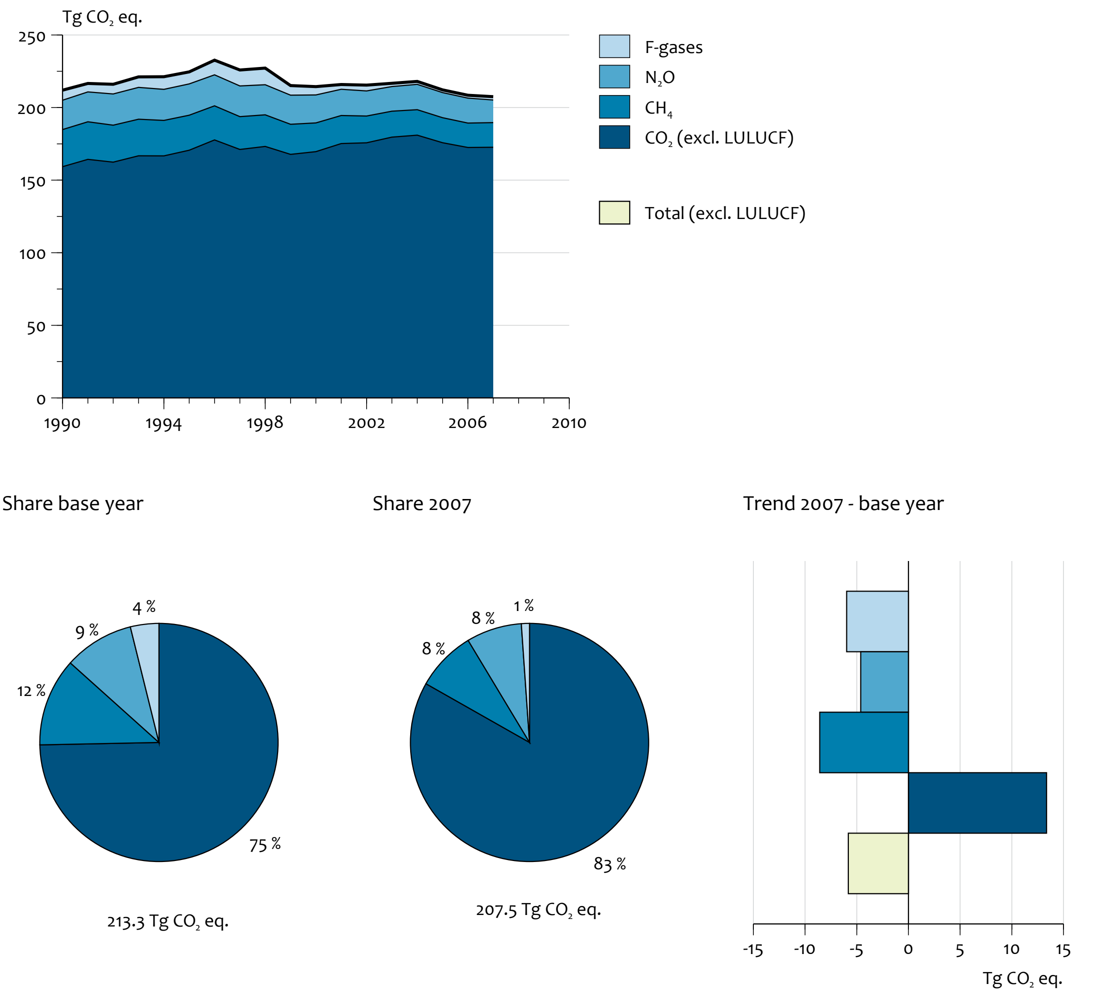
2

2.1 Emission trends for aggregated greenhouse gas emissions

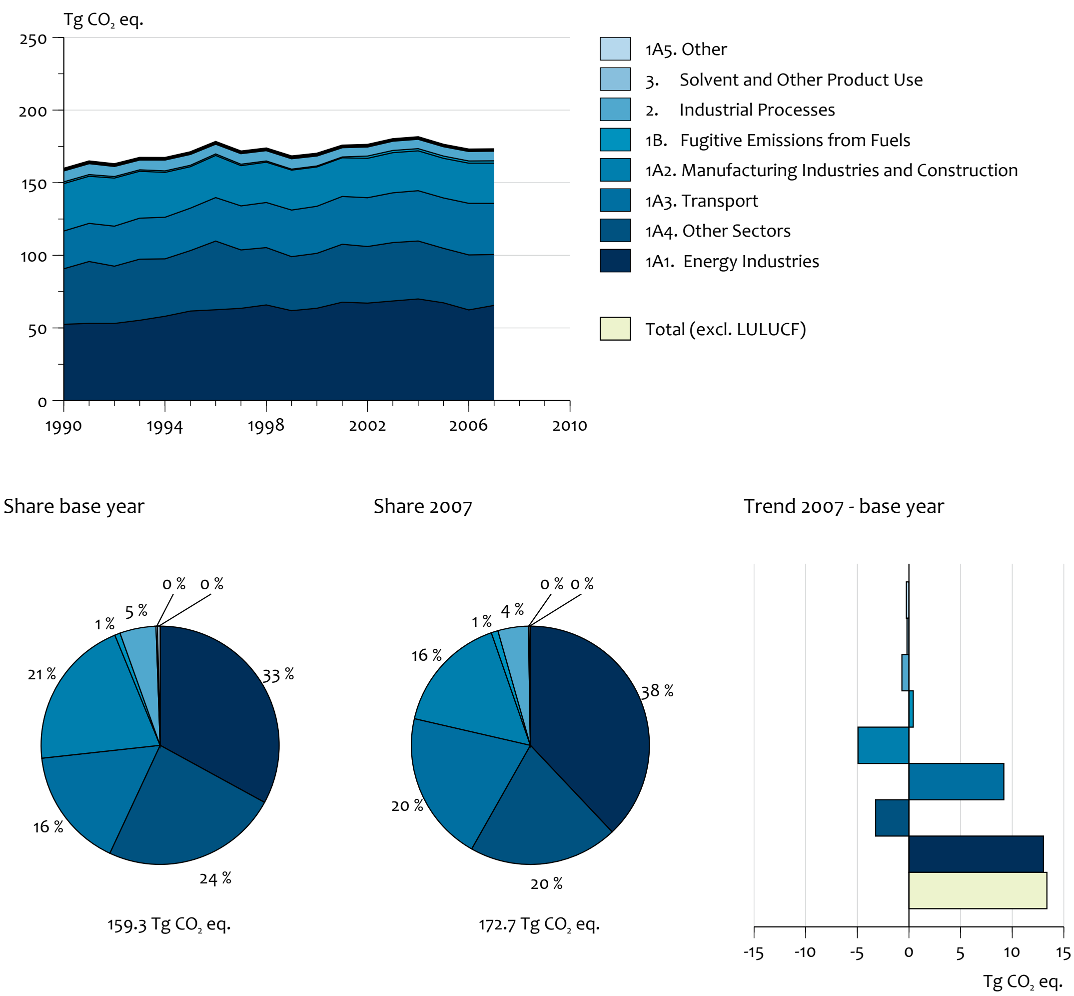
Chapter 2 summarizes the trends in greenhouse gas emissions during the period 1990–2007, by greenhouse gas and by sector. Detailed explanations of these trends are provided in Chapters 3–8. In 2007 total direct greenhouse gas emissions (excluding emissions from Land Use, Land Use Change and Forestry, LULUCF) in the Netherlands are estimated at 207.5 Tg CO_2 eq, which is 2.7% lower than the 213.3 Tg CO_2 eq reported in the base year (1990; 1995 is the base year for fluorinated gases).

Figure 2.1 shows the trends and relative contributions of the different gases to the aggregated national greenhouse gas emissions. In the period 1990–2007 emissions of carbon

Greenhouse gas emissions (excl. LULUCF) **Figure 2.1**



CO_2 emissions (excl. LULUCF) **Figure 2.2**



dioxide (CO_2) increased by 8% (excluding LULUCF), while emissions of non-CO_2 greenhouse gases decreased by 36% compared with the base year emissions. Of the non CO_2 greenhouse gases, methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (the F-gases) individually decreased by 34%, 23% and 72% respectively.

Emissions of LULUCF-related sources decreased by 2.3%, from 2.6 Tg in 1990 to 2.5 Tg CO_2 eq in 2007. In 2007, total greenhouse gas emissions (excluding LULUCF) decreased with 1 Tg CO_2 eq compared to 2006 (208.5 Tg CO_2 eq in 2006 and 207.5 Tg CO_2 eq in 2007).

2.2 Emission trends by gas

2.2.1 Carbon dioxide

Figure 2.2 presents the contribution of the most important sectors, as defined by the Intergovernmental Panel on Climate Change (IPCC), to the trend in total national CO_2 emissions (excluding LULUCF). In the period 1990–2007 the national CO_2 emissions increased by 8% (from 159.3 to 172.7 Tg). The Energy sector is by far the largest contributor to CO_2 emissions in the Netherlands (96%), with the categories 1A1 “Energy industries” (38%) and 1A4 “Other sectors” (20%) as largest contributors in 2007.

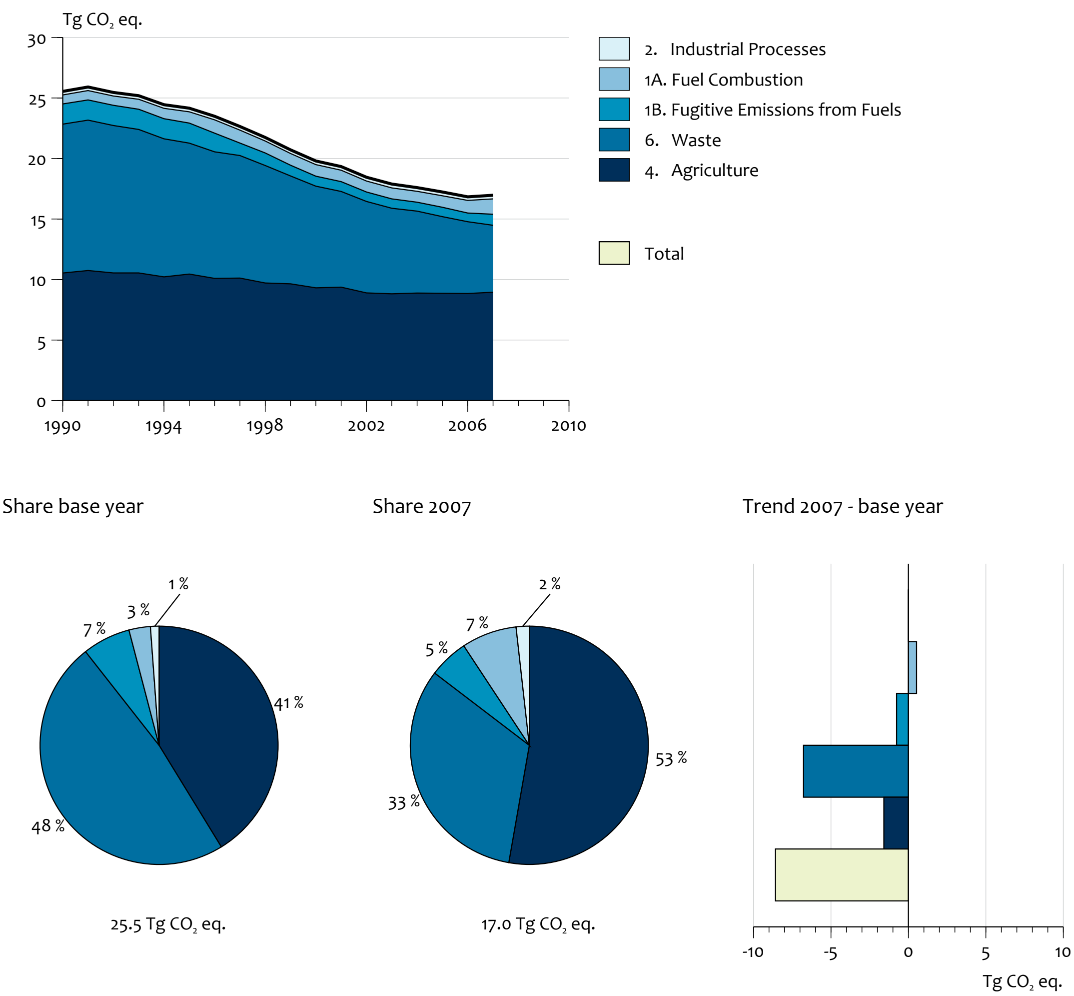
The relatively high level of CO_2 emissions in 1996 is mainly explained by a very cold winter, which caused increased energy use for space heating in the residential sector. The resulting emissions are included in the category 1A4 “Other sectors”. The relatively low level of CO_2 emissions in the category 1A1 “Energy industries” in 1999 is explained by the marked increase in imported electricity and a shift from the use of coal to residual chemical gas and natural gas in 1999; the share of imported electricity almost doubled. However, this increased import of electricity led to only a temporary decrease in the CO_2 emissions. In the period 2000-2004, the pre-1999 annual increase in CO_2 emissions from this category – about 1–2% – was observed again. In 2007 the import of electricity decreased.

In 2007, CO_2 emissions remained stable compared to 2006.

2.2.2 Methane

Figure 2.3 presents the contribution of the most important IPCC sectors to the trend in total CH_4 emissions. The national CH_4 emissions decreased by 34%, from 1.21 Gg in 1990 to 0.80

CH_4 emissions **Figure 2.3**



Gg in 2007 (25.5 to 17.0 Tg CO_2 eq). The Agriculture and Waste sector (53% and 33%) are the largest contributors in 2007.

Compared to 2006, national CH_4 emissions increased by 1% in 2007 (0.1 Tg CO_2 eq), due to the increase of CH_4 emissions mainly in category 1A: "Emissions from stationary combustion non- CO_2".

2.2.3 Nitrous oxide

Figure 2.4 presents the contribution of the most important IPCC sectors to the trend in national total N_2O emissions. The total national inventory of N_2O emissions decreased by about 23%, from 65.2 Gg in 1990 to 50.3 Gg in 2007 (from 20.2 to 15.6 Tg CO_2 eq). The sector contributing the most to this decrease in N_2O emissions is "Industrial Processes" (–32%). During the same period N_2O emissions from fossil fuel combustion increased. This latter trend can be largely clarified by increased emissions from Transport.

Compared to 2006, the total N_2O emissions decreased by 9% in 2007 (-1.5 Tg CO_2 eq).

2.2.4 Fluorinated gases

Figure 2.5 shows the trend in F-gas emissions included in the national greenhouse gas inventory. The emission level of the total F-gases decreased by 72% between 1995 and 2007, from 8.3 Tg CO_2 eq in 1995 (base year for F-gases) to 2.3 Tg CO_2 eq in 2007. Emissions of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) decreased by approximately 71% and 83% respectively during this same period, while sulphur hexafluoride (SF_6) emissions decreased by 29%.

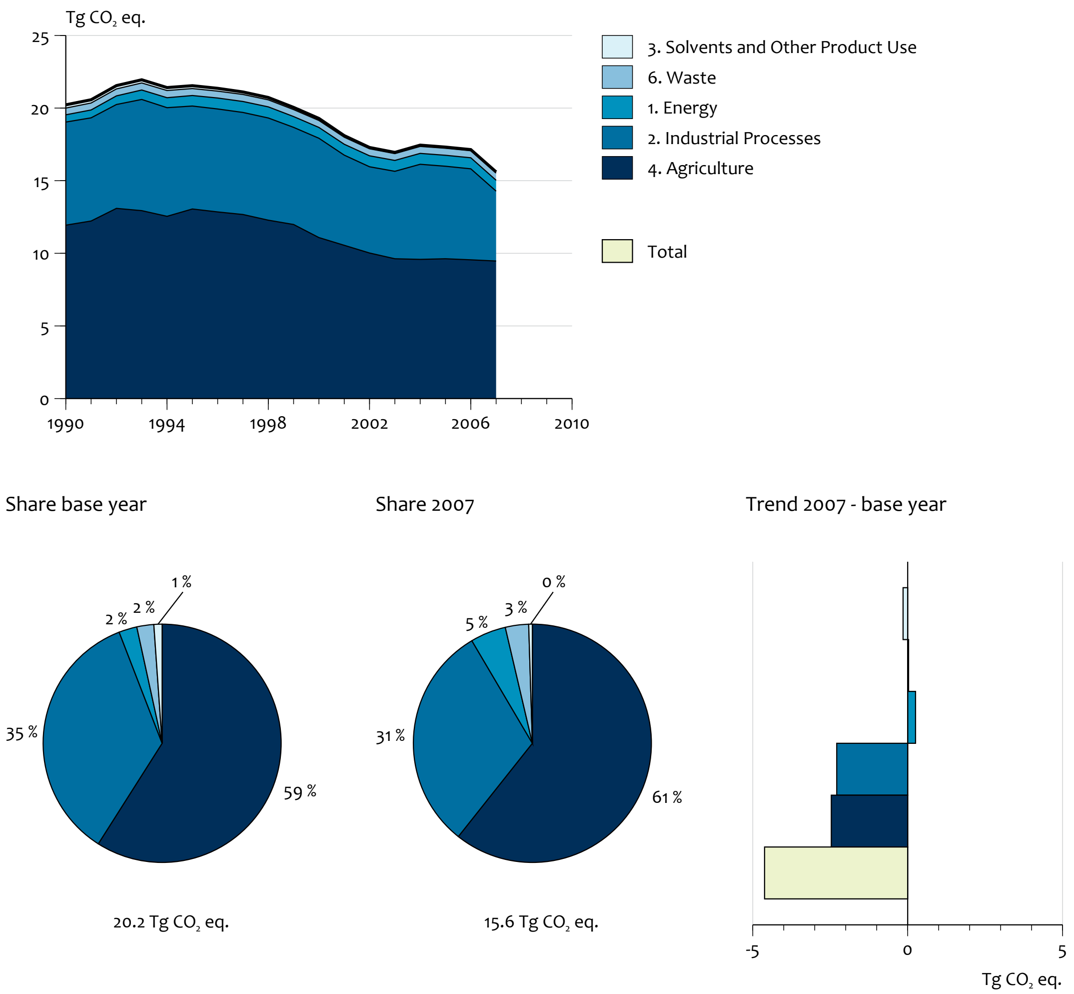
The aggregated emissions of F-gases increased by 13% from 2006 to 2007. PFC and HFC emissions showed an increase of 27%and 11% respectively, SF6 emissions increased by 6%.

2.2.5 Uncertainty in emissions specified by greenhouse gas

The uncertainty in the trend of CO_2 equivalent emissions of the six greenhouse gases taken together is estimated to be approximately 3% points, based on the IPCC Tier 1 Trend Uncertainty Assessment; see Section 1.7.

Per individual gas, the *trend uncertainty* in total emissions of CO_2, CH_4, N_2O and the sum of the F-gases is estimated to be ±2%, ± 10%, ±15% and ±9% points, respectively.

N_2O emissions **Figure 2.4**



For all greenhouse gases taken together the uncertainty estimate in *annual* emissions is ±4% and for CO_2 ±2%. The uncertainty estimates in *annual* emissions of CH_4 and N_2O are ±25% and ±50% respectively, and for HFCs, PFCs and SF_6, ± 50% (see Section 1.7).

2.3 Emission trends specified by source category

Figure 2.6 provides an overview of emission trends per IPCC sector in Tg CO_2 equivalents.

The IPCC Energy sector is by far the largest contributor to the total greenhouse gas emissions in the national inventory (contributing 72% in the base year and 81% in 2007). The relative share of the other sectors decreased correspondingly. The emission level of the Energy sector increased by approximately 9% in the period 1990–2007, and total greenhouse gas emissions from the Waste, Industrial Processes and Agriculture sectors decreased by 53%, 38%, and 18% respectively in 2007 compared to the base year.

Compared to 2006, greenhouse gas emissions in the Energy sector increased by about 0.4 Tg (mainly CO_2) in 2007. The emission of CO_2 from the combustion of fossil fuels in this category increased by approximately 2.8 Tg.

Trends in emissions by (sub) category are described in more detail in Chapters 3–8.

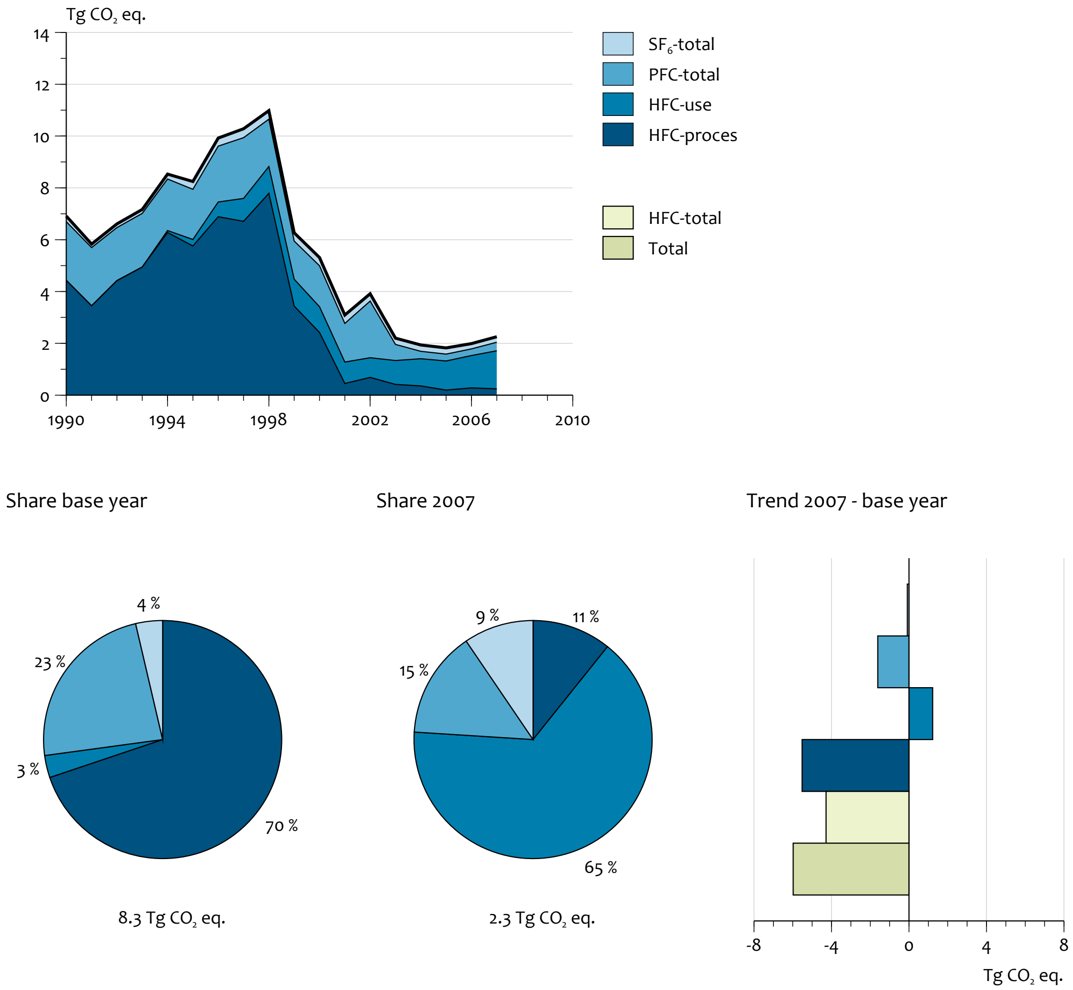
2.3.1 Uncertainty in emissions by sector

The uncertainty estimates in annual CO2 equivalent emissions of IPCC sectors Energy [1], Industry [2], Solvents and product use [3], Agriculture [4], and Waste [6] are about ±2%, ±9%, ±27%, ±40% and ±30% respectively; for sector 5 LULUCF it is ±100%. The uncertainty in the trend of CO_2 equivalent emissions per sector is calculated for sector 1 Energy at ±2% points in the 9% increase, for sector 2 Industry at ±6% points in the 38% decrease, for sector 4 Agriculture at ±15% points in the 18% decrease and for sector 6 Waste at ±9% points in the 53% decrease.

2.4 Emission trends for indirect greenhouse gases and SO_2

Figure 2.7 shows the trends in total emissions of carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile

F-gases **Figure 2.5**



organic compounds (NMVOC) and sulphur dioxide (SO_2). Compared to 1990, the CO and NMVOC emissions were reduced in 2007 by 50% and 66% respectively. For SO_2 this was as much as 69%, and for NOx, the 2007 emissions are 47% lower than the 1990 level. With the exception of NMVOC, most of the emissions stem from fuel combustion.

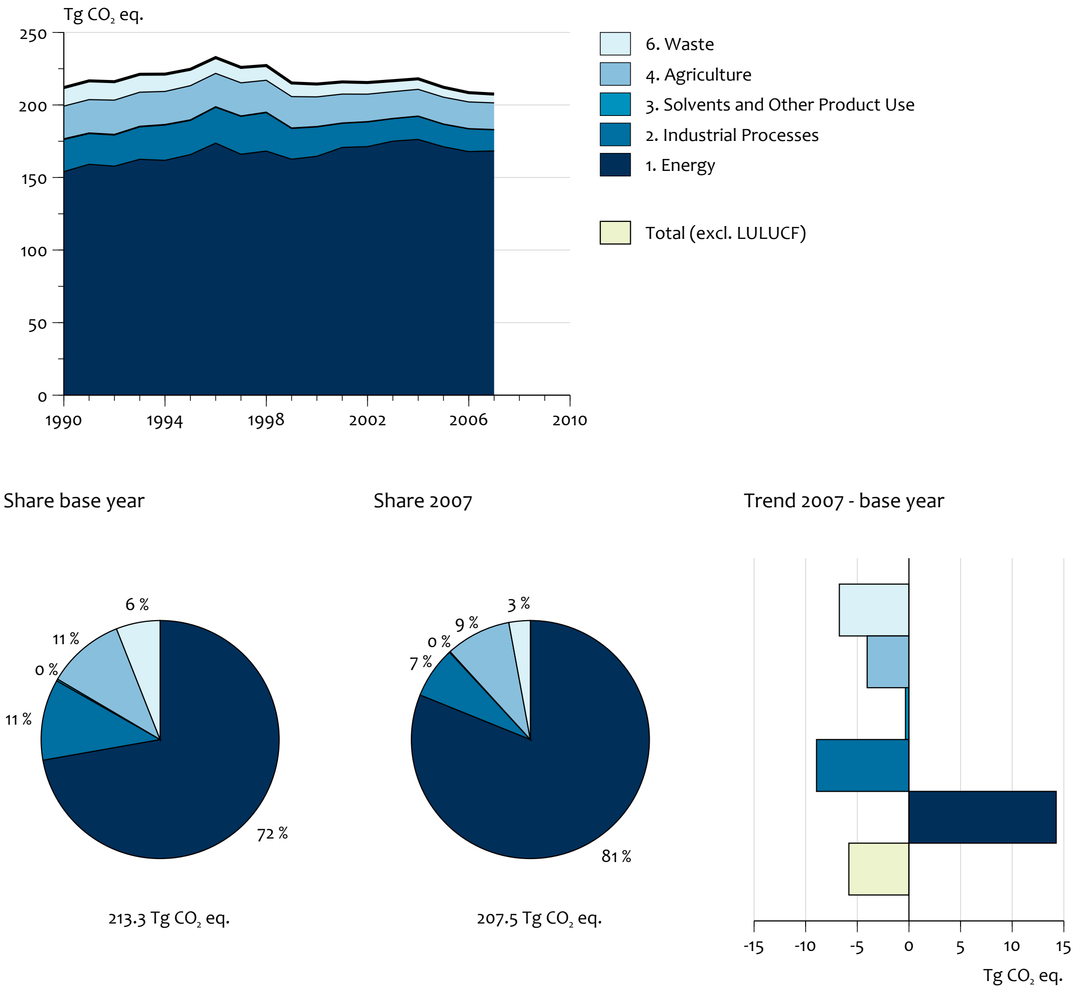
Because of the problems identified with annual environmental reporting (see Section 1.3.2.), emissions of CO from industrial sources are not verified; however, experts have suggested that possible errors will have a minor effect on total emission levels. Due to lack of data, the time series for 1991–1994 was interpolated between 1990 and 1995.

In contrast with the direct greenhouse gases, the calculations of emissions of precursors from road transport are not based on fuel sales according to the national energy statistics but are directly related to transport statistics on a vehicle-kilometer basis. To some extent this is different from the IPCC approach (see Section 3.5.4.).

Uncertainty in the emission factors for NOx, CO and NMVOC from fuel combustion is estimated to be in the range of 10–50%. The uncertainty in the emission factors of SO_2 from fuel combustion (basically the sulphur content of the fuels) is estimated to be 5%. For most compounds the uncertainty in the activity data is relatively small compared to the uncertainty in the emission factors. Therefore, the uncertainty in the overall total of sources included in the inventory is estimated to be in the order of 25% for CO, 15% for NOx, 5% for SO_2, and approximately 25% for NMVOC (TNO, 2004).

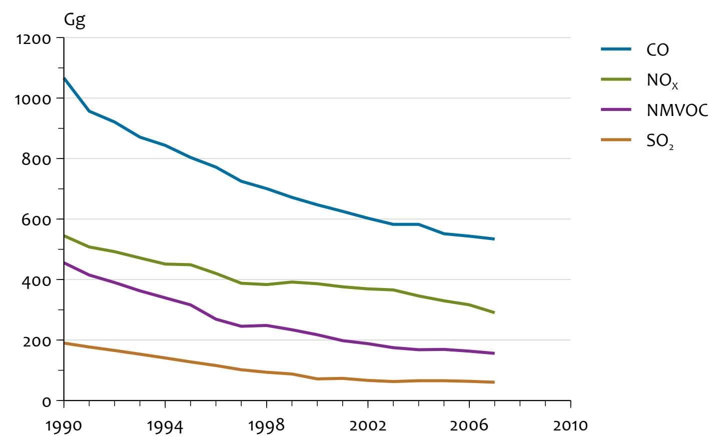
Sectors (excl. LULUCF)

Figure 2.6



Emissions of precursor gases

Figure 2.7



Energy [CRF Sector 1]

3

- Major changes in the Energy sector compared to the National Inventory Report 2008
  Emissions: Compared to the previous submission the GHG emissions stabilized
  Key sources: Compared to the previous submission, N_2O emissions from road transportation (1A3b) is not longer a key source.
  Methodologies: The emission factor for CH_4 for smaller CHP plants is changed which increased the emissions of CH_4 for the total time-series.

3.1 Overview of sector

Emissions from this sector include all emissions from energy use in the Netherlands. The Energy sector is divided into two main categories:

- 1A Fuel-related emissions from combustion activities
  - 1A1 “Energy Industries” (power generation, refineries, oil and gas production, coke ovens)
  - 1A2 ‘Manufacturing Industry and Construction’
  - 1A3 “Transport” (domestic)
  - 1A4 “Other sectors” (residential, services, agriculture/ fisheries)
  - 1A5 ‘Other’ (military ships and military aircraft)
- 1B Fuel-related emissions from non-combustion activities in the energy production and transformation industries
  - 1B1 ‘Solid Fuels’ (coke manufacture);
  - 1B2 ‘Oil and Gas’ (production, gas processing, oil refining, transport, distribution).

The Energy sector includes emissions from waste incineration for electricity and heat production (included in 1A1a instead of being reported under 6C ‘Waste Incineration’), combustion of by-products from blast furnaces in the iron and steel industry (blast furnace gas and oxygen furnace gas) (included in 1A1a and 1A2a) and energy-related emissions from the chemical industry (chemical waste gases, which are comparable with refinery gas) (included in 1A1a and 1A2c). According to the IPCC Guidelines only fossil-fuel related CO_2 emissions are included in the total national inventory, thus excluding CO_2 from organic carbon sources, i.e. from the combustion of biomass. On the basis of sectoral allocation in national statistics, data reported by joint ventures with utilities is reported under category 1A1a ‘Public Electricity and Heat Production’.

Trends in fossil fuel use and fuel mix

In 2007, natural gas was the most important of the fossil fuels, contributing 52% to total fossil fuel use. Liquid fuels contributed 32%, and solid fuels, mainly coal used for public power generation, contributed another 11%. Although the combustion of fossil waste (reported under Other Fuels) has tripled since 1990, its share in total fossil fuel use is still only 1% at the present time. In the 1990–2007 period total fossil fuel combustion increased by 8%, of which two-thirds was due to a 8% increase in gas consumption, while liquid fuel use increased by 10%. At the same time the combustion of solid fuels decreased by 7%.

Total fossil fuel consumption for combustion increased by about 0.1% between 2006 and 2007, mainly due to a 3% increase in gas consumption, but less solid and liquid fuels (6% and 2%) are used.

Structure of energy production and consumption sectors

The Netherlands produces large amounts of natural gas, both onshore (Groningen gas) and offshore; 71% of the gas produced is exported. Natural gas represents a very large share of the national energy consumption in all non-transport sectors: power generation, industry and other sectors (mainly for space heating). Oil products are primarily used in the transport sector, refineries and in the petrochemical industry, while the use of coal is limited to power generation and steel production. Natural gas production and distribution generates related emissions such as fugitive methane emissions. The Netherlands closed its last active underground coal mines in the late 1960s, and no post-mining emissions occur at the present time.

The Dutch electricity sector has a few notable features: it has a large share of coal-fired power stations and a large fraction of gas-fired cogeneration plants, with many of the latter being operated as joint ventures with industries. Compared to other countries in the EU, nuclear energy and renewable energy provide very little of the total primary energy supply in the Netherlands. The two main renewable energy sources are biomass and wind.

The Rotterdam harbor area houses four major refineries (a fifth one is located at Vlissingen) which export about 50% of their products to the European market. Consequently, the Dutch petrochemical industry is relatively large. In addition, most marine fuel oil produced in Russia is transported to Rotterdam where it is sold on the market. Combined, this makes Rotterdam the world's largest supplier of marine bunker oils. Freight transport by trucks makes up a large share of road transport due to the many goods that are transferred from ships to trucks for further transport into Europe. In addition, Schiphol Airport is Western Europe's largest supplier of aviation bunker fuels (jet-fuel) (see Section 3.8). The Netherlands also has one integrated steel plant, one cement manufacturer and two primary aluminum smelters. The food processing industry is relatively large due to the proximity of an intensive livestock breeding industry.

The protocols listed below can be accessed at www.greenhousegases.nl for a description of the methodologies applied for estimating emissions of the Energy sector in the Netherlands (see also *Annex 6*):

- Protocol 9052: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels' (included in 1A);
- Protocol 9088: Emissions from biomass combustion. Memo item on CO_2, CH_4 and N_2O emission, including emissions from combustion of fossil waste (1A1a, 6B, memo item CO_2);
- Protocol 9053: CO_2 , CH_4 and N_2O from 'Process Emissions: Fossil Fuels' (1B).
- Protocol 9054: CO_2 , CH_4 and N_2O from 'Mobile Equipment' (1A2f, 1A4c);
- Protocol 9055: CO_2 , CH_4 and N_2O from 'Inland Aviation' (1A3a);
- Protocol 9056: CO_2 from 'Road Transport' (1A3b);
- Protocol 9057: CH_4 and N_2O from 'Road Transport' (1A3b);
- Protocol 9058: CO_2 , CH_4 and N_2O from 'Rail Transport' (1A3c);
- Protocol 9059: CO_2 , CH_4 and N_2O from 'Inland Navigation' (1A3d);
- Protocol 9060: CO_2 , CH_4 and N_2O from 'Fisheries' (1A4c);
- Protocol 9061: CO_2 , CH_4 and N_2O from 'Military ships and aircraft' (1A5);
- Protocol 9062: CO_2 , CH_4 and N_2O from 'Oil and Gas Production' (1B2);
- Protocol 9063: CO_2, CH_4 and N_2O from 'Oil and Gas Distribution/Transport' (1B2);

Completeness
Fossil fuel combustion emissions from the Energy sector are completely consistent with the national energy statistics per sector, with the exception of a few categories which are partly based on other data or which have been re-allocated to comply with IPCC Reporting Guidelines:

- 'Stationary': own use (1A1c) and 'Flaring/Venting' (1B2) in the oil and gas production industries
- 'Mobile Sources': 'Domestic Aviation' (1A3a), 'Inland Navigation' (1A3d), 'Fisheries' (1A4c-ii), 'Military Ships and Aircraft' (1A5)
- 'Charcoal Production' (1B2) and Charcoal Combustion' (1A4) is not accounted for.

According to FAO statistics annual production is less than about 10 kton and apparent consumption varies between about 15 and 40 kton per year (see http://faostat.fao.org/). Related CH_4 and N_2O emissions are therefore almost negligible (considerable less than 1 Gg per year)

Transparency
All key emission factors for the Energy sector are listed in the methodology descriptions in either the source category Sections, in the Annexes or in the methodology descriptions available online at the national greenhouse gas website. Characteristics in emission trends are explained in the source category Sections on the basis of changes in either the activity data, the fuel mix determining implied emission factors, re-allocations over time due to changes in ownership of combustion facilities (joint ventures) or the different degrees of capturing residual gases that affect the proportion of emissions allocated to fuel combustion and to industrial processes.

Overview of shares and trends in emissions
Table 3.1 and Figure 3.1 show the contribution of the source categories in the Energy sector to the total national greenhouse gas inventory. In 2007 the Energy sector accounted for 80% of the total national emissions (excluding LULUCF), the predominant share of these being CO_2 emissions. About 46% of the CO_2 emissions from fuel combustion stems from the combustion of natural gas, 19% from solid fuels (coal) and 34% from liquid fuels. CH_4 and N_2O emissions from fuel combustion contribute less than 1% to the total emissions from this sector.

Key sources.
Table 3.1 also presents the key categories in the Energy sector specified by both level and trend (see also Annex 1). The key categories in 1A1, 1A2, 1A3 and 1A4 are based on aggregated emissions by fuel type and category, which is in line with the IPCC Good Practice Guidance (see Table 7.1 in IPCC (2001)). Since CO_2 emissions have the largest share in the total of national greenhouse gas emissions, it is not surprising to note that – with the exception of inland aviation and railways – almost all CO_2 sources are identified as key category. The total CH_4 emissions from stationary combustion sources together are also identified as a key category.

The following changes are found compared to the key source analysis for the NIR 2009:

- N_2O emissions from 1A3 Mobile combustion: road vehicles: now non-key (Tier 2). Category 1A1

"Energy Industries" is the main source category contributing to the Energy sector, accounting for 39% of the greenhouse gas emissions from this sector in 2007. Categories 1A2 "Manufacturing Industries and Construction", 1A3 "Transport" and 1A4 "Other sectors" (residential, services and agriculture/fisheries) contributed 16%, 21% and 22% of the total emissions, respectively (see Figure 3.1).

Since 1990, emissions from the Energy sector have increased by approximately 9% (154.0 to 168.3 Tg CO_2 eq), mainly due to the increased CO_2 emissions in categories 1A1a "Public Electricity and Heat Production" (32%) and 1A3 "Transport"

Contribution of main categories and key sources in CRF sector 1 Energy.

Table 3.1

Sector/category	Gas	Key*	Emissions in base year		Emissions in 2007		Change 2007 - 2006		Contribution to total in 2007 (%)	
		Level, Trend, Non Key	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Tg CO_2 eq	By sector	Of total gas	Of total CO_2 eq
1 Energy	CO_2			151.1		165.4	0.0	98	96	80
	CH_4		114.9	2.4	103.8	2.2	0.4	1.3	13	1.1
	N_2O		1.6	0.5	2.4	0.8	0.0	0.4	5	0.4
	All			154.0		168.3	0.4	100		81
1A Fuel combustion	CO_2			150.0		163.8	-0.1	97	95	79
	CH_4		35.4	0.7	60.6	1.3	0.0	0.8	7	0.6
	N_2O		1.6	0.5	2.4	0.8	0.0	0.4	5	0.4
	All			151.2		165.8	0.2	99		80
1A Emissions from stationary combustion (excl. 1A3)	CH_4	L,T	27.9	0.6	58.4	1.2	0.2	0.7	7	0.6
1A1 Energy Industries	CO_2			52.5		65.5	3.1	39	38	32
1A1a. Public Electricity and Heat Production	CO_2			39.9		52.7	2.9	31	31	25
1A1a liquids	CO_2	L1,T1		0.2		0.7	0.0	0	0	0
1A1a solids	CO_2	L,T1		25.8		26.1	2.0	15	15	13
1A1a gas	CO_2	L,T		13.3		23.7	0.8	14	14	11
1A1a other fuels: waste incineration	CO_2	L1,T		0.6		2.2	0.1	1	1	1
1A1b. Petroleum refining	CO_2			11.0		10.6	0.0	6	6	5
1A1b liquids	CO_2	L,T1		10.0		8.0	0.0	5	5	4
1a1b gases	CO_2	L1,T1		1.0		2.6	-0.1	2	2	1
1A1c Manufacture of Solid Fuels and Other Energy Industries	CO_2			1.5		2.2	0.3	1	1	1.1
1A1c gases	CO_2	L,T		1.5		2.2	0.3	1	1	1.1
1A2 Manufacturing industries and construction	CO_2			32.7		27.7	0.1	16	16	13
1A2 liquids	CO_2	L,T1		8.6		9.1	0.5	5	5	4
1A2 solids	CO_2	L,T1		5.0		4.5	0.1	3	3	2
1A2 gases	CO_2	L,T1		19.0		14.1	-0.5	8	8	7
1A2a. Iron and steel	CO_2			4.0		4.5	-0.1	3	3	2
1A2b. Non-Ferrous Metals	CO_2			0.2		0.3	0.0	0.1	0.1	0.1
1A2c. Chemicals	CO_2			17.2		12.8	0.4	8	7	6
1A2d. Pup, Paper and Print	CO_2			1.7		1.4	-0.2	0.8	0.8	0.7
1A2e. Food Processing, Beverages and Tobacco	CO_2			4.1		3.8	0.1	2	2	2
1A2f. Other	CO_2			5.5		4.9	-0.1	3	3	2
1A3. Transport	CO_2			26.0		35.2	-0.3	21	20	17
	N_2O		0.9	0.3	1.4	0.4	0.0	0.3	3	0.2
	All			26.4		35.7	-0.4	21		17
1A3a. Civil aviation	CO_2	NK		0.04		0.04	0.0	0.0	0.0	0.0
1A3b. Road	CO_2			25.5		34.5	-0.3	21	20	17
1a3b gasoline	CO_2	L,T1		10.9		13.0	-0.1	8	8	6
1a3b diesel oil	CO_2	L,T		11.8		20.5	-0.2	12	12	10
1a3b LPG	CO_2	L1,T		2.7		1.0	0.0	1	1	0.5
1A3b. Road	N_2O	NK	0.9	0.3	1.4	0.4	0.0	0.3	3	0.2
1A3c. Railways	CO_2	NK		0.1		0.1	0.0	0.1	0.1	0.0
1A3d. Navigation	CO_2	L1		0.4		0.6	0.0	0.4	0.4	0.3
1A4. Other sectors	CO_2			38.2		35.0	-2.9	21	20	17
	CH_4	NK	21.4	0.5	49.1	1.0	0.2	0.6	6	0.5
	All			38.7		36.0	-2.9	21		17
1A4 liquids (excl. From 1A4c)	CO_2	T		1.5		0.4	-0.1	0.3	0.3	0.2
1A4a. Commercial/ Institutional	CO_2			7.5		10.2	-1.6	6	6	5
1A4a gases	CO_2	L,T		6.6		10.0	-1.5	6	6	5
1A4b. Residential	CO_2	L,T		19.5		16	-1.4	10	9	8
	CH_4		16.9	0.4	14.1	0.3	0.0	0.2	2	0.1
1A4b gases	CO_2			18.7		15.7	-1.4	10	9	8
1A4c. Agriculture/ Forestry/Fisheries	CO_2			11.2		8.7	0.1	5	5	4

Sector/category	Gas	Key*	Emissions in base year		Emissions in 2007		Change 2007 - 2006		Contribution to total in 2007 (%)	
1A4c liquids	CO_2	L,T		2.9		2.2	-0.2	1	1	1
1A4c gases	CO_2	L,T		8.3		6.6	0.3	4	4	3
1A5 Other	CO_2			0.6		0.3	-0.1	0.2	0.2	0.2
1B Fugitive emissions from fuels	CO_2			1.2		1.6	0.1	0.9	0.9	0.8
	CH_4		79.5	1.7	43.3	0.9	0.0	0.5	5	0.4
	All			2.8		2.5	0.3	1.5	1.2	1.2
1B1. Solid fuels transformation: coke production	CO_2	NK		0.4		0.4	0.0	0.3	0.3	0.2
1B2. venting/flaring	CO_2	T		0.8		0.1	0.0	0.1	0.1	0.1
1B2. venting/flaring	CH_4	T	59.6	1.3	22.8	0.5	0.0	0.3	3	0.2
Total national emissions	CO_2		159,3	159.3	172,7	172.7	0.1			
	CH_4		1.216,5	25.5	807.9	17.0	0.1			
	N_2O		65.2	20.2	50.3	15.6	-1.5			
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.3		207.5	-1.0			

(35%). Overall emissions from 1A4 “Other sectors” decreased by 10%. Total Fugitive emissions from oil and natural gas’ [1B] decreased by 12% in the period 1990–2007 (from 2.8 to 2.5 Tg CO_2 eq), of which CH_4 emissions decreased by 46% and CO_2 increased by 36%. Between 2006 and 2007, total emissions in the Energy sector increased by 0.3% or 0.4 Tg CO_2 equivalents, mainly as a result of increased emissions of CH_4 as a result of the increased EF for this gas from CHP plants.

3.2 Fuel Combustion Activities [1A]

3.2.1 Source category description

This source category includes all fuel-related emissions from combustion activities:

- 1A1 “Energy Industries” (power generation, refineries, oil and gas production, coke ovens)
- 1A2 ‘Manufacturing Industry and Construction’
- 1A3 “Transport” (domestic)
- 1A4 “Other sectors” (residential, services, agriculture/fisheries)
- 1A5 “Other” (military ships and military aircraft)

The following Sections discuss the greenhouse gas emission inventory of the Energy sector per source category. Stationary and mobile sources of combustion-related emissions are discussed per fuel type.

Activity data and (implied) emission factors

Almost all activity data in this sector are derived from the national energy statistics. When more detailed information is used, the data sources and the allocation to IPCC source categories are described either in the NIR or in the methodology descriptions available online at the website www.greenhousegases.nl. All key emission factors for greenhouse gases are listed in the methodology descriptions (protocols) and background documents. In some instances, activity data for the year are based on preliminary data. More detailed information on activity data and emission factors and implied emission factors is provided in the following Sections.

3.2.2 Methodological issues

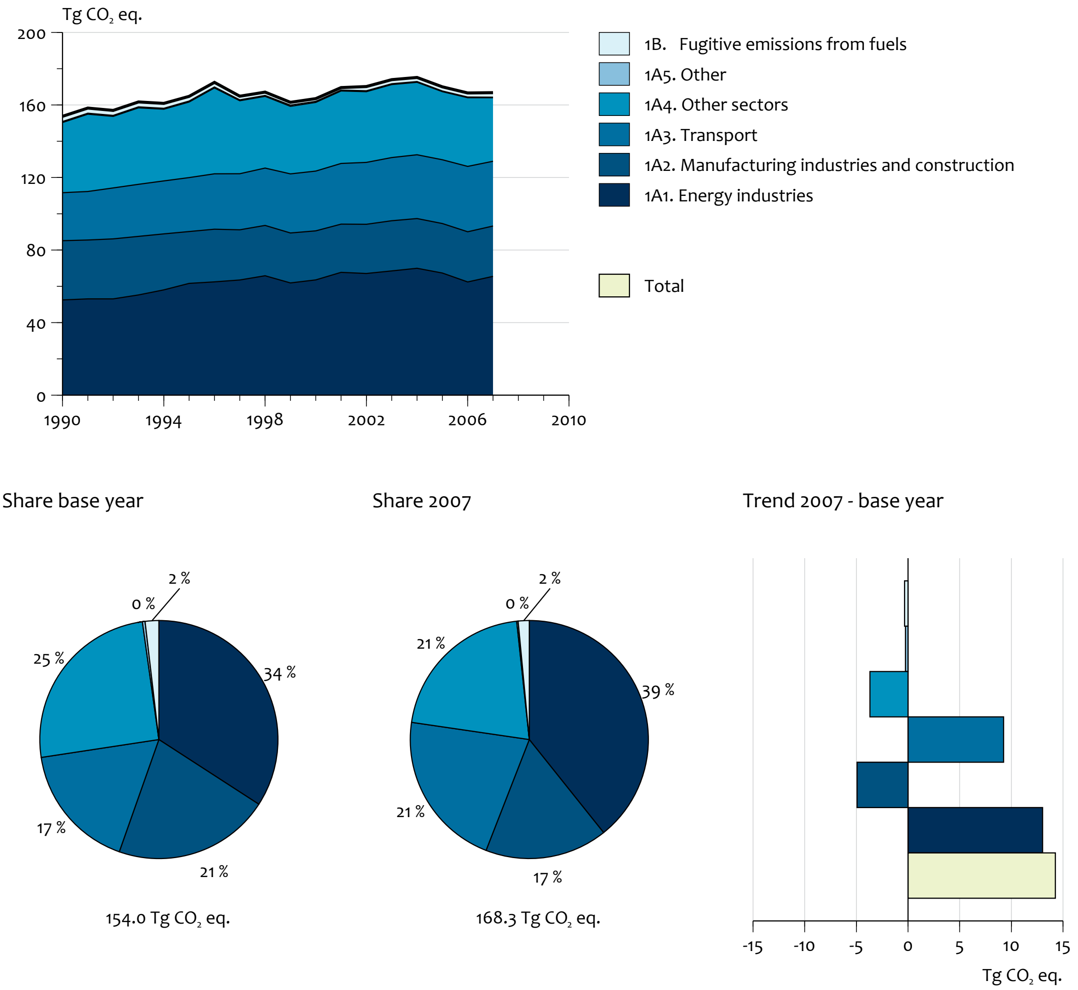
Different methods are used to estimate emissions from fuel combustion in related source categories. For more details on this subject, the reader is referred to the following Sections and the website www.greenhousegases.nl.

The emissions from fuel combustion in the Energy sector are consistent with the national energy statistics per sector. Possible areas of double counting or omissions of CO_2, such as conversion losses in refineries, coke ovens, blast furnaces in the steel industry and fuels used as feedstock in the chemical industry, are partly or wholly covered by the residual gases accounted for in the statistics. A carbon balance calculation is made for most of these processes (except for emissions from feedstock use in the chemical industry) to account for conversion losses in those cases where the residual fuels are not fully captured in the statistics. An energy balance calculation is made for the oil and gas production industry in which total net fuel use is allocated to either for own use (included in 1A1c) or to vented/flared (included in 1B2).

3.2.3 Uncertainty and time-series consistency

Uncertainty

Most uncertainty estimates for activity data are the judgments of CBS (Statistics Netherlands) and PBL experts and are based on the assumed accuracy of the underlying statistics, annual variability and the monitoring method of the fuel uses involved. For the emission factors, the uncertainty estimate is based on the background of the determination and selection of the emission factors, the degree of heterogeneity within the sources and within fuel types – this is particularly true for derived gases – and over time (see Olivier et al.,2009). In general, statistics for fuel consumption are much less accurate for the smaller figures, e.g. liquid and solid fuels in pulp and paper production and in the food



processing industry and solid fuels in the other sectors (1A4a, b). The interannual variability in the data suggests that the uncertainty could be as much as 50%.

Time-series consistency

The emissions from fuel combustion are consistent with the national energy statistics. However, the time-series of the energy statistics is not fully consistent at the detailed sector and detailed fuel-type levels for the years 1991–1994. This inconsistency is caused by revisions in the economic classification scheme that were implemented in 1993, a change from the "special trade" to "general trade" system to define the domestic use of oil products, some error corrections and the elimination of statistical differences. These changes were incorporated into the data sets for 1990, 1995 and subsequent years, thus creating the existing inconsistency with the 1991–1994 dataset. For the base year 1990, CBS has re-assessed the original statistics and made them compatible with the 'new' 1993 classification system and ECN (Energy Research Centre of the Netherlands) was commissioned to re-allocate the statistics of 1991–1994 at a higher level of detail (for both fuels and sectors). In some cases this re-allocation has resulted in apparent discontinuities in fuel use for liquid and solid fuels due to the simplified estimation of the residual gases or derived gases, or in discontinuities in implied emission factors due to the simplified fuel mix (liquids in 1A2b, d, f, and in 1A4a, b; solids in 12a, f and in 1A4a, b).

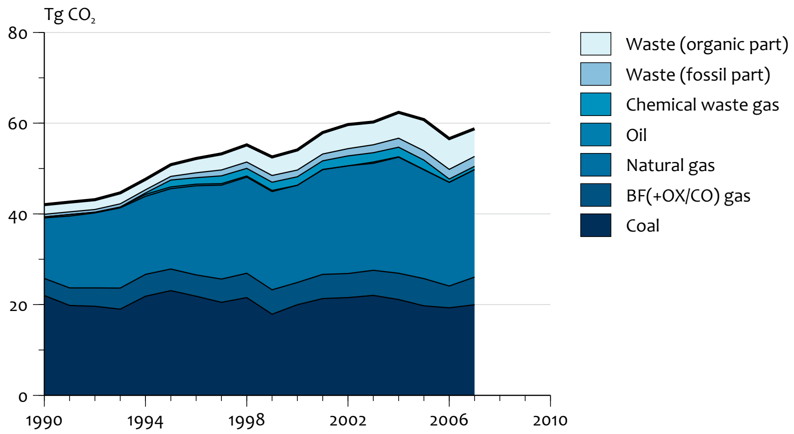
3.2.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures discussed in Chapter 1. In addition, in 2008 a quantitative assessment was made of the possible (in) consistencies in CO_2 emissions between data from ETS, NIR and National Energy Statistics. The figures that were analyzed concerned about 40% of the CO_2 emissions in the Netherlands in 2006 and 2007. The differences could reasonably be explained (e.g. different scope) within the given time available for this action [Guis et al, 2009]. Recommendations were elaborated for future improvements. One of these implies an annual update comparison as a sector specific QA/QC action, when new annual data become available.

3.2.5 Source-specific recalculations

The following methodological change is included in this submission:

CO_2 emissions from public power generation by fuel type — Figure 3.2



Emissions of methane from the smaller cogeneration facilities increased. Recent research shows that CH_4 emission from natural gas powered internal combustion engines is higher than formerly estimated. For the base year the emissions increased by 64 Gg CO_2 CO_2 eq compared to last NIR. For the year 2006 the increase is 457 Gg CO_2eq. The larger part of this effect is seen in category 1.A.4.c "Agriculture/Forestry/ Fisheries". In 2007 this methodical change results in a further increase of the CH_4 emissions because of the growing number of small CHP plants in the Netherlands.

The changes in the emission factor for CH_4 will be documented in the Protocol 9052: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.2.6 Source-specific planned improvements

There are no source-specific improvements planned.

3.3 Energy industries [1A1]

3.3.1 Source category description

This source category consists of 1A1a "Public Electricity and Heat Production" (including emissions from waste incineration), 1A1b "Petroleum Refining" and 1A1c "Manufacture of Solid Fuels and Other Energy Industries". Within these categories, natural gas and coal combustion by public electricity production and oil combustion by refineries are the dominating key sources. However, liquid fuels and other fuels (i.e. waste) in power generation and natural gas combustion in refineries and in manufacturing of solid fuels and other energy industries are also key sources. CH_4 and N_2O emissions from 1A1 "Energy Industries" contribute relatively little to the total national inventory of greenhouse gas emissions. CH_4 from stationary combustion is a now a key source, due to an increase of the CH_4 emission factor from small CHP plants. N_2O emissions from "Energy Industries" are not identified as a key source (see Table 3.1).

1A1a "Public Electricity and Heat Production" includes all emissions from large-scale waste incineration (see Figure 3.2; note that CO_2 from organic waste (waste organic part) does not contribute to net CO_2 emissions), since almost all incineration facilities also produce heat and/or electricity. In addition, a large fraction of the blast furnace gas and a significant part of coke oven gas produced by the one iron and steel plant in the Netherlands is combusted in the public electricity sector. This category also includes the cogeneration (Combined Heat and Power, CHP) facilities (and sometimes also steam boilers) that are operated as joint venture concerns. Since CHP has a substantial and increasing share in fuel consumption and the ownership of several privately owned facilities has changed over time in joint ventures with public electricity production industries, there has been a significant impact on emissions trends in the public electricity and heat production sector on one hand and the manufacturing industry and the other sectors on the other hand (see Figure 3.4).

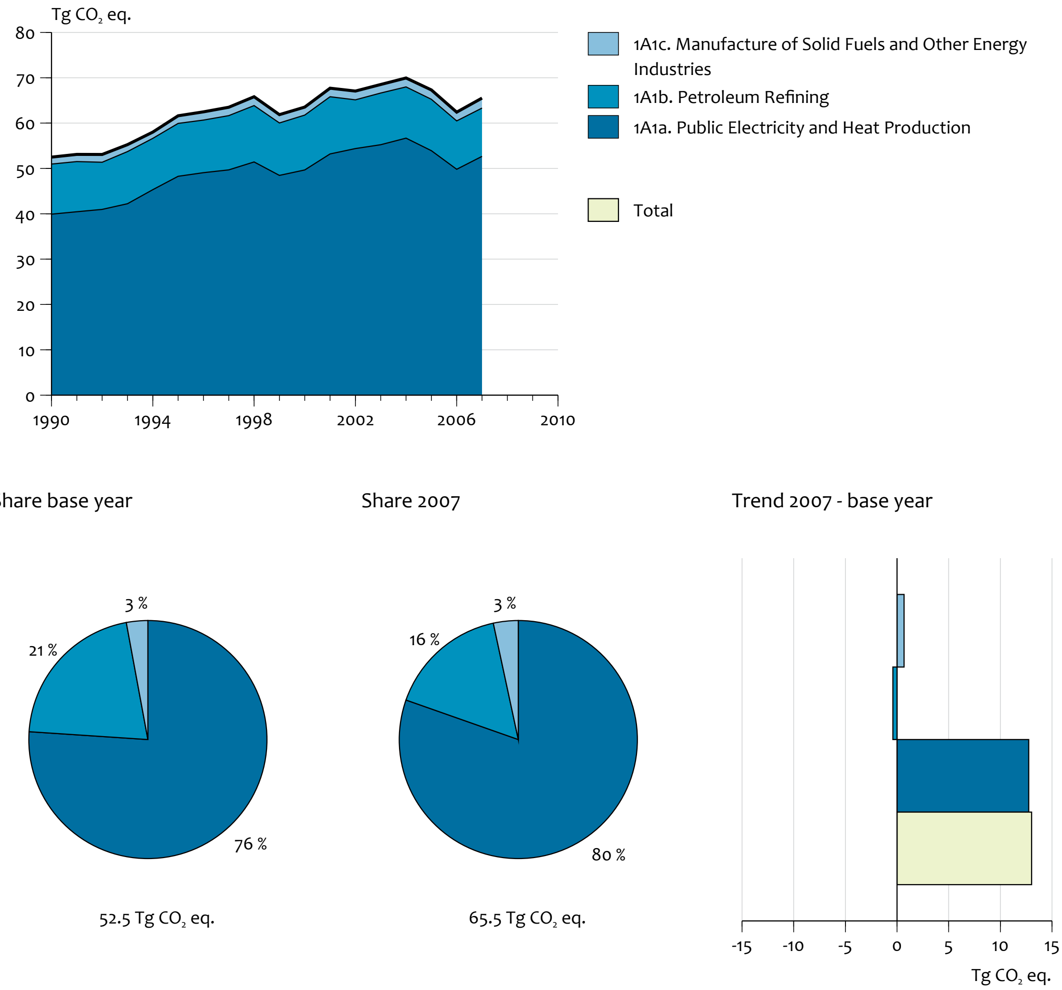
1A1c "Manufacturing of Solid Fuels and Other Energy Industries" includes emissions from the combustion of one independent coke production facility (Sluiskil), the operation of which discontinued in 1999. However, in accordance with IPCC classification guidelines, but contrary to the national SBI/NACE allocation scheme, emissions from fuel combustion for on-site coke production by the iron and steel company (Corus) are included in 1A2 "Manufacturing Industries and Construction" since this is an integrated coke, iron and steel plant (see Section 3.4.1.). Source category 1A1c also comprises:

- Combustion of "own" fuel use by the oil and gas production industry for heating purposes (the difference between the amounts of fuel produced and sold, minus the amounts of associated gas which is either flared or vented or otherwise lost by leakage, et cetera)
- Fuel combustion for space heating and in use in compressors for gas and oil pipeline transmission by the gas, oil and electricity transport and distribution companies.

Overview of shares and trends in emissions

In 2007 CO_2 emissions from category 1A1 "Energy Industries" contributed 32% to the total national greenhouse gas emission inventory (excluding LULUCF), while CH_4 and N_2O

1A1. Energy industries: CO_2 emissions Figure 3.3



emissions from this same category contributed relatively little to the total national greenhouse gas emissions. The share contributed by 1A1 "Energy Industries" to the total greenhouse gas emissions from the Energy sector increased from 34% in 1990 to 39% in 2007 (see Figure 3.3), partly due to a change in ownership of CHP plants (joint ventures, which are allocated to this source category).

Between 1990 and 2007, total CO_2 emissions from 1A1 "Energy Industries" increased by 24%, from 52.5 to 65.5 Tg (see Figure 3.3). Due to an increasing demand for electricity, 1A1a "Public Electricity and Heat Production" (+12.7 Tg CO_2). In 2007, CO_2 emissions from 1A1 "Energy Industries" increased by about 5%, especially in category 1A1a "Public electricity and heat production".

Public Electricity and Heat Production [1A1a]

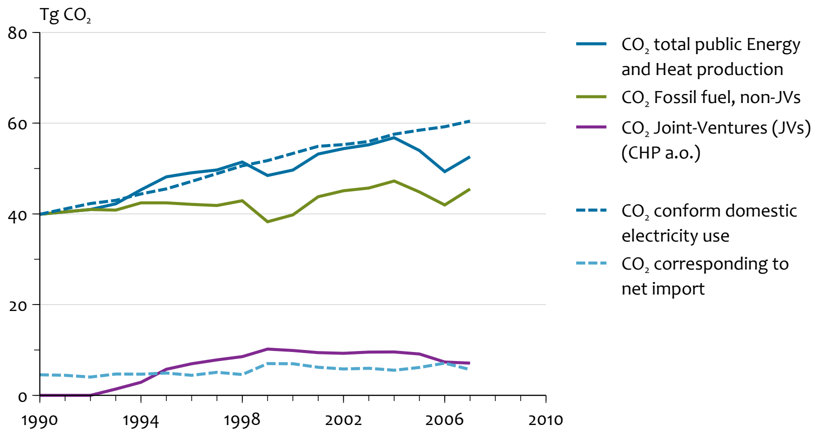
In 2007, 1A1a "Public Electricity and Heat Production" was the largest source category within the 1A1 Energy industries, accounting for 80% of the total greenhouse gas emissions from this category (see Figure 3.3). CO_2 emissions from waste incineration of fossil carbon represent 4% of the total greenhouse gas emissions in 1A1a Public electricity and heat production.

Between 1990 and 2007, total CO_2 emissions from "Public Electricity and Heat Production" increased by 32%, from 39.9 to 52.7 Tg. This increase in CO_2 emissions is mainly explained by an increase in fossil fuel combustion for the generation of electric power. The CO_2 emission level from waste incineration of fossil carbon increased from 0.6 to 2.2 Tg CO_2 due to the increasing amounts of municipal waste that are combusted instead of being deposited in landfills. The increasing level of CO_2 emissions in this period is partly compensated by a shift from the use of coal to natural gas and the increased efficiency of power plants.

Between 1990 and 1998, changed ownership relations of plants (joint ventures) caused a shift of cogeneration plants from category 1A2 "Manufacturing Industries" to "Public Electricity and Heat Production". About 50% of the increased emission levels included in this source category (almost 30% in the period 1990–1998) can be explained by a re-allocation caused by this phenomenon. Further explanations of the trends from the year 1998 are discussed below under the Section on Activity data and emission factors.

In 2007, the emissions of CO_2 from the combustion of fossil fuels in this source category increased by 6%.

CO_2 emissions from electricity production **Figure 3.4**



Petroleum Refining [1A1b]

The share of 1A1b "Petroleum Refining" in total greenhouse gas emissions from the category 1A1 "Energy Industries" is estimated to be 21% in 1990 and 20% in 2007. However, the combustion emissions from this category should be viewed in relation to the fugitive emissions reported under category 1B2. Between 1990 and 2007 total CO_2 emissions from the refineries (including fugitive CO_2 emissions from hydrogen production reported in 1B2a-iv Refining) fluctuated between 11 and 12 Tg (11.0 Tg in 1990 and 10.6 Tg in 2007).

Manufacture of Solid Fuels and Other Energy Industries [1A1c]

The share of 1A1c 'Manufacture of solid fuels (coke) and other energy industries (fuel production) in the total greenhouse gas emissions from the category 1A1 "Energy Industries" is approximately 3% in both 1990 and 2007. This category comprises mostly CO_2 emissions from the combustion of natural gas. The dominating source is the use for energy purposes in oil and gas production and in the transmission industry. The combustion emissions from oil and gas production refer to the so-called 'own use' of the gas and oil production industry, which is the difference between the amounts of fuel produced and sold, after subtraction of the amounts of associated gas which is either flared or vented or otherwise lost by leakage etc. Production and sales data are based on the national energy statistics; amounts flared and vented are based on reports from the sector. CO_2 emissions from this source category increased from 1.5 Tg in 1990 to 2.2 Tg CO_2 in 2007 mainly due to the exploitation of less favorable production sites for oil and gas production compared with those exploited in the past.

Public electricity and heat production [1A1a]

The increasing trend in electric power production corresponds to considerably increased CO_2 emissions from fossil fuel combustion by power plants, which are partly compensated for by a shift from coal to natural gas and the increased efficiency of power plants (Figure 3.3). Half of the almost 30% increase in natural gas combustion that occurred between 1990 and 1998 – for example, 19% in 1991 and 11% in 1996 – is largely explained by cogeneration plants and a few large chemical waste gas-fired steam boilers being shifted from "Manufacturing Industries" to the "Public Electricity and Heat Production" due to changed ownership (joint ventures). The corresponding CO_2 emissions allocated to the Energy sector increased from virtually zero in 1990 to 8.5 Tg in 1998 and 9.1 Tg in 2005 (see Figure 3.5).

Figure 3.3 also shows a remarkable drop in the emissions from 1A1a 'Electricity and heat production' in 1999 (–6% compared to 1998), which is, however, associated to the increasing emission trend in the 1990–1998 period and 2000 and thereafter. In actual fact, electricity consumption in the Netherlands was 2% higher in 1999 than in 1998. The relatively low emissions for 1999 are explained by the higher share of imported electricity in domestic electricity consumption in that year, which was almost double that in 1998 (10% in 1998 versus 20% in 1999), and to a relatively large shift from coal to chemical waste gas and natural gas in 1999. The high import of electricity corresponds to approximately 4 Tg CO_2, while the shift from coal to natural gas and oil corresponds to approximately 1 Tg CO_2 in 1999. The net import of electricity decreased again in 2001, and this was compensated for by an increased production of electricity from gas and coal combustion in the public electricity sector. In 2004, CO_2 emissions increased by 3% as a direct result of the start-up in 2004 of a large new gas-fired 790 MWe cogeneration plant, and a 2% decrease in coal combustion.

In 2007, CO_2 emissions in this category increased by 3.1 Tg. After several years of a strong increase, biomass combustion in power generation decreased significantly in 2007. Due to this trend emissions from solid fuels and gas increased

The strong increase in liquid fuel use in 1994 and 1995, with a sharp increase in 1995, is due to chemical waste gas being used in joint venture electricity and heat production facilities. This also explains the somewhat lower IEF for CO_2 from liquids since 1995.

The increase in combustion of "other fuels" is explained by the strong increase in waste incineration with heat and electricity recovery, which is the result of environmental policy to reduce waste disposal in landfills (see Chapter 8). Although CO_2 emissions from the waste incineration of fossil carbon increased, their share in the total 1A1a category is only

Trends in CO_2 emissions from refineries by fuel type (Units:Tg) **Table 3.2**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Liquid: total	10.0	10.4	10.2	10.8	8.6	9.3	9.0	8.9	8.0	8.0
o.w. oil products, excl. refinery gas	1.6	4.5	3.1	3.1	2.7	2.8	2.6	2.6	2.3	2.3
o.w. refinery gas in refineries	3.8	4.2	5.2	5.1	5.9	6.5	6.4	6.3	5.7	5.7
o.w. unaccounted for liquid fuel	4.6	1.0	1.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Gaseous fuels: total	**1.0**	**1.2**	**1.9**	**1.8**	**2.1**	**2.1**	**2.3**	**2.5**	**2.6**	**2.6**
*Process vent in SGHP plant**	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	1.0
Total CO_2 from refineries	11.0	11.7	12.1	12.6	10.7	11.4	11.3	11.3	10.7	10.6
Refinery act data: throughput (PJ)	2.2	2.7	2.5	2.5	2.2	2.3	2.3	2.3	2.4	2.4
CO_2/PJ throughput	5.0	4.3	0.0	5.0	4.9	5.0	4.9	4.9	4.5	4.4

4 percent. The increase in the CO_2 emission factor for "other fuels" since 2004 is due to the increase in the share of plastics (which have a high carbon fraction) in the combustible waste (see Table 8.6 on the composition of incinerated waste). The decrease in 2006 and 2007 in the implied emission factor for CO_2 from biomass is due to the increase of the share of pure biomass (co-combusted with coal-firing) as opposed to the organic carbon in waste combustion with energy recovery. For the former type a lower emission factor is applied than for the latter.

Refineries [1A1b]
Besides combustion emissions from this category also fugitive CO_2 emissions from hydrogen production (including gasification) are reported under 1B2. For 2002 onwards, the latter are no longer included as 'unaccounted for' in liquid fuel combustion of this category. This affects both activity data for liquid fuel and the related emissions. Resulting CO_2 combustion emissions from 'Refineries' decreased by 7% in 1999 and by 15% in 2002. This corresponds with similar reductions in the activity data in terms of liquid fuel combustion and in terms of crude throughput (somewhat larger, but partly compensated by increases in gas combustion). These liquid fuel combustion emissions constitute about 4% of the national total CO_2 emissions (see Table 3.2).

The inter-annual variation in the IEFs for CO_2 , CH_4 and N_2O from liquid fuels is explained both by the high but variable shares (between 40% and 55%) of refinery gas in total liquid fuel, which has a relatively low default emission factor compared to most other oil products and has variable emission factors for the years 2002 onward (see Section 3.3.2), and by the variable addition of 'unaccounted for liquids', which is only used for estimating otherwise missing CO_2 emissions (but not for CH_4 and N_2O). However, for 2002 onwards the 'unaccounted for' amount has been reduced substantially due to the subtraction of fuel used for the non-combustion process of producing hydrogen (with CO_2 as by-product), of which the emissions are now reported under 1B2.

In fact, is assumed that after the re-allocation of this fugitive CO_2 source and if more detailed CO_2 emissions reported by the individual refineries would be used, which is presently not the case, no unaccounted for liquid fuel would remain for these years. As the 'unaccounted for' amounts decreases over time, this causes the IEFs of CH_4 and N_2O to increase over time because the 'unaccounted for fuel use' was determined solely to calculate CO_2 emissions due to net carbon losses only, not for other emissions. All remaining differences with the CO_2 calculation based on the national energy statistics and default emission factors are, therefore, show up in the calculated carbon content of the combusted refinery gas and thus in the implied emission factor of CO_2 for liquid fuel.

Manufacture of solid fuels (coke) and other energy industries (fuels production) [1A1c]
This category comprises mainly CO_2 emissions from natural gas. The dominating source is 'own use' for energy purposes by the oil and gas production and transmission industry. The emissions from this source category increased from 1.5 Tg in 1990 to 1.8 Tg CO_2 in 2007 due to the exploitation of less favorable production sites than in the preceding years. This fact explains the steady increase in time shown by this category with respect to gas consumption. The inter-annual variability in the emission factors for CH_4 from gas combustion is mainly due to the variable losses in the compressor stations of the gas transmission network, which are reported in the Annual Environmental Reports (MJVs) of the gas transport company and included herein. The trend in solid fuel use is explained by the activities of the one stand-alone coke production plant in Sluiskil, the operation of which was discontinued in 1999. The small amounts of solid fuel combustion by this coke production facility in the period 1990 –1994 are not separately recorded in the energy statistics but are included in the iron and steel industry (category 1A2a). The fuel consumption for the on-site coke production by the integrated steel works is also reported under 1A2a.

3.3.2 Methodological issues
It should be re-emphasized that all four fossil fuels are key sources for this category: all of the fossil fuels in 1A1a (in particular solids and gases); liquids and gases in 1A1b and gases in 1A1c. A country-specific top-down (Tier 2) method is used for calculating the emissions for fuel combustion in the 1A1 'Energy Industries'. The fuel combustion emissions in this sector are calculated using fuel consumption data from national sectoral energy statistics and IPCC default emission factors for CO_2 and N_2O, with the exception of CO_2 for natural gas and chemical waste gas and coal, for which country-specific emission factors are used. When available, company-specific or sector-specific emission factors have been used, in particular for derived gases such as refinery gas, chemical waste gas and blast furnace gas (see Table A2.2). More details on methodologies, the data sources used and country-specific

source allocation issues are provided in the monitoring protocols (see www.greenhousegases.nl and Section 3.1).

Category 1A1a 'Public Electricity and Heat Generation' includes cogeneration (and some steam boilers) operated as joint ventures of a utility and private industries. In the national energy statistics, fuel consumption of these sources are also included in 'Public Electricity and Heat Generation', following international NACE guidelines for allocating economic activities and, consequently, so are their emissions. The type of ownership may change with time – which has indeed happened – thereby affecting the allocation of the emissions to the IPCC source categories. The effect can be seen in the energy consumption trends and, subsequently in the emission trends on the sector level. The trends in both this sector and the manufacturing industries categories can be well explained (see Figures 3.4 and 3.5) if the activity data and the related emissions in 1A1a relating to these re-allocations are explicitly displayed. The same criterion applies for emissions from waste incineration, which are included in this category since they all are subject to heat or electricity recovery, albeit this is not their main activity. Most of the combustion of biogas recovered at landfill sites is in CHP operated by utilities; therefore, it is allocated in this category.

For 1A1b "Petroleum Refining"the calculation of emissions from fuel combustion is based on the sectoral energy statistics, using the fuel consumption for energetic purposes as activity data (including the consumption of residual refinery gases). Although the same method is still used, the quality of the data used to calculate and report CO_2 emissions is now improved by incorporating the CO_2 emissions reported by the individual refineries for 2002 onwards. Since 1998 one refinery operates the SGHP unit, supplying all the hydrogen for a large scale hydrocracker. When producing hydrogen also CO_2 is produced as a co-product from the chemical processes (CO_2 removal and a two stage CO shift reaction). Refinery data specifying these fugitive CO_2 emissions are available and used for 2002 onwards. The fuel used to provide the carbon for this non-combustion process is subtracted from the fuel consumption used to calculation the combustion emissions reported in this category. However, the use of plant-specific emission factors for refinery gas for 2002 onwards – arithmetically resulting from the reported CO_2 emissions and combustion emissions as calculated using the default data – also causes changes in the implied emission factor for CO_2 for total liquid fuel compared to the years prior to 2002 (i.e. the emission factor for refinery gas is adjusted to get exact correspondence between the total calculated CO_2 emissions and the total CO_2 emissions officially reported by the refineries).

However, besides this non-energy/feedstock use of fuel for hydrogen production, for years prior to 2002 the energy and carbon balance between the oil products produced does not match the total crude oil input and of fuel used for combustion. The conclusion drawn, therefore, is that not all residual refinery gases and other residual fuels are accounted for in the national energy statistics. The carbon difference is always a positive figure. As such, it is assumed that part of the residual refinery gases and other residual fuels are all combusted (or incinerated by flaring) but not monitored/reported by the industry are thus unaccounted for. The CO_2 emissions from this varying fuel consumption are included in the fuel type 'liquids'. Table 3.2 shows that this represents approximately 10% (5 –20%) of the total fuel consumption accounted for in the statistics. For 1998-2001 also the unspecified CO_2 process emissions from the hydrogen plant are included.

In 1A1c 'Other Energy Industries', the combustion emissions from oil and gas production refers to the so-called 'own' use of the gas and oil production industry. Production and sales data are based on the national energy statistics, while the amounts flared and vented are based on MJVs from the sector. Also included in this category is energy consumption for gas transmission (for gas compressor stations), which is not separately recorded in the national energy statistics but is included in the MJVs of the gas transport industry. Fuel consumption for coke production is included elsewhere (in 1A2a), with the exception of the data for the years 1995–1999 for which the fuel consumption of one stand-alone coke production plant has been separately included in the national energy statistics.

In the Netherlands one large production site for charcoal production serves most of the Netherlands and also serves a large share of the market of our neighboring countries. Greenhouse gas emissions from fossil fuel use for charcoal production are not included in 1A1, but included in 1A2.

3.3.3 Uncertainty and time-series consistency

Uncertainties

The uncertainty in CO_2 emissions of this category is estimated to be 3% (see Section 1.7 for more details). The accuracy of fuel consumption data in power generation and oil refineries is generally considered to be very accurate, with an estimated uncertainty of approximately 0.5%. The high accuracy in most of these activity data is due to the limit number of utilities and refineries that report their large fuel consumption as part of the national energy statistics and which are verified as part of the European Emission Trading Scheme. The two exceptions are solids in the power generation and liquids in refineries, which have a larger estimated uncertainty of 1% and 10%, respectively, based on the share of blast furnace gas in total solid consumption, the 'unaccounted for liquids' calculated for refineries and the recalculations made for 2002-2004 as presented in this report (Olivier et al., 2009). The high uncertainty in the liquids in refineries apply mainly to the years prior to 2002, for which accurate reported CO_2 emissions are not available at the required aggregation level. The consumption of gas and liquid fuels in the 1A1c category is mainly from the oil and gas production industry, where the split into own use and venting/flaring has proven to be quite difficult, and thus a high uncertainty of 20% is assigned. For other fuels a 10% uncertainty is used, which refers to the amount of fossil waste being incinerated and thus to the uncertainties in the total amount of waste and the fossil and biomass fractions.

For natural gas the uncertainty in the CO_2 emission factor is now estimated to be 0.25% (instead of 1%) based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2007) and further discussed in Olivier et al. (2009); however this value is not yet used in the uncertainty assessment in Section 1.7 and key source assessment in Annex 1. For hard coal (bituminous coal) an analysis was made of coal used in power generation (Van Harmelen and Koch, 2002). For the default power plant factor, 94.7 CO_2/GJ is the mean value of 1270 samples taken in 2000, which is accurate within about 0.5%. However, in 1990 and 1998 the emission factor varies ±0.9 CO_2/GJ (see Table 4.1 in Van Harmelen and Koch, 2002); consequently when the default factor is applied to other years, the uncertainty is apparently larger, about 1%. Analysis of the default CO_2 emission factors for coke oven gas and blast furnace gas reveals uncertainties of about 10% and 15%, respectively (data reported by the steel plant). Since the share of BF/OX gas in total solid fuel emissions from power generation is about 15-20%, the overall uncertainty in the CO_2 emission factor of solids in power generation is estimated to be about 3%. The CO_2 emission factors of chemical waste gas and – to a lesser extent – of BF/OX gas are more uncertain than those of other fuels used by utilities. Thus, for liquid fuels in these sectors is a higher uncertainty of 10% assumed in view of the quite variable composition of the refinery gas used in both sectors. For natural gas and liquid fuels in 'Oil and Gas Production' (1A1c) uncertainties of 5% and 2% are assumed, respectively, which refer to the variable composition of the offshore gas and oil produced. For the CO_2 emission factor of other fuels (fossil waste), an uncertainty of 5% is assumed, which reflects the limited accuracy of the waste composition and of the carbon fraction per waste stream. The uncertainty in the emission factors of CH_4 and N_2O from stationary combustion is estimated at about 50%, which is an aggregate for the various subcategories (Olivier et al., 2009).

Time-series consistency
See Section 3.2.3.

3.3.4 Source-specific QA/QC and verification
The trends in fuel combustion in the "Public Electricity and Heat Production" (1A1a) are compared to trends in domestic electricity consumption (production plus net imports). First, large annual changes are identified and explained (e.g. changes in fuel consumption by joint ventures). For 'Oil Refineries' (1A1b) a carbon balance calculation is made to check completeness. Moreover the trend in total CO_2 reported as fuel combustion from refineries is compared to trends in activity indicators, such as total crude throughput. The IEF trend tables are then checked for changes, and inter-annual variations are explained in this NIR. More details on the validation of the energy data are to be found in the monitoring protocol 9052: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.3.5 Source-specific recalculations
The CH_4 emission from this sector is increased for the total times series. This is the result of a new study into the emissions from small scale CHP plants. These natural gas powered plants, which have increased in numbers significantly during the period 1990-2007, emit CH_4 as a result of incomplete combustion. Recent study revealed that the emission factor for CH_4 was underestimated by a factor of 60 in the past. This new information also effect the emissions (in a larger extend than in Industry) in Agriculture and in Commercial and institutional services [1.A.4]. More information can be found in the monitoring protocol 9052: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

Emissions in CO_2 eq will increase in the order of magnitude of 0.06 Tg (in 1990) to 0.45 Tg CO_2 eq (2006, this is the total for all effected CHP in category 1A).

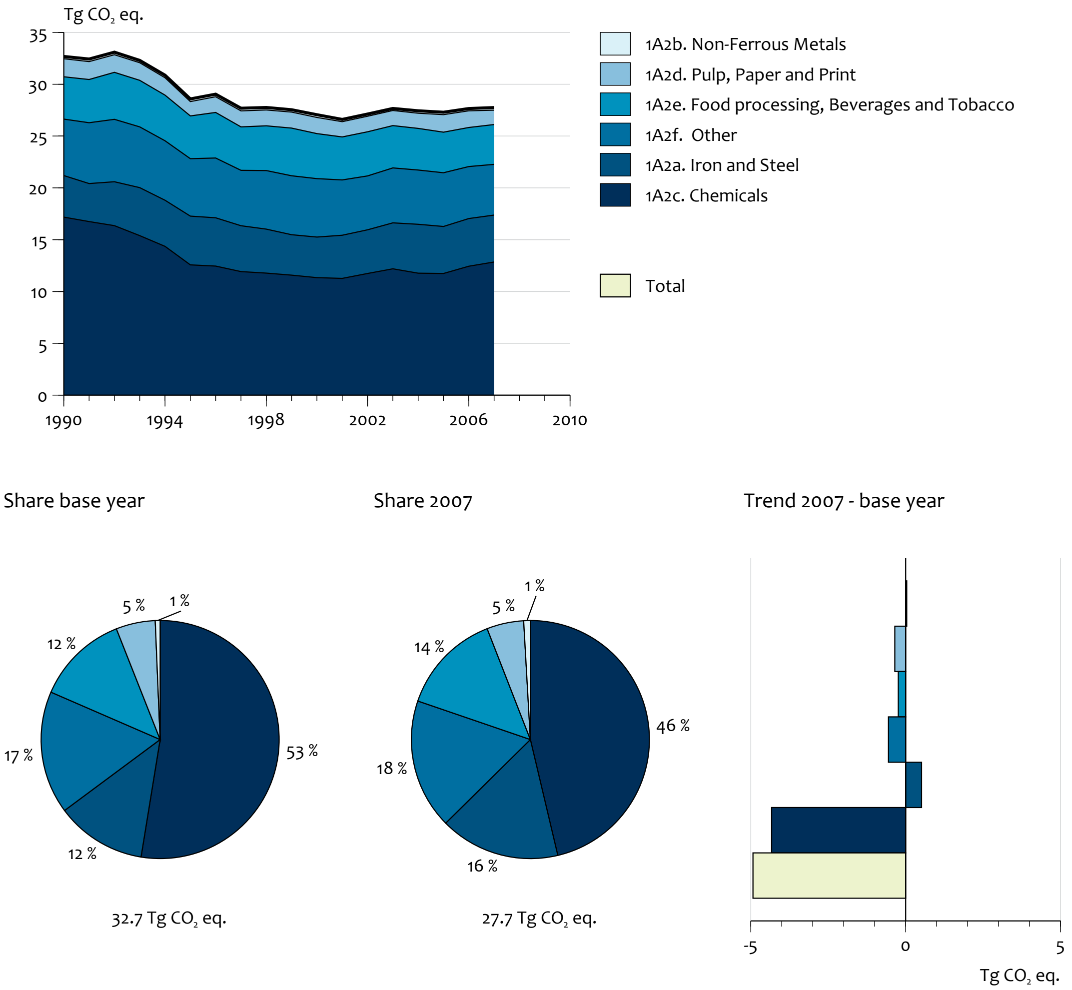
3.3.6 Source-specific planned improvements
For Oil and natural gas [CRF Category 1B2] the combustion emissions are reported in Sector 1A1c. The emissions reported are based on primarily data from the sector. The emissions and activity data reported in this sector are normally based on data from the sector. During the compilation of this submission these sector data were not yet available. Only preliminary data from the sector (which contained some obvious errors) were at our disposal. These data have been used to make an expert judgment for the 2007 emissions. Final data came available after 15 march 2009 and showed that the CO_2 emissions in this submission were overestimated by 0.4 Tg. We will correct this in the NIR of 2010.

For refineries, the high IEF values for CO_2 from liquid fuel for 2002 onwards suggest that also some other CO_2 emissions occur that are not accounted for by the fuel consumption data only. Therefore, the present allocation method for reporting CO_2 emissions from refineries will be evaluated and reconsidered, when another method appears to present the data more transparently. This item will get attention in the ongoing project to improve the data consistency between the Emission Trading System (ETS) and the PRTR system. If in the future part of the CO_2 produced by the gasification and hydrogen plant is sold to external users (for example for industrial applications or for crop fertilization in greenhouse horticulture), this may be monitored separately and allocated accordingly. Please note that above mentioned reallocations (if possible) do not change the national total emissions.

3.4 Manufacturing industries and construction [1A2]

3.4.1 Source category description
This source category consists of the six categories 1A2a 'Iron and Steel', 1A2b 'Non-ferrous Metals', 1A2c 'Chemicals', 1A2d Pulp, Paper and Print', 1A2e 'Food Processing, Beverages and Tobacco' and 1A2f 'Other'. Within these categories, liquid fuel and natural gas combustion by the chemical industry, solid fuel combustion by the iron and steel industry and natural gas combustion by the food processing and other industries are the dominating emission sources. However, natural gas in the pulp and paper industries and liquid fuels (mainly for off-road machinery) in the other industries are also large emission sources. The shares of CH_4 and N_2O emissions from industrial combustion are relatively small and these are no key sources. Natural gas is mostly used in the chemical. food and drinks and other industries; solid fuels (that means coal and coke-derived fuels such as blast furnace/oxygen furnace gas) are

1A2. Manufacturing Industries and construction **Figure 3.5**



mostly used in 1A2a 'Iron and Steel' industry; liquid fuels are mostly used in 1A2c 'Chemicals' industry and in 1A2f 'Other' industries.

1A2a 'Iron and Steel' refers mainly to the integrated steel plant Corus, which produces approximately 6000 kton crude steel (in addition to approximately 100 kton of electric steel production and iron foundries). Since Corus is an integrated plant, the category includes fuel combustion for on-site coke production as well as the emissions of the combustion of blast furnace gas and oxygen furnace gas in the steel industry.

The category 1A2b 'Non-ferrous Metals' consists mainly of two aluminum smelters. CO_2 emissions from anode consumption in the aluminum industry are included in 2C. Dutch industry comprises a relatively large share of petrochemical plants, which is mirrored in the combustion CO_2 emissions in 1A2c 'Chemicals' in association with the manufacture of chemical products and non-energy use of natural gas. Category 1A2f 'Other' includes all other industry branches, among which are mineral products (cement, bricks, other building materials, glass), textiles, wood and wood products. Also included are the emissions from the building construction industry and the emissions of off-road vehicles (mobile machinery) for building construction and for the construction of roads and waterways and other off-road sources (except agriculture) (liquid fuels). The latter refers mainly to sand and gravel production.

Another feature of industry in the Netherlands is that it operates a large number of combined heat and power (CHP) facilities (and sometimes also steam boilers), several of which have changed ownership over time and are now operated as joint venture concerns with electrical utilities, the emissions of which are reported in "Energy Industries" (1A1a).

Overview of shares and trends in emissions

In 2007 the share of CO_2 emissions from 1A2 "Manufacturing Industries and Construction" in the total national greenhouse gas emission inventory was estimated to be 13% compared to 21% in 1990. In contrast, the share of the other greenhouse gas emissions in this category is relatively small. Category 1A2c 'Chemical industry' is the largest contributor to CO_2 emissions, accounting for approximately 50% of the total emissions from the manufacturing industry.

In the period 1990–2007, CO_2 emissions from combustion in 1A2 "Manufacturing Industries and Construction" decreased by 15% (from 32.7 to 27.7 Tg; see Figure 3.5).

The chemical industry contributes the most to this decrease in emissions in this source category, with its contribution to CO_2 emissions decreasing by 4.3 Tg. When the re-allocations of CO_2 emissions to the Energy industry due to the above-mentioned formation of joint ventures are taken into account (see Sections 2.3.1 and 3.3.1 for more details), the CO_2 emissions from fuel combustion in most of the industrial source categories remained almost stable, while the production significantly increased (see Section 3.4.1). Total CO_2 emissions from 1A2 "Manufacturing Industries and Construction" in 2007 remained stable at 27.7 Tg compared to 2006.

The derivation of these figures, however, should also be viewed in the context of industrial process emissions of CO_2 since the separation of the source categories is not always fixed. Most so-called industry process emissions of CO_2 are reported in CRF sector 2 (soda ash, ammonia, carbon electrodes and industrial gases such as hydrogen and carbon monoxide). However, when in manufacturing processes this oxidation is accounted for in the energy statistics as the production and combustion of residual gases (e.g. in the chemical industry) – as is often the case in the Netherlands – then the corresponding CO_2 emissions are reported as combustion and not as an industrial process in sector 2.

Iron and Steel [1A2a]
The contribution of 1A2a 'Iron and steel' to the CO_2 emissions from 1A2 "Manufacturing Industries and Construction" was about 12% in 1990 and 17% in 2007. Inter-annual variations in CO_2 emissions from fuel combustion from the iron and steel industry can be explained as being mainly due to varying amounts of solid fuels used in this sector (see Section 3.4.1). In 2007 CO_2 emissions from solid fuel combustion of the iron and steel industry decreased slightly (-0.1 Tg).

Non-ferrous metals [1A2b]
This small source category only contributes about 0.3 Tg CO_2 to the total national greenhouse gas inventory, predominantly from the combustion of natural gas. Energy use in the aluminum industry is largely based on electricity, the emissions of which are included in 1A1a 'Public electricity and heat production.

Chemicals [1A2c]
The share of 1A2c 'Chemical industry' to the total CO_2 emissions from 1A2 "Manufacturing Industries and Construction" decreased from 52% in 1990 to 46% in 2007. The combustion of natural gas and liquid fuels accounts for 55% respectively 39% in the CO_2 emissions from the chemical industry. CO_2 emissions from this source category have decreased by approximately 27% since 1990, which is mainly due to the 45% decrease in the consumption of natural gas during the same period.

CO_2 emissions from liquid fuel combustion in the chemical industry increased mainly due to a decrease in ownership of joint ventures, of which the emissions were formerly allocated in the energy industries (1A1a), whereas emissions from gas combustion decreased.

The steady decline in the amount of natural gas and the increase in of liquids used for combustion by the chemical industry can be explained largely by reallocation of the emissions to and from the Energy sector due to the above-mentioned formation of joint ventures (see Sections 2.3.1 and 3.4.1).

Taking into account all CO_2 emissions, including the net process emissions included in category 2B and the re-allocation of CO_2 emissions to the energy industry, the total CO_2 emission level from the chemical industry is rather constant in the period 1990–2007. Given that since 1990 the production has increased significantly (see Section 3.4.1), the constant emission level indicates substantial improvements in the efficiency of energy use and/or structural changes within the chemical industry.

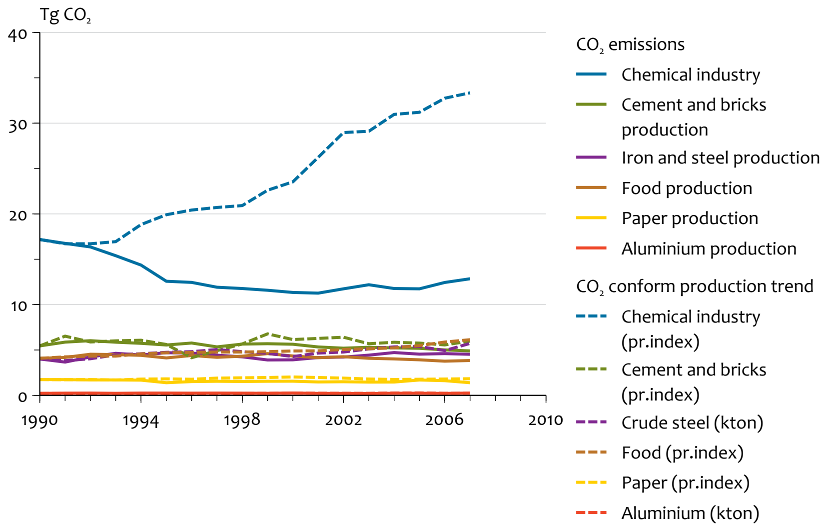
Pulp, paper and print [1A2d]
The contribution of 1A2d 'Pulp, paper and print' to CO_2 emissions from 1A2 "Manufacturing Industries and Construction" is estimated to be approximately 5% in 1990 and about 6% in 2007. In line with the decreased consumption of natural gas, CO_2 emissions have decreased by approximately 20% since 1990, of which a substantial fraction is used for co-generation. The relatively low CO_2 emissions in 1995 can be explained by re-allocation of emissions to the energy sector due to the above-mentioned formation of joint ventures. In 2007, CO_2 emissions from gaseous fuel combustion decreased by about 14% or 0.2 Tg CO_2.

Food processing, beverages and tobacco [1A2e]
The share of 1A2e 'Food processing, beverages and tobacco industries' in the CO_2 emission from 1A2 "Manufacturing Industries and Construction" was 12% in 1990 and 14% in 2007. The CO_2 emissions, which originate largely from the combustion of natural gas, decreased by almost 6% in the period 1990–2007. This is due to a decrease since 2003 of joint ventures of cogeneration plants located in the pulp and paper industry (see Figure 3.5), of which the emissions were formerly allocated in 1A2e but are now reported under public electricity and heat production (1A1a). This shift in allocation corresponds with a CO_2 decrease of about 0.3 Tg. In 2007 CO_2 emissions from gaseous fuel combustion in this source category decreased by about 2%.

Other [1A2f]
The share of category 1A2f 'Other' (including construction and other off-road machinery) in the CO_2 emissions from 1A2 "Manufacturing Industries and Construction" was approximately 17% in 1990 and 2007. Most of the 4.8 Tg CO_2 emissions from this source category in 2007 stem from gas combustion (3.3 Tg), while almost all of the remaining CO_2 emissions are associated with the combustion of liquid fuels (1.4 Tg CO_2), of which off-road machinery accounts for 1.3 Tg CO_2. CO_2 emissions from this source category have decreased by 10% since 1990, mainly due to a decrease in the off-road machinery emissions. In 2007 total CO_2 emissions from the other manufacturing industries decreased by 2% compared to 2006.

CO_2 combustion emissions and production trend of industrial sectors

Figure 3.6



Activity data and (implied) emission factors

Although total industrial production has increased about by approximately 36% (in fixed monetary units) since 1990, the combustion emissions of CO_2 have decreased by 17% – or by about 5.6 Tg – to which the shift of ownership through CHP joint ventures has contributed more than 7 Tg and that of steam boilers in joint ventures about 2 Tg CO_2.The largest change is in the chemical industry, the CO_2 emissions of which decreased by 28% or 4.7 Tg (with about the same amount of CHP re-allocated to the Energy sector and another 2 Tg CO_2 from steam boilers now operated in joint ventures). Nevertheless, it can be concluded that, apart from the CHP re-allocation, by and large the CO_2 emissions from combustion have remained almost constant in most industry source categories, while their production has significantly increased. The trend in CO_2 combustion emissions from the 1A2 categories and the trends in the underlying production data are presented in figure 3.6. This figure shows that per category the inter-annual variation is closely linked and that CO_2 emission trends are generally lower than the activity trends. Apart from the re-allocation of joint ventures, the remaining differences can be explained mainly by energy conservation. Between 1989 and 1999, the Dutch industrial sectors improved energy efficiency by 20%, which is equivalent with an energy conservation of 142 PJ (EZ, 2000) or approximately 8.5 Tg CO_2 emissions or more (depending on the fuel mix assumed).

Iron and steel [1A2a]

The iron and steel industry shows inter-annual variations in combustion CO_2 emissions that are mainly due to the varying amounts of solid fuels that are used in the sector. The 14% decrease in solid fuel use in 1999 and the 10% decrease in associated CO_2 emissions corresponds with the 8% decrease in crude steel production. When all CO_2 emissions from the sector are combined – including the net process emissions reported under category 2C1 – total emissions closely follow the inter-annual variation in crude steel production (Table 3.4). Total CO_2 emissions have remained rather constant in the period 1990–2007 even though production has increased by about 23%. This indicates a substantial energy efficiency improvement in the sector. This conclusion is supported by the decreasing trend in CO_2 losses from the coke and coal inputs in the blast furnaces, which have fallen from about 22% in 1990 to 14% at the present time and the corresponding increase (about 30%) in the capture and energetic use blast furnace gas (and oxygen furnace gas).

In 2007 steel production decreased due to maintenance and renovation of a blast furnace, which also explains the smaller amount of blast and oxygen furnace gas which was sold to the public electricity production sector (see 1A1a). Solid fuel combustion increased compared to 2006, which is due to a temporary decrease in overall energy efficiency of the steel production process due large-scale maintenance works on the blast furnace and a pellet production plant. This is also reflected in the increase of total CO_2 emissions per ton of steel produced as presented in Table 3.3.

The inter-annual variation in the IEF for CO_2 from solid fuels is due to variable shares of BF/OX gas and coke oven gas, which have much higher and lower emission factors, respectively, than hard coal and coke have. The relative low IEFs in 1990–1994 compared to later years are due to the higher share of coke oven gas in the solid fuel mix in those years due to CO gas combustion by the independent coke manufacturer in Sluiskil, which was in these years not accounted for in the energy statistics separately but included in this category.

Non-ferrous metals [1A2b]

The amounts of liquid and solid fuels vary considerably between years, but the differences in the amounts and related emissions are almost negligible. The inter-annual variation of the IEFs from liquid fuels is a result of changes in the mix of underlying fuels (e.g. the share of LPG which has a relatively low emission factor) and partly due to the small amounts used. Energy use in the primary aluminum industry consists mostly of electricity use, of which the related combustion emissions from the production are accounted for in category 1A1a ‘Public Electricity and Heat Production’.

Table 3.3 CO_2 emissions from the iron and steel industry by fuel type (excluding CO_2 losses in coke ovens) (Units:Tg)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Solid: total	3.3	3.9	3.1	3.4	3.4	3.7	4.0	3.8	3.9	3.9
o.w. BF/OX gas in steel	2.4	3.1	2.5	2.7	2.8	3.0	3.3	3.1	3.2	3.2
N.B. BF/OX gas 1A1a	3.8	4.8	4.9	5.3	5.3	5.5	5.9	6.1	4.7	4.7
Total BF/OX gas	6.2	7.9	7.4	8.1	8.1	8.6	9.2	9.2	8.0	8.0
o.w. CO gas in steel	0.8	0.8	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6
o.w. other than BF/OX or CO gas	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1
Gaseous fuels	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.6
Liquid: total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net CO_2 from C inputs in BF (2C1)	2.5	1.8	1.3	1.3	1.3	1.5	1.3	1.2	1.4	1.3
o.w. carbon from iron ore	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
o.w. coke in blast furnaces	2.2	1.5	1.0	1.0	1.1	1.2	0.7	0.8	0.7	0.8
o.w. limestone use	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total CO_2 from steel production	6.5	6.5	5.2	5.4	5.6	5.9	6.0	5.7	6.0	6.1
Activity data: crude steel prod. [Gg]	5.2	6.1	5.5	6.0	6.2	6.6	6.9	6.9	6.4	7.4
CO_2/ton crude steel	1.3	1.1	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.8

It should be noted that CO_2 from anode consumption, which was about 0.4 Tg in 2007, is reported under 2C.

Chemicals [1A2c]

The steady decreasing CO_2 emissions from the combustion of natural gas can be largely explained by the decreasing use or ownership of cogeneration facilities by the industry. CO_2 emissions from liquid fuel combustion stem predominantly from the combustion of chemical waste gas. The marked decrease in liquid fuel consumption since 1995 (see Table 3.4) is not due to a decrease in chemical production or data errors, but mainly to a large shift of ownership of a large cogeneration plant – one using chemical waste gas – into a joint venture, thus re-allocating it to energy industries. In 2007 the number of cogeneration joint ventures of the chemical industry decreased, resulting in a re-allocation to the chemical industry. This also explains the 88% decrease in solid fuel combustion in 1994 and the 28% decrease in liquid fuel combustion in 1995: in these years the then-existing coal-fired and oil-fired cogeneration plants, respectively, shifted to joint venture and thus moved to the 'Energy Industry'.

When all CO_2 emissions from the chemical industry are combined – including the net process emissions reported under category 2B – and the shift to joint ventures are taken into account, it is apparent that total CO_2 emissions have remained rather constant during the 1990–2007 period (see Table 3.4). Since 1990 the production has increased significantly (e.g. in terms of fuels used as chemical feedstock), indicating a substantial improvement in energy efficiency and or structural changes within the chemical industry.

The increase in 2003 of the IEF for CO_2 from liquid fuels is also explained by the increase in the use of chemical waste gas and the change in composition[1]. The operation of the phosphorous plant started around 2000, which explains the increase in the IEF for solid fuels to about 149.5 kg/GJ. Similarly, the increased use of chemical waste gas (included in liquid fuels) since 2003 (see Table 3.4) and the changes in the mix of compositions explain the increase in the IEF for liquid fuels from about 55 to about 60 kg/GJ.

Pulp, paper and print [1A2d]

The CO_2 emission level in 1995 is relatively low, due to the shift of joint venture cogeneration to the energy sector (approximately 1 Tg CO_2) (see Figure 3.5). The amounts of liquid and solid fuel combustion vary considerably between years, but the amounts and related emissions are almost negligible. The inter-annual variation in the IEFs for liquid fuels is due to variable shares of derived gases and LPG in total liquid fuel combustion. The emission factors for biomass combustion have not yet been re-calculated. The large changes in the (very small) amounts of biomass combustion are due to the incomplete monitoring of individual industries (see completeness paragraph in Section 3.1). A large fraction, almost 0.5 Tg from a total of about 1.6 Tg CO_2, results from cogeneration.

1 For CO_2 from chemical waste gas from liquid and solid fuels source-specific emission factors are used for 1995 onwards based on data of selected years. For 16 individual plants residual chemical gas from liquids is either hydrogen, for which the specific CO_2 emission factor is 0. For CO_2 from phosphorous furnace gas plant-specific values are used, with values around 149.5 kg/CJ. This gas is made from coke and therefore included in solid fuels. For another 9 companies, plant-specific CO_2 emission factors were used based on annual reporting by the companies (most in the 50-55 range, with exceptional values of 23 and 95). For 1990, an average sector-specific value for the chemical industry was calculated using the plant-specific factors for 1995 from the 4 largest companies and the amounts used per company in 1990. For more details we refer to Appendix 2 of the NIR 2005.

CO_2 emissions from the chemical industry specified by fuel type (Units: Tg).

Table 3.4

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Natural gas	9.5	7.7	6.6	6.1	5.8	5.6	5.6	5.7	5.3	5.0
Liquid: total used in chem.. ind.	6.6	4.9	4.5	4.9	5.7	6.3	5.9	5.8	6.9	7.6
o.w. chem. Waste gas	5.4	3.8	3.8	4.2	5.1	5.8	5.7	5.6	6.7	7.3
N.B. chem. waste gas in power gen.	0.0	1.5	1.8	1.9	2.1	2.2	2.1	2.1	0.7	0.8
Total chem. Waste gas	5.4	5.3	5.7	6.1	7.2	8.0	7.8	7.7	7.4	8.1
o.w. other fuels	1.2	1.1	0.6	0.6	0.6	0.5	0.3	0.2	0.2	0.3
Natural gas	9.5	7.7	6.6	6.1	5.8	5.6	5.6	5.7	5.3	5.0
Solid fuels	1.1	0.0	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3
Ammonia production (a.o.) (2B)	3.1	3.6	3.6	3.0	2.9	2.9	3.1	3.1	3.1	3.0
Total CO_2 chemical industry	17.2	12.6	11.3	11.3	11.7	12.2	11.8	11.7	12.4	12.8
Joint ventures (JV)	0.0	4.8	7.5	7.4	7.5	7.8	7.4	7.4	5.7	5.8
Total including JVs	17.2	17.3	18.9	18.6	19.2	20.0	19.2	19.1	18.2	18.6

Food processing, beverages and tobacco [1A2e]

The amounts of liquid and solid fuels vary considerably between years, but the amounts and related emissions are verifiably small. The inter-annual variation in the IEFs for liquid fuels is due to variable shares of LPG in total liquid fuel combustion. The emissions of biomass combustion have been re-calculated, although not yet validated. The large changes in the (very small) amounts of biomass combustion are due to incomplete monitoring of individual industries (see completeness paragraph in Section 3.1). About 1.5 Tg of a total of about 3.8 Tg CO_2 is currently emitted by cogeneration plants owned by the food industry.

Other [1A2f] (including construction and other off-road)

Most of the present 4.9 Tg CO_2 emissions from this source category stem from gas combustion (about 3.3 Tg). Almost all of the remaining CO_2 emissions relate to the combustion of liquid fuels (1.4 Tg CO_2), of which off-road machinery accounts for 1.3 Tg CO_2. A very small portion of the CO_2 emissions (0.2 Tg) originates from cogeneration plants.

3.4.2 Methodological issues

It should be re-emphasized that in this category liquid, solid and gaseous fossil fuels are key sources (in particular, gases and liquids). Major emission sources are solids in 1A2a, liquids and gases in 1A2c, gases in 1A2d and 1A2e, and gases and liquids in 1A2f (using a threshold of 0.6 Tg CO_2, derived from the 95% cumulative share in total national greenhouse gas emissions).

A country-specific top-down (Tier 2) method is used for calculating the emissions for fuel combustion from 'Manufacturing Industries and Construction' (1A2). Fuel combustion emissions in this sector are calculated using fuel consumption data from national sectoral energy statistics and IPCC default emission factors for CO_2 and N_2O, with the exception of CO_2 for natural gas and chemical waste gas and coal, for which country-specific emission factors are used. When available, company-specific or sector-specific emission factors have been used, in particular for derived gases such as chemical waste gas, blast furnace gas and coke oven gas (see Annex 2). More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.greenhousegases.nl) and Section 3.1.

In the 'Iron and Steel Industry' a substantial large fraction of total CO_2 emissions is reported as process emissions in CRF 2C1, based on net losses calculated from the carbon balance from the coke and coal inputs in the blast furnaces and the blast furnace gas produced. Since the fraction of BF/OX gas captured and used for energy varies over time, the trend in the combustion emissions of CO_2 accounted for by this source category should be viewed in association with the reported process emissions. The fuel combustion emissions from on-site coke production by the iron and steel company Corus are included here in 1A2a instead of in 1A1c, since these are reported in an integrated and aggregated manner. In addition to including the emission from Corus, this category also includes the combustion emissions of a small electric steel producer and – for the period 1990–1994 – of one small independent coke production facility for which the fuel consumption was not separately included in the national energy statistics during this period. The fugitive emissions, however, from all coke production sites are reported separately (see Section 3.4.1).

For the chemical industry, CO_2 emissions from the production of silicon carbide, carbon black, methanol and ethylene from the combustion of residual gas (produced as by-product from the non-energy use of fuels) are included in 1A2c 'Chemicals'. Although these CO_2 emissions are more or less process-related, they are included in 1A2 for practical purposes: consistency with Energy statistics that account for the combustion of residual gases. This inclusion in 1A2 is justified since there is no strict IPCC guidance on where to include those emissions.

The fuel consumption data in 1A2f 'Other Industries for Construction' and 'Other Off-road' are not based on large surveys. Therefore, the energy consumption data of this part of the Category 1A2f are the least accurate.

3.4.3 Uncertainty and time-series consistency

Uncertainties

The uncertainty in CO_2 emissions of this category is estimated to be about 3% (see Section 1.7 for more details). The accuracy of fuel consumption data in the manufacturing industries is generally considered to be rather accurate, about 2%, with the exception of those for derived gases included in solids and liquids (Olivier et al., 2009). This includes the uncertainty in the subtraction of the amounts of gas and solids for non-energy/feedstock uses on the one hand, including the uncertainty in the conversion from physical units to Joules, and the completeness of capturing blast furnace gas in total solid consumption and chemical waste gas in liquid fuel consumption.

For natural gas the uncertainty in the CO_2 emission factor is now estimated to be 0.25% (instead of 1%) based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2007) and further discussed in Olivier et al. (2009), but not yet used in the uncertainty assessment in Section 1.7 and Annex 1. The 5% uncertainty estimate in the CO_2 emission factor for liquids is based on an uncertainty of 10% in the emission factor for chemical waste gas in order to account for the quite variable composition of the gas and its more than 50% share in the total liquid fuel use in the sector. An uncertainty of 10% is assigned for solids, which reflects the uncertainty in carbon contents of blast furnace gas/oxygen furnace gas based on the standard deviation in a 3-year average. BF/OX gas accounts for the majority of solid fuel use in this sector.

Time-series consistency

See Section 3.2.3.

3.4.4 Source-specific QA/QC and verification

The trends in CO_2 emissions from fuel combustion in the iron and steel industry, non-ferrous industry, food processing, pulp and paper and other industries are compared to trends in the associated activity data: crude steel and aluminum production, indices of food production, pulp and paper production and cement and bricks production. Large annual changes are identified and explained (e.g. changed fuel consumption by joint ventures). Moreover, for the iron and steel industry the trend in total CO_2 emissions reported as fuel combustion-related emissions (included in 1A2a) and industrial process emissions (included in 2C1) is compared to the trend in the activity data (crude steel production). A similar comparison is made for the total trend in CO_2 emissions from the chemical industry (sum of 1A2c and 2B) and trends split per main fuel type or specific process (chemical waste gas combustion and process emissions from ammonia production etc.), IEF trend tables are checked for large changes and large inter-annual variations at different levels and explained in the NIR. More details on the validation of the energy data is found in the monitoring protocol 9052: CO_2. CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.4.5 Source-specific recalculations

A new method has been developed for calculating emissions from off-road mobile machinery, using sales figures and usage data for different types of machinery (TNO, 2009). The new method has no implications for the total reported energy use and CO_2 emissions from off-road mobile machinery, as both are still based on figures from the national energy statistics (NEH), supplied by Statistics Netherlands (CBS). The share of the different types of machinery (agriculture, building and construction and other) in the total energy use has been recalculated though for the entire 1990-2007 period, using the new methodology. This recalculation has led to an increase in energy use by construction machinery and a decrease in energy use by other machinery compared to last years submission. Total energy use and CO_2 emissions from off-road mobile machinery in source category 1A2f 'Other' has increased for almost the entire 1990-2006 period compared to last years submission.

3.4.6 Source-specific planned improvements

There are no source-specific improvement planned.

3.5 Transport [1A3]

3.5.1 Source category description

The source category 1A3 "Transport" comprises the following sources: 'Civil Aviation', 'Road Transportation', 'Railways', 'Navigation' and 'Other Transportation'. 1A3a 'Civil Aviation' only consists of the emissions from domestic aviation, i.e. aviation between Dutch airports including aviation from and to the same airport. Emissions from international aviation (aviation bunkers) are reported separately; see Section 3.8. 1A3d 'Navigation' includes emissions from domestic navigation only. Emissions from fuel used in international navigation are not included in 1A3 but in the inventory in 'Marine Bunkers'; see also Section 3.8. Emissions from national fisheries are included in 1A4c 'Agriculture, Forestry and Fisheries'; see Section 3.6, while greenhouse gas emissions from fuel combustion by military aircraft and shipping activities are included in 1A5; see Section 3.7. Emissions from off-road agricultural machinery, such as tractors, are included in 1A4c 'Agriculture', while emissions from other off-road machinery, such as road and building construction equipment, are reported under category 1A2f 'Other'. Energy consumption for pipeline transport is not recorded separately in the national energy statistics, but included in 1A1c for gas compressor stations and in 1A4a for pipelines for oil and other products.

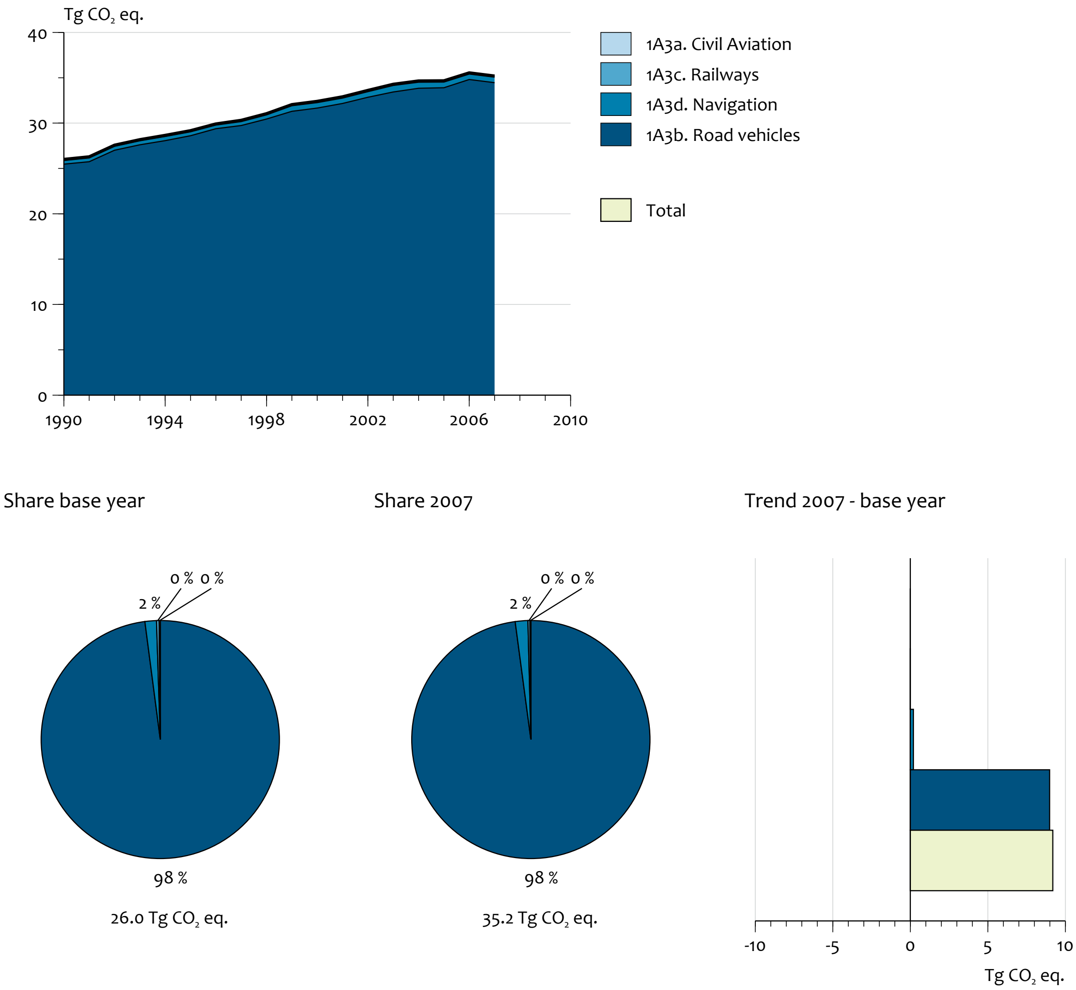
Overview of shares and trends in emissions

Between 1990 and 2007, total greenhouse gas emissions from 1A3 "Transport" increased by 35%, from 26.4 Tg CO_2 eq in 1990 to 35.7 Tg CO_2 eq in 2007. The greenhouse gas emissions from the transport sector are summarised in Figure 3.8.

CO_2 emissions from 1A3b 'Road transport' are dominant in this category (more than 95% of total emissions over the whole time-series). In the period 1990–2007, total CO_2 emissions from 1A3 "Transport" increased by 35.4%, mainly due to the 34% increase in fuel consumption by road transport.

In 2007, total energy use from 1A3 "Transport" was 1.2% (6.0 PJ) higher then in 2006, largely due to an increase in

Figure 3.7



diesel use in road transport (5.8 PJ). CO_2 emissions from 1A3 "Transport" are 0.4 Tg lower though than in 2006 due to an increase in the use of biofuels in road transport. The share of biodiesel in the total energy use of diesel vehicles amounted to 3.3% in 2007, while the share of bio-ethanol in the total energy use of petrol vehicles amounted to 2.0%. The share of biofuels in the total energy use by road transport increased from 0.4% in 2006 to 2.8% in 2007. In this submission the emissions from biodiesel and ethanol in gasoline are reported separately in the CRF.

Civil Aviation [1A3a]
The share of 1A3a 'Civil Aviation' in total national CO_2 emissions was less than 1% in both 1990 and 2007. The reported energy use and greenhouse gas emissions by civil aviation in the Netherlands are based on a rough estimate of fuel consumption in 2000, which is applied to the whole time-series (see Section 3.5.2).

Road transport [1A3b]
The contribution of 1A3b 'Road transport' to the national inventory of CO_2 emissions was 16% in 1990 and 20% in 2007. In the period 1990-2007 CO_2 emissions from road transport increased by 9.0 Tg (35.3%) to 34.5 Tg in 2007. CH_4 emissions from road transport fell from 6.8 Gg in 1990 to 2.2 Gg in 2007, which translates to a decrease of about 68%. N_2O emissions from road transport increased from 0.9 Tg in 1990 to 1.6 Tg N_2O in 1997, but decreased to 1.4 Tg in 2007.

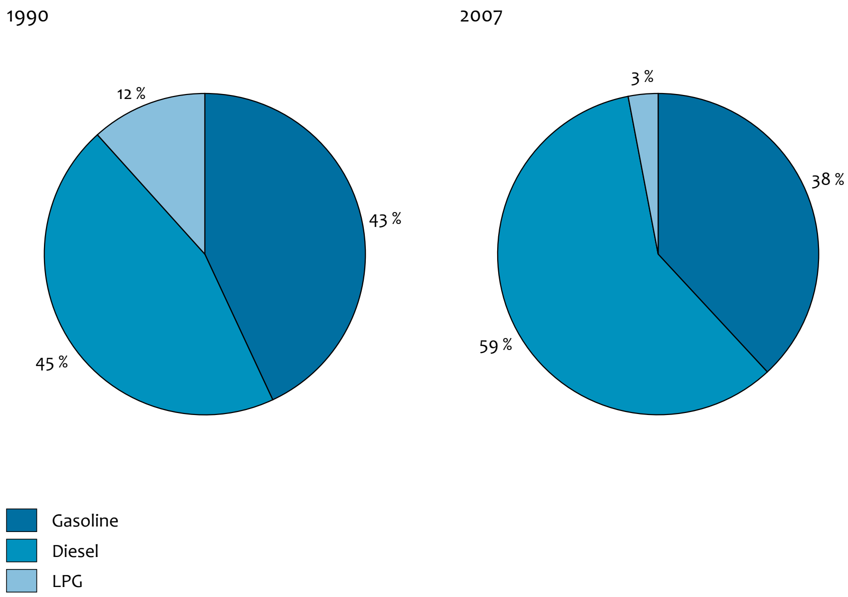
Rail transport [1A3c]
The share of 1A3c Rail transport in total national CO_2 emissions was only 0.1% in 1990 and 2007 (0.1 Tg).

Navigation [1A3d]
The share of domestic waterborne navigation (1A3d) in total national CO_2 emissions is small (about 0.3%) in both 1990 and 2007. Emissions were about 0.4 Tg in 1990 and 0.6 Tg in 2007.

Key sources
CO_2 emissions from 1A3b 'Road Transport', all fuel types, and from Navigation are identified as key sources. N_2O from road transport is no longer a key source.

Road transport [1A3b]
The share of diesel in fuel sales to road transport (PJ) has increased significantly between 1990 and 2007, while the share of LPG has decreased significantly (see Figure 3.8). The share of petrol has decreased slightly.

Fuel mix in fuel to road transport **Figure 3.8**



The 68% reduction of CH_4 emissions from road transport results from a reduction in total VOC emissions caused by the implementation of European Union emission legislation for new road vehicles: total combustion and evaporative VOC emissions by road transport decreased by approximately 79% during the period 1990–2007, primarily due to the penetration of catalyst- and canister-equipped vehicles in the passenger car park.

The increasing trend in N_2O emissions up to 1997 can be explained by the increased vehicle kilometers of petrol cars equipped with a catalytic converter, as the latter have higher emission factors than cars without this emission control technology. The subsequent decrease in N_2O emissions between 1997 and 2007, despite an increase in vehicle-kilometers in this period, can be explained by a mix of developments:

- Subsequent generations of catalytic converters (the second was introduced in 1996) appear to have lower N_2O emission factors (Gense, 2002)
- The share of diesel cars in the passenger car park, which are assumed to have lower emissions per vehicle kilometer than catalyst-equipped petrol cars, has increased during the last few years.

3.5.2 Methodological issues

A detailed description of the methodology and data sources used to calculate transport emissions is provided in the monitoring protocols that can be found at www.greenhousegases.nl and are listed in Section 3.1.

Civil Aviation [1A3a]

An IPCC Tier 2 methodology is used for calculating the greenhouse gas emissions of ‘Civil Aviation’. It is not possible to use fuel sales figures because there are no reliable data available on the distribution of these sales between national, international and military aviation. Therefore, the figures included in the national energy statistics (NEH) are not used. Instead, fuel consumption by domestic aviation has been roughly estimated based on the 2000 consumption figures of aviation petrol (avgas) and jet kerosene for domestic flights in the Netherlands reported by the Civil Aviation Authority Netherlands (Pulles, 2000). Because of the very small amounts involved (342 TJ aviation petrol and 230 TJ jet kerosene) and since there are no reasons to except a major increase, these figures are used for the whole time-series. Default IPCC emission factors for kerosene and aviation petrol are used to calculate greenhouse gas emissions. Deliveries of bunkers to international aviation are not included in this source category.

Emissions of precursor gases (NOx, CO, NMVOC and 2) reported in the NIR under domestic air traffic are the uncorrected emission values from the Netherlands Pollutant Emissions Register and refer to aircraft emissions associated with the Landing and Take-Off (LTO) cycles of Schiphol Airport. By far the most aircraft activities (>90%) in the Netherlands are related to Schiphol Airport; therefore emissions from other airports are ignored. No attempt has been made to estimate non-greenhouse gas emissions specifically related to domestic flights (including cruise emissions of these flights) since these emissions are almost negligible anyway.

Road Transport [1A3b]

For national policy purposes, air pollution from ‘Road Transport’ is, in general, calculated bottom-up from statistics collected on vehicle-kilometers and emission factors expressed in grams per vehicle-kilometer. The Revised IPCC Guidelines (IPCC, 1997) prescribe countries to report greenhouse gas emissions from combustion on the basis of fuel sales within the national territory. Thus, ‘Road Transport’ emissions of the direct greenhouse gases CO_2, CH_4 and N_2O are calculated using fuel sales data.

An IPCC Tier 2 methodology is used for CO_2 emissions from 'Road Transport', using Dutch data on fuel sales to 'Road Transport' from Statistics Netherlands (CBS) and country-specific emission factors, as reported in Klein et al. (2008), see Annex 2 for more details.

An IPCC Tier 3 methodology is used for CH_4 emissions from 'Road Transport'. CH_4 emissions from 'Road Transport' are calculated based on data on the mass fractions of different compounds in total VOC emissions (Veldt, 1993). VOC emissions from 'Road Transport' are calculated using data on vehicle-kilometers from Statistics Netherlands (CBS), and VOC emission factors obtained from the Netherlands Organization for Applied Scientific Research (TNO). The mass fraction is dependent on the fuel type and – for petrol vehicles – whether or not the vehicle is equipped with a catalyst. Petrol-fuelled vehicles equipped with a catalyst emit more CH_4 per unit of VOC than vehicles without a catalyst. In absolute terms, however, passenger cars with catalysts emit far less CH_4 than passenger cars without a catalyst because total VOC emissions are far lower. Diesel-fuelled vehicles emit less CH_4 per unit of total VOC than petrol-fuelled vehicles without a catalyst. For each diesel-fuelled vehicle category, the calculation methodology distinguishes between several vehicle characteristics, such as age, fuel type and weight. In addition, the methodology also distinguishes between three road types and takes into account cold starts.

An IPCC Tier 3 (country-specific) methodology is also used for N_2O emissions from 'Road Transport'. N_2O emissions are calculated by combining fuel deliveries with energy-specific emission factors. Data on fuel deliveries are obtained from Statistics Netherlands. The emission factors for passenger cars and light-duty vehicles using petrol or LPG are based on country-specific data (Gense, 2002). Emission factors for diesel light-duty vehicles, heavy-duty vehicles, motorcycles and mopeds are based on Riemersma et al. (2003).

Since the CO_2 emissions from 'Road Transport' are considered to be a key source (see Table 3.1), the present Tier 2 methodology complies with the IPCC Good Practice Guidance (IPCC, 2001). CH_4 and N_2O emissions from 'Road Transport' are not a key source.

Emissions of all other compounds, including ozone precursors and SO_2, which are more directly involved in air quality, are calculated bottom-up using vehicle-kilometer data (with fuel consumption figures that are somewhat different from the energy supply statistics; see Section 3.5.4 for more details).

In this submission we report the emissions from biodiesel and ethanol in gasoline separately in the CRF. The calculation of the emissions is comparable to the emission calculation for diesel/gasoline and based on the sold amount of biodiesel and ethanol.

Rail Transport [1A3c]

Information on fuel use by diesel trains is obtained from the Dutch Railways (NS). For calculation CO_2 emissions country-specific emission factors are used (Olivier, 2004); see Annex 2 for more details. For CH_4 and N_2O emissions IPCC default emission factors are used.

Navigation [1A3d]

An IPCC Tier 2 methodology is used for CO_2 emissions from domestic shipping. CO_2 emissions are calculated based on fuel deliveries to waterborne navigation in the Netherlands and country-specific emission factors (Klein Goldewijk et al., 2004). In the Netherlands, domestic commercial inland ships are allowed to use bunker fuels (sold without levies and VAT). Although the national energy statistics (NEH) make a distinction between trips on the Rhine river and other inland shipping in the fuel consumption data for shipping, the sum of bunker fuel sales and domestic fuel sales to waterborne navigation in the NEH includes fuel used for international navigation that should not be reported as part of domestic shipping according to IPCC Good Practice. Using the Emission Monitor Shipping (EMS) however, it is possible to distinguish between national and international navigation based on ton-kilometers traveled by ships (AVV, 2003). The share of fuel used by international navigation as calculated with the EMS is therefore subtracted from the total fuel sales to navigation in order to arrive at the fuel sales to national navigation, which is reported under 1A3d.

The present Tier 2 methodology level complies with the IPCC Good Practice Guidance (IPCC, 2001). Emissions from fisheries are allocated to the domestic source category 1A4c 'Commercial/ Institutional/Fisheries' as required by the IPCC Reporting Guidelines (see Section 3.2.5).

3.5.3 Uncertainty and time-series consistency

Uncertainties

The uncertainty in CO_2 emissions from 'Road Transport' is estimated to be about 4% in annual emissions (see Section 1.7 for more detailed information).). The uncertainty in fuel sales to road transport is estimated to be 2% for petrol, 5% for diesel oil and 10% for LPG. The uncertainty in the CO_2 emission factor for petrol and diesel is calculated to be 0.4% and 0.2% respectively, while the uncertainty in the CO_2 emission factor for LPG is estimated to be 0.2%. For petrol and diesel fuel, the uncertainty in the emission factor for CO_2 is based on 50 samples of petrol and diesel fuel from petrol stations in the Netherlands in 2004 (Olivier, 2004). There are however indications that the carbon content of petrol and diesel fuels for road transport is changing due tightening of European standards for fuel quality. It is therefore unknown if these uncertainty figures are still valid. The uncertainty in CO_2 emissions from Road Transport might therefore be underestimated.

The uncertainty in CH_4 emissions from 'Road Transport' is estimated to be approximately 80% in annual emissions. The share of CH_4 in VOC emissions is based on the report of Veldt and Van der Most (1993) and the composition of VOC emissions from 'Road Transport' has not been validated since. It is possible that the mass fraction of CH_4 has changed due to, for example, recent changes in the aromatic content of road transport fuels or improved exhaust after-treatment technology. The uncertainty in annual N_2O emissions from

‘Road Transport’ is estimated to be 80%. N_2O emission factors have not been updated recently and therefore are relatively uncertain.

The uncertainty in fuel used by ‘Civil Aviation’ is presently estimated to be about -80%/+200%, while that in ‘Navigation’ is estimated to be -80/+100%. The high uncertainty in aviation is due to the lack of data on fuel sales for domestic flights. See the previous Section for more details on the fuel consumption estimation method and for further explanation of the high uncertainty estimate. For jet kerosene and diesel used in non-road categories, the uncertainty in the CO_2 emission factors applied is estimated to be 0.5% and 0.2% respectively. These uncertainties (expressed as the standard error of the mean) are much lower than the uncertainties presented in the NIRs of other West European countries (Ramírez et al., 2007) and might be underestimated. The uncertainty in CH_4 and N_2O emissions from other non-road transport sources is estimated to be about -80%/+200% in annual emissions.

Time-series consistency

The methodologies used to estimate emissions from transport are consistent throughout the time-series.

3.5.4 Source-specific QA/QC and verification

Vehicle-kilometer approach versus IPCC approach

The Netherlands applies two methodologies to calculate CO_2 emissions from ‘Road Transport’: (1) the IPCC approach (based on fuel sales) and (2) the (informal) domestic approach, which is based on fuel consumed on national territory, calculated on the basis of transport statistics in terms of vehicle-kilometers travelled and fuel consumption per vehicle kilometer. A comparison between both approaches gives an indication of the validity of the fuel sales data.

The difference in fuel consumption inferred from transport statistics compared with data on fuel sales inferred from supply statistics on deliveries to fuelling stations is in the range of about 4–9% (data on fuel sales are higher). This is caused mostly by differences in diesel and LPG figures, which differ annually by up to 23% with an average of about 12% and 14% respectively (see NIR 2007, Figure 3.8). Differences in petrol sales and calculated petrol consumption are much smaller with an average of around 2%. The differences in fuel sales and the calculated fuel consumption on Dutch territory can partly be explained by the fact that part of the fuel sold in the Netherlands is consumed abroad and vice versa (Van Amstel et al., 2000a). Another explanation is the lack of a reliable fuel consumption figures per vehicle kilometers for most vehicle types. It can be concluded that roughly both methods show similar trends in fuel consumption by fuel type over the last 10 years.

3.5.5 Source-specific recalculations

There are no source specific recalculations compared to the pervious submission.

3.6 Other sectors [1A4]

3.6.1 Source category description

Source category 1A4 “Other sectors” comprises the following categories:

- 1A4a ‘Commercial and Institutional Services’;
- 1A4b ‘Residential’;
- 1A4c ‘Agriculture (mainly greenhouse horticulture), Forestry and Fisheries’.

1A4a ‘Commercial/Institutional Services’ comprises commercial and public services such as banks, schools and hospitals, and trade, retail and communication; it also includes the production of drinking water and miscellaneous combustion emissions from waste handling activities and from wastewater treatment plants.

1A4b ‘Residential’ refers to fuel consumption by households for space heating, water heating and cooking. Space heating requires about three-quarters of the total consumption of natural gas.

1A4c ‘Agriculture, Forestry and Fisheries’ comprises stationary combustion emissions from agriculture, horticulture, greenhouse horticulture, cattle breeding and forestry, and fuel combustion emissions from fisheries and from off-road machinery used in agriculture (mainly tractors). Most of the energy in this source category is used for space heating and water heating; although some energy is used for cooling. The major fuel used in the categories is natural gas, which accounts for approximately 90% of total fossil fuel consumption; much less liquid fuel is used by off-road machinery and by fisheries. Almost no solid fuels are used in these sectors.

Overview of shares and trends in emissions

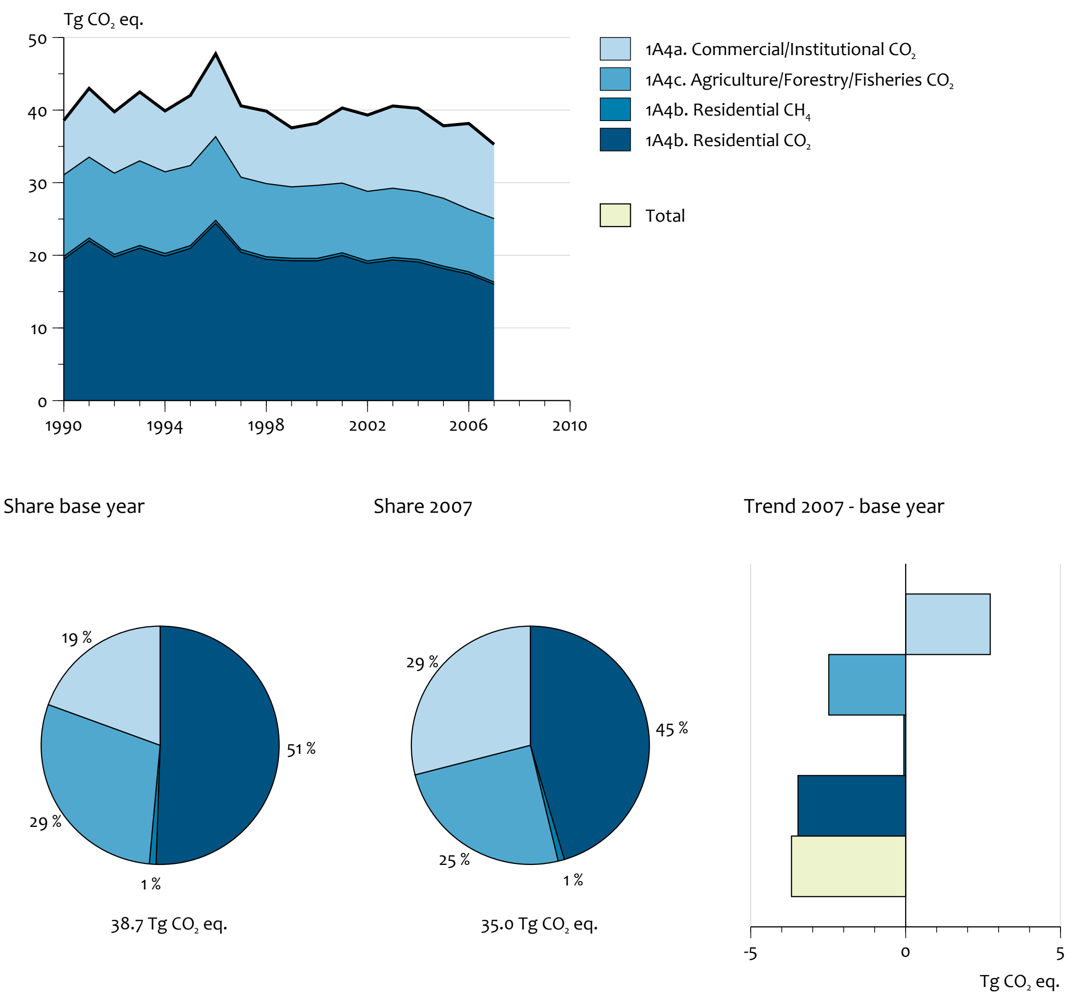
The share of CO_2 emissions from 1A4 “Other sectors” in total national CO_2 equivalent emissions (excluding LULUCF) was about 18% in 1990 and 17% in 2007, respectively. The share of CH_4 emissions from this source category in the national total greenhouse gas emissions is very small (0.4 Tg CO_2 eq or about 0.2%); the share of N_2O emissions is almost negligible, 1A4b ‘Residential’ is the main contributor, contributing approximately 10% to the total national CO_2 equivalent emissions.

About 24% of the total CH_4 emissions in the Energy sector originate from the ‘Residential’ sector (0.3 Tg CO_2 eq, see Table 3.1). Over 80% of these CH_4 emissions stem from gas combustion in particular from cooking losses; the remainder is from biofuel combustion.

CO_2 emissions of 1A4 “Other sectors” decreased by 2 Tg or 6% in the period 1990–2007. The main contributor this decrease is 1A4b ‘Residential’ (Figure 3.8 and Table 3.1).

The decreased emissions in ‘Agricultural’ are due to energy conservation measures in the category of greenhouse horticulture, CO_2 emissions from off-road machinery used in agriculture and from fisheries are included in the total

1A4. Other Sectors **Figure 3.9**



emissions from category 1A4c (total CO_2 emissions from 1A4c: approximately 9 Tg CO_2).

In 2007, CO_2 emissions from 1A4 "Other sectors" decreased by 8% or 2.9 Tg compared to the 2006 level mainly due to decreased gas combustion in the residential sector.

Key sources
Within this source category, the combustion of gases and liquids form a key source for CO_2 emissions. See Table 3.1 for details.

Commercial and institutional services [1A4a]
In the 'Commercial/Institutional Services' sector, CO_2 emissions have increased by 40% since 1990. However, when a temperature correction is taken into account, the structural, anthropogenic trend shows a somewhat lower increase of 23% in this period. The 'Commercial/Institutional Services' sector has grown strongly during this period: the amount of manpower (in man-years) increased by 35% in the period 1990–2007. This increase is roughly comparable with the increase of fuel consumption (excluding electricity) of 36%, and thus of CO_2 emissions. It should be noted that of the 7.5 Tg CO_2 emissions from the service sectors, about 0.4 Tg in 1990, increasing to about 0.8 Tg in 2007, are emissions from cogeneration facilities, which may also provide electricity to the public grid.

However, the emission trends should not be considered to be very robust. The fossil fuel consumption of natural gas and the small uses of liquid and solid fuels in this category show a very large inter-annual variation due to the relatively large inaccuracy of fuel consumption data in the energy statistics. This large inaccuracy is a result of the calculation scheme used in the national energy statistics, which allocates all fossil fuel use remaining after subtraction of the amounts allocated to the previous source categories (1A1, 1A2, 1A3) and other categories (1A4b and 1A4c) to this category. Thus, all uncertainties in the other allocations accumulate in this remaining category, which also results in large inter-annual changes in the underlying fuel mix of solid and liquid fuels. This explains the relatively large inter-annual variation that can be observed in the IEFs of CO_2, CH_4 and N_2O for solid and liquid fuels. As mentioned above, the strong decrease of CO_2 emissions in 2005, and of gas and solids consumption, must be an artifact of the very large uncertainty in the fuel consumption data of this category, which is for natural gas magnified in 2005 by the assumption of almost constant gas consumption in the agricultural category.

For 1991–1994, in particular, the detailed fuel mix assumed for liquid and solids fuels was different from the adjoining years 1990 and 1995 due to the revision of the energy statistics at a high aggregation level (discussed in the recalculation paragraph in Section 3.1). The biomass combustion reported here refers mainly to the combustion of biogas recovered by waste water treatment plants (WWTP), which shows a rather smooth increasing trend, and biomass consumption by industrial companies, which are classified in this economic sector, e.g. landfill gas used as fuel (see Section 3.9). According to the renewable energy statistics, the latter increased substantially in 2005.

Residential sector [1A4b]

When corrected for the inter-annual variation in temperatures, the trend in total CO_2 – i.e. in gas consumption – becomes quite smooth, with inter-annual variations of less than 4% (Figure 3.13). The variations are much larger for liquid and solid fuels because of the much smaller figures. The biomass consumption is almost all wood (fuel wood, other wood: also less than 1% waste). The cause of the irregularity in biomass fuel use in 1999 is unknown but may be due to a small error in the survey procedures (for details see the monitoring protocol 9088 on biomass fuel combustion).

The IEF for CH_4 from national gas combustion is the aggregate of the standard emission factor for gas combustion of 5.7 g/GJ plus the 30 g/GJ of total residential gas combustion that represents start-up losses, which occur mostly in cooking but also in central heating and warm water production devices. This second component is neither accounted for in the IPCC default nor in emission factors used by most other countries.

In the 'Residential' sector, CO_2 emissions have remained almost constant since 1990. However, when the temperature correction is accounted for, the structural anthropogenic trend including temperature correction shows a decrease of 13% in this period. Although the number of households and residential dwellings increased by about 15% since 1990, the average fuel consumption per household decreased by about 23% mainly due to the improved insulation of dwellings and the increased efficiency of heating apparatus (increased use of high-efficient boilers for central heating).

Agriculture and forestry [1A4c] (stationary combustion)

Total CO_2 emissions in the 'Agriculture and Fisheries' category have decreased since 1990, mainly due to decrease in gas consumption for stationary combustion. However, when the temperature correction is taken into account, the structural, anthropogenic trends of the total category show a decrease of 13% in this period. This is mainly due to energy conservation measures in greenhouse horticulture. Energy use in this sector accounts for approximately 85% of the primary energy use of the agricultural sector. Space heating and artificial lighting are the dominant uses of energy here. The sector has significantly improved its energy efficiency in the past decade (Van Harmelen and Koch, 2002). The total area of heated greenhouses increased by about 8% in the 1990's and now occupies over 95% of the total area of greenhouses. In particular, the cultivation of flowers and plants showed a large areal increase, namely of about 15%. Thus heated greenhouses have reduced their energy consumption, although their surface area has increased by about 8% and the physical production only decreased by 5% over this period (LEI/CBS, 2002). It should be noted that about 0.6–0.8 Tg of the CO_2 emissions from the agricultural sector are emissions from cogeneration facilities, which may also provide electricity to the public grid.

In addition, since the fall of 2005 CO_2 from the hydrogen production plant in a refinery is starting to be used for crop fertilization in greenhouse horticulture, thereby avoiding some CO_2 emissions otherwise generated by CHP facilities merely for producing CO_2 for horticulture. Total annual amounts, however, will be limited to a few tenths of Tg CO_2. In addition, in 2007 production and use of biogas from composting of manure in the 'Agriculture/Forestry/Fisheries' category increased from virtually zero to 0.5 PJ.

Agricultural machinery and fisheries [1A4c] (mobile combustion)

The CO_2 emissions from off-road machinery in agriculture and from fisheries amount to about 1 Tg each. CO_2 emissions from fisheries have shown a decreasing trend in recent years, whereas CO_2 emissions from agricultural machinery have fluctuated in these years.

3.6.2 Methodological issues

In this category liquid and gaseous fossil fuels are key sources of CO_2 emissions (in particular, gaseous fossil fuels, which cover about 90% of the source category 1A4). Emissions from the combustion of gases in the categories 1A4a, 1A4b and 1A4c are identified as key sources, as are the emissions from the combustion of liquids in 1A4c, IPCC Tier 2 methodologies are used to calculate greenhouse gas emissions from stationary and mobile combustion in this category. More details on methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (www.greenhousegases.nl).

The activity data for the 'Residential' sector (1A4b) and from stationary combustion in agriculture (1A4c-i) are compiled using data from separate surveys for these categories ('HOME' survey, formerly called 'BAK' and 'BEK' surveys, and LEI). However, due to late availability of the statistics on agricultural fuel use, preliminary data are often used for the most recent year in the national energy statistics. Also, it is likely that trends in agricultural fuel consumption are estimated using indicators that take no account of the varying heating demand due to changes in heating degree days. This is also suggested by Figure 3.9, where the uncorrected trend is smoother than the temperature-corrected trends. The fuel consumption data in 1A4a 'Commercial/Institutional Services' is determined by subtracting the energy consumption allocated to the other source categories (1A1, 1A2, 1A3) and other categories (1A4b and 1A4c) from the total energy consumption, which means that resulting activity data are the least accurate of all three categories. The emission factors for CO_2 from natural gas and from diesel fuel are based on country-specific data; for the CH_4 emission factors country specific values are also used, which for the residential gas combustion includes start-up losses, a factor mostly neglected by other countries. For other factors IPCC defaults were used.

Emissions from 'Off-road Machinery and Fisheries' in this category (1A4c-ii) are calculated based on IPCC Tier 2 methodologies. The fuel use data from LEI is combined with country-specific emission factors for CO_2 and IPCC default emission factors for N_2O and CH_4. In 2007 a study into the emissions from non-greenhouse gasses from off road vehicle revealed an erroneous allocation of fuel amounts between 1AA2f and 1A4c in the past. This submission includes the corrected fuel allocation which led to an increase of the CO_2 emission in 1A4c compared to the last submission.

Fuel consumption by 'Fisheries' (1A4c-ii) is included in the Netherlands international bunker statistics, which are part of the NEH. However, since the NEH does not separately account for fisheries, it is not possible to use fuel sales figures in the NEH. Instead, the fuel consumption of diesel oil and heavy fuel oil by fisheries is estimated based on statistics of the number of days at sea ('hp-days') of four types of Dutch fishing ships. This information is compiled by LEI, and the estimate includes specific fuel consumption per ship [per day and per unit of power (hp) based on a study of TNO (Hulskotte, 2004b)]. This amount is reported as part of category 1A4c and subtracted from the amount of bunker fuel consumption in the NEH. The modified bunker figures are reported as a Memo item. Please note that in 2008 improved fuel data became available which changed the emissions for the past three years. For more details, see the monitoring protocol 9060 for Fisheries.

3.6.3 Uncertainty and time-series consistency

Uncertainties

It should be noted that the energy consumption data for the total category 1A4 "Other sectors" are much more accurate than the data for the categories of 1A4. In particular, energy consumption by the commercial/institutional and – to some extent – agricultural categories (in particular the latest year) is monitored less accurately than that by the 'Residential' sector. Trends of emissions and activity data of these categories should be treated with some caution when drawing conclusions. The uncertainty in total CO_2 emissions from this source category is about 6%, with an uncertainty of the composite parts of about 5% for the 'Residential' sector, 9% for the 'Agricultural' sector and 20% for the 'Service' sector (see Section 1.7 and Annex 1 for more details).

The uncertainty in gas consumption data is estimated at 5% for the 'Residential' sector, 10% for 'Agriculture' and 20% for the 'Commercial' sector. An uncertainty of 20% is assumed for liquid fuel use for 'Off-road Machinery and Fisheries' and in the 'Service' sector. Since the uncertainty in small figures in national statistics are generally larger than large numbers, as also indicated by the high inter-annual variability of the data, the uncertainty in solid fuel consumption is estimated to be even higher at 50%. However, the uncertainty of fuel statistics for the *total* "Other sectors" is somewhat smaller than the data for the sectors: consumption per fuel type is defined as the remainder of total national supply after subtraction of amount used in the 'Energy', 'Industry' and "Transport" sectors. Subsequently, energy consumption by the residential and agricultural sectors is estimated separately using a trend analysis of sectoral data (the so-called BAK and BEK data sets of annual surveys of the 'Residential' sector and LEI data for 'Agriculture').

For natural gas the uncertainty in the CO_2 emission factor is now estimated at 0.25% (instead of 1%) based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2007) and further discussed in Olivier et al. (2009), but this has not yet been used in the uncertainty assessment in Section 1.7 and Annex 1. For the CO_2 emission factors for liquids and solids, uncertainties of 2% and 5% were assigned. The uncertainty in CH_4 and N_2O emission factors is estimated to be much higher (about 50% and 100%, respectively).

If the changes made in earlier years are indicative of the quality of the data (see Table 3.22 of NIR 2004 and Table 3.26a of NIR 2005; Klein Goldewijk et al., 2004, 2005). then the uncertainty in total CO_2 emissions from this source category is about 7%, with an uncertainty of the composite parts of 3% for the 'Residential' sector, 15% for the 'Agricultural' sector and 20% for the 'Service' sector. This is in line with the results from the Tier 1 uncertainty analysis.

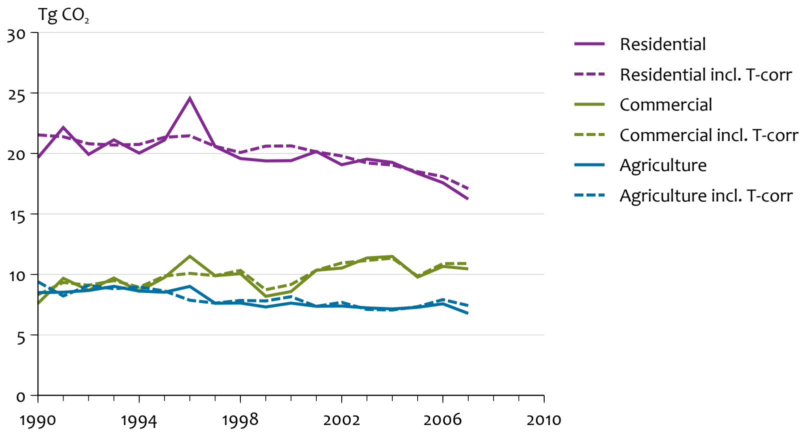
Time-series consistency

For general information on time-series consistencies, see Section 3.2.3. Since most of the fuel consumption in this source category is used for space heating, the gas consumption from the "Other sectors" varies considerably across years due to variations in winter temperatures over time. For trend analysis a method is used to correct the CO_2 emissions from gas combustion for the varying winter temperatures. This involves the use of the number of heating degree-days under normal climate conditions, which is determined by the long-term trend as explained in Visser (2005).

Figure 3.9 compares the actual emission trend data for CO_2 of the three categories with temperature-corrected data and the basic activity indicator trends of the 'Residential', 'Service' and 'Agricultural' sectors. This comparison clearly shows that in 1990 and 1996 much less and much more gas was consumed as a result of a relatively warm and cold winter, respectively, than under normal weather conditions. The corrected trends for the 'Residential' and 'Agricultural' sectors are quite smooth (all or most large inter-annual variations are removed), with the exception of that for the 'Commercial/Institutional' sector (see Section 3.6.1). Figure 3.9 shows that the temperature correction method used is indeed a reasonable proxy for correcting for the weather influence since it removes the largest inter-annual variations; however, the resulting time-series is still not a completely smooth line. This is of particular interest in the 'Residential' sector, since the quality of the data on annual gas consumption is assumed to be quite good.

CO_2 emission trend with and without temperature correction

Figure 3.10



Emission factors [1] used for military marine and aviation activities.

Table 3.5

Category		CO_2	CH_4	N_2O
Military ships	Emission factor	75.25 kg/GJ	2.34 g/GJ	1.87 g/GJ
Military aviation	Emission factor	72.9 kg/GJ	5.8 g/GJ	10 g/GJ
Total	Emissions in 2007 (Gg)	0.32	0.03	0.02

1) Source: Hulskotte (2004b).

The deviating IEFs in the 1991–1994 period of CH_4 for liquids and gas and of N_2O for liquids are due to the higher aggregation level used in the revised energy statistics.

3.6.4 Source-specific QA/QC and verification

The trends in CO_2 from the three categories were compared to trends in related activity data: the number of households, number of persons employed in the 'Service' sectors and the area of heated greenhouses. Large annual changes were identified in special trend tables and explanations were sought (for example inter-annual changes in CO_2 emissions by calculating temperature-corrected trends to identify the anthropogenic emission trends). The trend tables for the IEFs were then used to identify large changes and large inter-annual variations at the category level for which explanations were sought and included in the NIR. More details on the validation of the energy data can be found in the monitoring protocol 9052: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.6.5 Source-specific recalculations

This submission includes revised emissions for CH_4 from small scale combined heat and power plants. The emissions increased on the basis of new (higher) emission factors for CH_4 (see Section 3.3.5). Emissions in CO_2–eq increased in the order of magnitude of 0.06 Tg (in 1990) to 0.45 Tg CO_2–eq (in 2006) (this is the total for all effected CHP in category 1A).

3.6.6 Source-specific planned improvements

There have no source-specific recalculations envisaged.

3.7 Others [1A5]

3.7.1 Source category description

Category 1A5 'Others' includes the emissions from military ships and aircraft (in 1A5b). This category is not a key source.

Overview of shares and trends in emissions

The CO_2 emissions from this source category are approximately 0.5 Tg, with some inter-annual variation caused by different levels of operations, including fuel use for multilateral operations, which are included here. The emissions of CH_4 and N_2O are negligible.

Activity data and (implied) emission factors

The emission factors used are presented in Table 3.5.

3.7.2 Methodological issues

A country-specific top-down (Tier 2) method is used for calculating the emissions for fuel combustion from 1A5 'Others'. The fuel combustion emissions in this sector are calculated using fuel consumption data for both shipping and aviation that have been obtained from the Ministry of Defense and are the total emissions for domestic military shipping and aviation activities and the so-called multilateral operations. The fuel data for aviation consist of a mixture of jet kerosene, F65 and SFC. In the national energy statistics these activity data are included in the bunker fuel consumption. The sector-specific emission factors that are used are those reported by the Ministry of Defense. The methodology and data sources for the calculation of these emissions can be found on the website www.greenhousegases.nl and in Section 3.1.

Energy consumption [1] (Units:PJ) in the period 1990–2007 **Table 3.6**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Marine bunkers [2]	445	461	555	611	603	562	611	702	729	663
Heavy fuel oil	368	375	473	522	521	491	540	628	655	612
Gas/diesel oil	73	82	75	82	77	67	67	69	69	47
Lubricants	4	4	6	7	5	5	4	5	5	4
Aviation bunkers [3]	64	106	136	133	140	137	147	152	153	152
- jet fuel (kerosene)	64	106	136	133	140	137	147	152	153	152
Total bunkers	509	567	691	744	743	700	758	854	882	816

1) Source: CBS (NEH/Energy Monitor. Table 1.1; revised data), with a few corrections for differences in the definitions.
2) Lubricants used as bunker fuel are 100% oxidised (instead of 50% in the National Approach).
3) Aviation petrol is included under jet fuel.

3.7.3 Uncertainty and time-series consistency

Uncertainties

The uncertainty in CO_2 emissions from fuel combustion from 1A5 'Others' is estimated to be about 20% in annual emissions. The uncertainty for CH_4 and N_2O emissions is estimated to be about 100%. The accuracy of fuel consumption data is tentatively estimated at 20%. For emission factors, the uncertainties were estimated at 2% for CO_2 and 100% for CH_4 and N_2O.

Time-series consistency

A consistent methodology is used throughout the time-series. The time-series consistency of the activity data is good due to the continuity in the data provided.

3.7.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures discussed in Chapter 1.

3.7.5 Source-specific recalculations

There have been no source-specific recalculations.

3.7.6 Source-specific planned improvements

There are no source-specific planned improvements.

3.8 International bunker fuels

3.8.1 Source category description

Category 1C1 'International Bunker Fuels' include fuels used for international civil aviation or by seagoing ships engaged in international transport. In accordance with the Revised 1996 IPCC Guidelines, emissions from fuel sold to ships or aircraft engaged in international transport are not included in national emission totals but are instead reported separately.

Overview of shares and trends in emissions

Emissions in category 1C1 'international bunkers' are not included in the total Dutch greenhouse gas emissions. Total greenhouse gas emissions in this category increased from 39 Tg CO_2 eq in 1990 to 62.3 Tg CO_2 eq in 2007. CO_2 emissions from 1C1b 'Marine bunkers' showing an increase during this period (up to about 51 Tg in 2007). CO_2 emissions from 1C1a 'Aviation bunkers' increased in the same period to reach 11 Gg in 2007.

In 2007 CO_2 emissions from marine bunkers decreased by 9% (-4.8 Tg). CO_2 emissions from aviation bunkers increased by 1% or +0.1Tg.

Activity data and (implied) emission factors

The energy consumption of 1C1b Marine bunkers and 1C1a Aviation bunkers has grown substantially in the period 1990–2007 (see Table 3.6). In 2007 marine bunker fuel consumption decreased by about 9%.

3.8.2 Methodological issues

Emissions from international bunkers are calculated based on energy statistics provided by Statistics Netherlands (CBS) and default IPCC emission factors for CH_4 and N_2O and for CO_2 from residual fuel oil (heavy fuel oil), lubricants and jet kerosene. The emission factor for CO_2 from gas/diesel oil is based on the measured carbon contents of 50 samples of diesel fuel (Olivier, 2004).

Although the results of a recent study on CH_4 and N_2O emission factors show that the IPCC defaults (IPCC, 1997) may be outdated (Denier van der Gon et al., 2002), these factors have still been used for the calculation of N_2O and CH_4 emission estimates since no better data are currently available.

The following adjustments to the international marine and aviation bunker data included in the national energy statistics were made for the calculation of greenhouse gas emissions:

Bunker data for international fisheries are estimated and reported separately (under 1A4c) and thus subtracted from the bunker totals.

Bunker data from military aviation and shipping, including those for multilateral operations which are not estimated separately, are estimated and reported separately (under 1A5, see Section 3.4.7) and thus subtracted from the bunker totals.

Bunker data from domestic navigation total fuel consumption are estimated and reported separately (under 1A3d. see Section 3.4.7) as these are included in the national energy statistics as a part of domestic shipping (i.e. this also includes some international shipping) and as a part of Marine bunkers. Therefore, both an addition to and a subtraction from the Marine bunker totals was carried out to correct for the total

Biomass fuel consumption specified per source category and fuel type (Units: in PJ) .

Table 3.7

Source	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total 1A1	13.8	17.4	32.6	35.4	41.2	37.6	44.9	60.8	60.3	52.0
Total 1A2	2.6	2.8	3.0	3.0	3.2	3.7	4.4	4.5	5.4	5.5
Total 1A3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	13.0
Total 1A4	13.9	13.3	13.9	14.2	14.1	13.4	13.5	12.8	13.1	12.0
National total	30.3	33.5	49.5	52.6	58.6	54.6	62.8	78.2	80.0	82.5

Organic CO_2 emissions (Units: Gg) reported as CO_2 from biomass combustion (included in 1A).

Table 3.8

Cat.	Source	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
1A	Fuel combustion o.w.:	3.9	4.3	6.2	6.5	7.1	6.8	7.6	8.8	8.9	9.3
1A1	Energy industries	2.1	2.6	4.4	4.7	5.3	5.0	5.7	7.0	6.9	6.1
1A2	Manufacturing industries	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.6
1A3	Transport	NO	NO	NO	NO	NO	NO	NO	NO	0.1	1.0
1A4	Other sectors. o.w.:	1.5	1.4	1.4	1.5	1.5	1.4	1.4	1.3	1.4	1.7
1A4a	- Commercial/Institutional	0.2	0.3	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.4
1A4b	- Residential	1.3	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0
1A4c	- Agriculture/ Forestry/Fisheries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Total memo CO_2 from biomass		3.9	4.3	6.2	6.5	7.1	6.8	7.6	8.8	8.9	9.3

1) NO = Not occurring; o.w. = of which

consumption for domestic shipping reported here as part of the national totals (under 1A3d).

For bunker data for domestic aviation, the minor total fuel consumption (the Netherlands is a very small country) is not based on national energy statistics but estimated and reported separately (under 1A3d, see Section 3.4.7), since it appears that the national energy statistics for domestic aviation are compounded with military fuel use. Thus, the original domestic aviation fuel consumption is added to the original aviation bunker fuel consumption, and the new amount estimated as consumption for domestic aviation is subtracted from it.

The method for calculating emissions from national fisheries and military activities (reported under 1A4c and 1A5) and the distinction between fuel use by domestic navigation and international navigation are documented in Hulskotte (2004a, b).

3.8.3 Uncertainty and time-series consistency

Uncertainty

The uncertainty of CO_2 emissions from international bunkers is estimated to be about 2% in annual emissions (Boonekamp et al., 2001).

Time-series consistency

The methodology used to estimate emissions from international bunkers is consistent throughout the time-series.

3.8.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures discussed in Chapter 1.

3.8.5 Source-specific recalculations

There have been no source-specific recalculations.

3.8.6 Source-specific planned improvements

There are no source-specific planned improvements.

3.9 CO_2 emissions from biomass

In accordance with the Revised 1996 IPCC Guidelines, CO_2 emissions from biomass are not included in national emission totals but are reported separately as a Memo item 'CO_2 emissions from biomass'.

3.9.1 Source category description

In the Netherlands biomass fuels are used in various categories:

1A1a 'Electric Power and Heat Generation' – organic part of municipal waste combusted in waste incinerators that are recovering heat and electricity for energy purposes, wood and other biogenic material co-combusted in coal-fired power plants, biogas (methane) recovered by landfills operators and mostly combusted in CHP facilities owned by utilities;

1A2 'Manufacturing Industries' – mainly in the pulp and paper industry (e.g. paper sludge) and the wood construction industry (e.g. wood waste); biomass combustion in the cement industry is not reported;

- 1A3b 'Road transport'– effectively from 2007 biofuels are introduced in petrol and diesel fuel: ethanol is blended with petrol and in addition biodiesel is used
- 1A4a 'Commercial/Institutional' – biogas (methane) recovered from waste water treatment plants and used for energy purposes, and some individual companies classified in 1A4a that report biomass combustion in their annual environmental reports
- 1A4b 'Residential' sector –fuel wood only
- 1A4c 'Agriculture/Forestry/Fisheries' – biogas from composting of manure, and composting of kitchen and garden waste

Activity data and implied emission factors

Table 3.8 presents an overview of all biofuel combustion data included in the greenhouse gas inventory. There has been a strong increase in total biofuel use since 1990: from about 30 PJ to about 83 PJ in 2007. This increase is the result of increased waste incineration with energy recovery since the early 1990's and the strong increase in the co-combustion of biomass in coal-fired power plants since 2000; both of these developments were stimulated by environmental policy on waste and climate, respectively. In 2007 biomass combustion in power generation decreased by about 14%, mainly due to decreased co-combustion of biomass in coal-fired power stations. This is the result of a change in the MEP subsidizing scheme to encourage the use of biomass in electricity production. Although very effective the MEP was more expensive than the government estimated, as a result in June 2005 the MEP for new large biomass projects and for offshore wind energy projects was cancelled. On the other hand, fuel wood use in the 'Residential' sector has decreased somewhat since 1990. In addition, the use of biogas produced from landfills and WWTPs has increased significantly and now has about a 6% share in total biofuel combustion. Through these developments, the share of residential biofuels decreased from 1990 to 2007. Note that no sludge combustion outside 1A1a has been reported and that no greenhouse gas emissions from charcoal combustion in barbeques are reported in source category 1A4.

3.9.2 Methodological issues

All activity data is from a special annual project with the aim of monitoring the use of renewable energy sources in the Netherlands (Segers and Wilmer, 2007; Segers, 2005), which contains a consistent time-series back to 1990. For residential biofuel use, the present PRTR monitoring data include fuel wood and organic waste combustion in residential multi-burners even though this is not included in the data collection method of the DE project. The use of biofuel in road transport started in 2006 with a 0.4% share. The data on biofuel consumed are as of now incorporated in the inventory.

Charcoal consumption is included in Segers (2005), while the PRTR emissions from charcoal (for non-greenhouse gases) are derived from proxy data (a fraction of meat consumption is assumed to be prepared on barbeques fired with charcoal). As these two very small sources have a high degree of uncertainty, these sources are not (yet) included in the PRTR data set for greenhouse gas emissions. However, according to FAO statistics annual apparent consumption varies between about 15 and 40 kton per year (see http://faostat.fao.org/) and related CH_4 and N_2O emissions are therefore almost negligible (e.g. considerably less than 1 Gg per year).

3.9.3 Uncertainty and time-series consistency

Uncertainty

The uncertainty in the activity data is much higher for biofuels than for fossil fuels since the monitoring of biomass use is much less detailed and less extensive. Based on expert judgments, the uncertainty in fuel wood and biogas consumption is estimated to be approximately 25% and 10%, respectively (Olivier et al., 2009).

For the organic fraction of waste incineration in 1A1a as well as for wood and other organic material co-combusted in coal-fired power plants, the uncertainty is also estimated at 10% for all years (perhaps higher for recent years). For the manufacturing industries and individual companies reported under 1A4a, current fuel data from the individual companies and other sources are used in the compilation of the Netherlands greenhouse gas inventory and the associated CRF files, the total uncertainty of which is much higher due to incomplete monitoring – for example, +50 to -100%. The uncertainty in the emission factors is rather high (for example 10% for CO_2) due to the uncertainty in the carbon and energy content of the biomass; this is caused by the inclusion of variable fractions of water in the weight and variable composition of the biomass. The uncertainty in CH_4 and N_2O emission factors is estimated to be much higher (for example about 50% and 100%, respectively).

Time-series consistency

The methodology used to estimate emissions from biomass is consistent throughout the time-series.

3.9.4 Source-specific QA/QC and verification

More details on the validation of the biomass fuel data can be found in the monitoring protocol 9088 on the Memo item: 'CO_2 from Biomass'.

3.9.5 Source-specific recalculations

There are no source-specific recalculations.

3.9.6 Source-specific planned improvements

There are no source-specific planned improvements.

3.10 Comparison of the sectoral approach with the reference approach for CO_2

The IPCC Reference Approach (RA) for CO_2 from energy use utilizes apparent consumption data specified per fuel type in order to estimate CO_2 emissions from fossil fuel use. This has been used as a means of verifying the sectoral total CO_2 emissions from fuel combustion (IPCC, 2001). More details on the calculation and the recalculation differences can be found in Annex 4. The protocol itself is described in 9051.

There are four main causal factors for differences in the two approaches, some are country-specific and others are inherent to the comparison method itself (see Annex 4):

- the non-inclusion of CO_2 from incineration of waste that contains fossil carbon in the Reference Approach (RA);
- the fossil fuel-related emissions reported as process emissions (sector 2) and fugitive emissions (sector 1B), which are not included in the Sectoral Approach (SA) total of sector 1A, the most significant of which being gas used as feedstock in ammonia production (2B1) and losses from coke/coal inputs in blast furnaces (2C1);
- the country-specific storage factors used in the RA are multi-annual averages; therefore, the RA calculation for a specific year will deviate somewhat from the factors that could be calculated from the specific mix of feedstock/non-energy uses of different fuels.

Comparison of CO_2 emissions: Reference Approach (RA) versus National Approach (in per cent) **Table 3.9**

Fuel type	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Liquid fuels [1]	-0.1%	-1.7%	-1.1%	-1.7%	-2.4%	-1.5%	-3.3%	-2.3%	-2.8%	4.0%
Solid fuels	9.9%	7.2%	6.1%	4.5%	5.8%	7.1%	5.9%	6.9%	5.8%	8.2%
Gaseous fuels	4.8%	5.2%	5.5%	4.6%	4.4%	4.1%	4.0%	4.2%	3.4%	3.1%
Other	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Total (RA-NA)/NA	3.8%	2.8%	2.4%	1.6%	1.4%	1.7%	0.8%	1.2%	0.4%	3.0%

1) Excluding international bunkers.

- the liquids and other fuel components in the RA are different from those in the SA in that the LPG in "Transport" is in the National Approach (NA) reported under 'Other Fuel' versus in 'Liquid Fuel' in the RA.

In Table 3.9 the results of the IPCC Reference Approach calculation are presented for 1990–2007 and compared with the official national total emissions reported as fuel combustion (source category 1A).

It can be observed, as was done by the ERT in 2007, that CO_2 emissions from liquid fuels are lower in the reference approach than in the sectoral approach for all years, which is not plausible. Moreover, the difference for liquid fuels increases over time. One of the reasons for this is the fact that the storage fractions are kept constant over time which results in peculiarities in the Netherlands' energy statistics (a) accidentally, some chemical products are reported by companies as fuels. The inclusion of chemical products in the energy statistics can either result in increasing or decreasing emissions under the RA, depending on whether these chemical products are more exported or imported in the Netherlands compared to the year the storage fractions were determined; (b) some chemical product are reported as LPG in the energy statistics; since a part is exported, which leads to *decreasing* emissions in the reference approach; (c) as export-related effect is larger than the product-reporting effect, the overall emissions are smaller in the reference approach than in the sectoral approach. The increase over time of the discrepancies is caused increasingly incorrect reporting of chemical products as fuels. The errors in reporting in the energy surveys have already been identified and corrected: in 2005 an improvement project started in the national energy statistics and correct reporting can be expected in due course. From the information above it can be concluded that these problems only affect the reference approach (apparent consumption) and not the sectoral approach, since process emissions in the sectoral approach are calculated using a carbon balance and company-specific storage factors.

The annual difference calculated from the direct comparison varies between 3% for 2007 and 4.5% for 1991 and 1992 and is (2.5±0.6)% on average. The largest differences are seen for the 1990s. If corrected for the fossil waste included in the NA and selected sector 1B and sector 2 emissions that should be added to the 1A total before the comparison is made, then the remaining differences in totals are much smaller and between -1% and 1.2%. Also, the largest differences do not concentrate in a particular time span of the period in question. The corrected 1990–2007 trends differ only about 1%: 9.2% for the NA (= sum of sectoral emissions in source category 1A plus selected 1B and 2) and 8.3% for the RA (including fossil waste). The corrected comparison with the RA based on national energy balance data (including fossil waste from 1A for 'other fuels') shows less differences in emissions if corrections are made for 2G ('Non-Energy Uses') in NA-liquids, 1B1 ('Coke Production'), 2A ('Soda Ash'), 2B5, 2C1 ('Blast Furnaces) and 2D in NA-solids, and 1B2 ('Gas Flaring') and 2B1 (Ammonia') in NA-gases.

Please note that the difference between NA and RA increased significantly between 2006 and 2007 due to an increase in naphta consumption in 2007.

3.11 Feedstocks and other non-energy use of fossil fuels

3.11.1 Source category description

In energy statistics the non-energy use of fossil fuels generally refers to the total consumption of fuels as chemical feedstock, the consumption of the non-energy refinery products, such as naphtha, bitumen and lubricants and the use of other refinery products for non-combustion purposes. Chemical feedstock use refers to hydrocarbons that are used for the production of synthetic organic materials, such as plastics and solvents, and as a raw material for non-carbon-containing products, such as ammonia and hydrogen. A part of the carbon in feedstocks is embodied in petrochemical products (storage of carbon), and a part can be attributed to by-product CO_2 emissions (e.g. ammonia production from natural gas) or leakages and another part is used as a fuel for energy purposes (e.g. chemical waste gas used partially within and partially outside the chemical sector and refinery gas). Subsequently, CO_2 emissions may occur during domestic use of these petrochemical products, often in the form of NMVOC emissions. In the context of greenhouse gas inventories, the fossil carbon inputs in blast furnaces are also considered to be a feedstock, but this is not reflected in the IPCC Reference Approach for CO_2. Finally, in the waste phase, fossil CO_2 emissions will occur if the waste products are incinerated; because this is part of the life cycle of fossil carbon, this aspect is also discussed here, but it is formally not considered to be a feedstock/non-energy use. At the present time the following emissions are accounted for as feedstocks and other non-energy use:

- CO_2 emissions from the use of feedstock and other non-energy uses of fuels: feedstocks from natural gas and oil products in the chemical industry (IPCC categories 2B1 and 2B5) and coke and coal inputs in blast furnaces in the iron and steel industry (part of 2C1);

CO_2 emissions from non-energy and feedstock uses of fossil fuels (production and product use) in sectors 1, 2 and 3 (Units: Tg)

Table 3.10

IPCC no./category	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
1A1a Public power & heat										
BF/OF/OX gas	3.8	4.8	4.9	5.3	5.3	5.5	5.9	6.1	4.7	6.1
Chemical waste gas	0.0	1.5	1.9	1.9	2.2	2.0	2.1	2.1	0.6	0.8
Waste (fossil part)	0.6	0.8	1.5	1.5	1.6	1.7	2.1	2.1	2.1	2.2
1A2a Iron and Steel										
BF/OF/OX gas	3.2	3.9	3.1	3.4	3.4	3.6	4.0	3.8	3.9	3.2
1A2c Chemicals										
Chemical waste gas	5.4	3.8	3.8	4.2	5.1	5.8	5.7	5.6	6.7	7.3
TOTAL ENERGY	13.0	14.8	15.2	16.3	17.5	18.8	19.7	19.7	18.1	19.6
2A Mineral products										
Soda Ash Production	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2B Chemical industry										
1 Ammonia Production	3.1	3.6	3.6	3.0	2.9	2.9	3.1	3.1	3.1	3.0
5 Prod. other chemicals	0.6	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.3
5 Carbon electrodes	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5 Prod. activated carbon [2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2C Metal Production										
1 Coke inputs blast furnace	2.2	1.5	1.0	1.0	1.1	1.2	0.9	0.8	1.1	2.1
2D Other Production										
Food and Drink	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2G Other										
4 Other economic sectors	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
TOTAL IND. PROC.	6.2	6.1	5.5	4.8	4.8	4.9	4.9	4.9	5.1	5.7
3 Solvents / Product use	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Total Feedstock/Non-Energy Use	19.6	21.1	20.8	21.3	22.5	23.9	24.8	24.7	23.3	25.3

1) 0.0 means a non-zero emission, less than 0.05.
2) Peat consumption is not included in the Netherlands Energy Statistics (NEH) but is taken from other sources.

Chemical industry: feedstock uses of fuels (Units: PJ).

Table 3.11

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Oil products [1]	303	321	386	411	427	472	496	547	506	630
o.w. naphtha	136	159	74	77	94	181	159	104	73	254
o.w. natural gas liquids	143	182	201	210	253	217	227	237	252	221
o.w. LPG	63	55	39	35	3	4	20	36	29	92
o.w. gas/diesel oil	34	10	6	4	6	4	3	IE	IE	IE
Natural gas	101	110	113	100	97	97	97	101	87	91

1) Excluding lubricants, bitumen. coals, coal-derived fuels, which are mainly or fully used elsewhere.

- CO_2 emissions from other non-energy uses of fuels for their physical properties in other industrial sectors: coke for soda ash production (part of 2A4), coke (2D2), lubricants and waxes (2G4);
- Indirect CO_2 emissions from solvents and other product use (3);
- CO_2 emissions from 'Waste Incineration' (6C, in the Netherlands reported under 1A1a);
- CO_2 emissions from the combustion of by-products produced in the Industry sector (e.g. blast furnace gas, chemical waste gas and refinery gas), reported as combustion emissions in the Energy sector under 1A1a 'Electricity and Heat Production' and 1A1c 'Manufacturing Industry and Construction'.

Key sources

The major CO_2 sources reported under 'Industrial Processes' are identified as key sources: 'Ammonia Production' (2B1). 'Other Chemical Product Manufacture' (2B5) and 'Carbon Inputs in Blast Furnaces' (2C1). It should be noted that the Netherlands accounts for most of the use of chemical waste gas and of blast furnace gas separately as combustion in the source categories 1A1a, 1A2a and 1A2c.

Overview of shares and trends in emissions

The share of total feedstock-related emissions, including the combustion of chemical waste gas and waste combustion in national total CO_2 emissions (excluding LULUCF) is about 12%. The largest part of these emissions, 64% in 1990 and about 80% in 2007, is reported under 'Fuel Combustion' (1A). About

Trends in CO_2 emitted by feedstock use of energy carriers (production and direct uses) according to the correction term in the IPCC Reference Approach for CO_2 from fossil fuel use (Units: Tg). **Table 3.12**

Fuel type	Oxidation Factors [3]	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	Trend
Liquids [1]	22.3%	5.0	5.2	6.1	6.6	6.8	7.8	7.9	8.8	8.1	9.5	4.5
Solids [2]	42.5%	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.2
Gaseous	61.2%	3.5	3.8	3.9	3.5	3.4	3.2	3.4	3.5	3.0	0.5	-3.0
Total		8.9	9.4	10.4	10.5	10.6	11.4	11.7	12.7	11.4	10.2	1.3

1) Excluding refinery gas.
2) Coal oils and tars (from coking coal), coke and other bituminous coal, and coal derived gases (e.g. coke oven gas).
3) Using country-specific carbon fuel type-averaged Oxidation Factors, calculated from all processes for which emissions are calculated in the sectoral approach, assuming an oxidised fraction – for example ammonia – or by accounting for by-product gases.

50% of these emissions are from blast furnace gas, which is largely used for power generation, and the other 50% stems from chemical waste gas, which is predominantly used in the chemical industry. The share of combustion of the by-product gases and waste incineration reported under sector 1A has increased from 3% to 10% since 1990, while the share of industrial process emissions in sector 2 has remained about 3%. The share of emissions from 'Waste Incineration' (sector 6, but allocated under 1A1a) was 3% in 1990 and about 12% in 2007. The share of emissions from industrial processes (sector 2) decreased from 32% in 1990 to about 21% in 2007 (Table 3.10). Most of the feedstock emissions reported in sector 2 are found in the iron and steel industry in blast furnaces (2C1) and ammonia production in the chemical industry (2B1). Indirect CO_2 emissions from product use (domestic solvent evaporation in sector 3) account for a small share of about 1%.

Activity data and implied emission factors

The reduction of industrial process emissions is largely due to the increasing fraction of blast furnace gas captured and used as fuel; this is particularly true for the 1990s (see Section 4.4.1). This also explains one half of the increase in the combustion emissions in the 1A sector. The environmental policy that encourages waste being incinerated rather than being used as landfill resulted in a 1 Tg increase in fossil waste emissions. As a result of the policy of reducing NMVOC emissions, the evaporative emissions from paints and other solvents has been substantially reduced. Since the indirect CO_2 emissions, however, are quite small, the associated reduction in CO_2 emissions is also very minor.

Table 3.11 shows that the increase of oil feedstocks of about 65% since 1990 originates from a variety of inputs: naphtha use decreased by one quarter, whereas the feedstock use of natural gas liquids (NGL) increased by about two third. On average, it has been calculated for the CO_2 RA that about 20% of the carbon in the oil feedstocks and about 60% of the natural gas is emitted as CO_2 (e.g. about 2-3 Tg each from naphtha, NGL and natural gas). Additional information on feedstock/non-energy uses of fuels is provided in Annex 4.

3.11.2 Methodological issues

Clearly, not all CO_2 emissions from the use of feedstock and other non-energy uses of fuels are allocated under sector 2. This is mainly because the Netherlands allocates a large part of the chemical waste gas produced in the industry sector into the energy sector. In addition, significant parts of chemical waste gas and blast furnace gas are combusted in a sector (i.e. public power generation) other than the one in which they were produced, making it logical to allocate these combustion emissions to sector 1 Energy rather than to sector 2 Industrial Processes. This allocation applies to the chemical waste gases from the production of silicon carbide, carbon black, ethylene and methanol. In addition, the Netherlands reports waste combustion emissions under fuel combustion by the Energy sector (1A1a) since most of these facilities also produce commercial energy (heat and/or electricity).

Country-specific methodologies are used for the emissions from feedstock use and feedstock product use with country-specific or default IPCC emission factors (see Annex 2). Only indirect CO_2 emissions from domestic uses of petrochemical products are reported here. A full description of the methodology is provided in the monitoring protocol 9052: CO_2, CH_4 and N_2O emissions from the stationary combustion of fossil fuels and protocol 9053: CO_2, CH_4 and N_2O process emissions from fossil fuel use. In the Sectoral Approach, the Netherlands uses the following data sources to estimate these emissions:

- Sectoral energy consumption statistics by fuel type on feedstock and other non-energy uses of fuels as part of Total sectoral energy consumption, based on information provided by the companies, including chemical waste gas produced from feedstock uses of fuels
- Plant-specific fuel consumption data to identify a particular industrial process – for example, soda ash production
- Production data for estimating the net oxidation fractions – for example, urea production
- NMVOC emissions from solvents and other products
- Emissions from waste: the amount (and composition in order to calculate the fraction and amount of fossil carbon) of waste incinerated

This approach in which all statistics on feedstock and other non-energy uses of fuels are considered as activity data for sources of CO_2 complemented with industrial production data necessary for a more accurate estimation of these emissions, each with a specific allocation to CRF categories, guarantees completeness of reporting of these sources.

Trends in CO_2 emitted by feedstock use of energy carriers by fuel type (Units: Tg). **Table 3.13**

Fuel type	Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	Trend
Liquids	Chemical waste gas in 1A + 2G4 lubr./wax	5.6	5.5	5.8	6.3	7.4	8.2	8.0	7.9	7.6	9.6	4.0
Solids [1]	2A4 soda ash + 2D2 food	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
Gaseous	2B1 ammonia + 2B5 other chemicals [2]	3.6	3.9	4.0	3.4	3.3	3.3	3.6	3.7	3.6	3.3	-0.3
Total		9.4	9.8	10.0	9.9	10.9	11.7	11.7	11.8	11.5	13.1	3.7

1) Excluding coke used a reducing agent in blast furnaces. Also excluding coal and coke-derived gases such as coke oven gas, blast furnace gas and oxygen furnace gas. Included is 2B5 electrode production (refers to a mixture of liquid [pet coke] and solids [coke] used as input).
2) Including some emissions from coke use (or combustion of phosphorus furnace gas).

Trend in CO_2 emissions from coke production (transformation losses reported in 1B1b). **Table 3.14**

Source	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 emissions (Gg)	403	517	422	412	430	464	509	457	449	444
Coke production (PJ)	78.0	82.3	60.3	62.8	60.3	61.1	62.9	60.3	61.6	66.7
CO_2 loss/coke prod. (kg/GJ)	5.2	6.3	7.0	6.6	7.1	7.6	8.1	7.6	7.3	7.3

3.11.3 Uncertainty and time-series consistency

Uncertainty

The uncertainty in the feedstock/non-energy use emissions of CO_2 in sector 2 is estimated to be about 5% and 2% for the production of soda ash (2A) and ammonia (2B1), respectively. For most other sector 2 sources the uncertainty estimate is about 10%. Emissions from chemical waste gas combustion reported in sector 1A are also less accurate – for example, about 10% – due to the variability of its carbon content; CO_2 emissions from waste incineration may have a similar uncertainty due to the limited accuracy of both the total activity data and the underlying composition and fossil carbon fraction of the various waste types. More details and assumptions on uncertainties in energy data and emission factors will be documented in Olivier et al. (2009).

Time-series consistency

The methodology used to estimate feedstock/non-energy use emissions is consistent throughout the time-series.

3.11.4 Source-specific QA/QC and verification

The main question is whether the accounting of chemical waste gas, blast furnace gas and refinery gas production in energy statistics is complete. For blast furnace gas this question is not relevant, since the not-captured gas is by definition included in the net carbon loss calculation used for the process emissions in 2C1. The unaccounted use of refinery gas by refineries is included in a similar way (in unaccounted for liquids in 1A1b). For chemical waste gas, however, the question if the accounting is complete may be an issue to be elaborated further. The area of concern is that of oxidation losses in the production of ethylene, methanol and carbon black; it does not apply to ammonia production for which a carbon storage factor is applied to calculate CO_2 emissions from the non-energy use of natural gas for this process, since there is no reporting of residual gases here.

3.11.5 Comparison with the CO_2 Reference Approach

All feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for CO_2 from fossil fuel use. The fraction of carbon not oxidized during the use of these fuels during product manufacture or other uses is subtracted from the total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidized have been calculated as three average values, one each for gas, liquid and solid fossil fuels (see Annex 4 for more details). In Table 3.12 the total CO_2 calculated as being emitted from the oxidation of these non-energy uses are presented per fuel type.

According to the Reference Approach data set, the CO_2 emissions of this group of sources increased by about 30% (or 3.7 Tg CO_2), mostly due to changes in emissions from liquid fuels (Table 3.13). This should be compared to sector 2 emissions and selected by-product emissions in sector 1A, but with the exclusion of waste incineration and blast furnace gas in 1A1a and product use in sector 3.

3.12 Fugitive emissions from fuels [1B]

3.12.1 Overview source category

This source category includes fuel-related emissions from non-combustion activities in the energy production and transformation industries:

- 1B1 'Solid Fuels' (coke manufacture)
- 1B2 'Oil and Gas' (production. gas processing, oil refining, transport, distribution).

The contribution of emissions from source category 1B to the total national greenhouse gas emissions inventory was 1.3% in 1990 and 1.2% in 2007.

Between 1990 and 2007 total greenhouse gas emissions in this category decreased from 2.8 Tg to 2.5 Tg.

3.13 Solid fuels [CRF category 1B1]

3.13.1 Category description

Fugitive emissions from this category refer mainly to CO_2 from 1B1b 'Coke Manufacture' (see Table 3.1). The Netherlands currently has only one on-site coke production facility at the iron and steel plant of Corus. A second independent coke producer in Sluiskil discontinued its activities in 1999. The fugitive emissions of CO_2 and CH_4 from both coke production sites are included here. We note that fugitive emissions from all coke production sites are included (in contrast with fuel combustion emissions from on-site coke production by the iron and steel industry. which are included in 1A2a instead of 1A1c, since these are reported in an integrated and aggregated manner).

There are no fugitive emissions from coal mining and handling activities (1B1a) in the Netherlands; these activities ceased with the closing of the last coal mine in the early 1970s.

With respect to fugitive emissions from 'Charcoal Production', the Netherlands has one large state of the art production location that serves most of the Netherlands and also occupies a large share of the market of our neighbouring countries. These emissions are presently not accounted for. Recent research showed only minor CH_4 emissions of the plant due to the abatement technology used. Because no activity data is available on a regular basis we do not foresee inclusion of this minor source in the inventory.

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocols on the website www.greenhousegases.nl. Table 3.14 shows the trend in CO_2 emissions from coke production during the period 1990–2007.

3.13.2 Methodological issues

The CO_2 emissions related to transformation losses (1B1) from *coke ovens* are based on national energy statistics of coal inputs and coke and coke oven gas produced and a carbon balance of the losses. The completeness of the accounting in the energy statistics of the coke oven gas produced is not an issue, since the not-captured gas is by definition included in the net carbon loss calculation used for the process emissions.

3.13.3 Uncertainty and time-series consistency

Uncertainty

For emissions from 'Coke Production' (included in 1B1b) the uncertainty in annual CO_2 emissions from this source category is estimated to be about 50%. This uncertainty refers to the precision with which the mass balance calculation of carbon losses in the conversion from coking coal to coke and coke oven gas can be made (for details see Olivier et al., 2009).

Time-series consistency

The methodology used to estimate emissions from solid fuel transformation is consistent throughout the time-series.

3.13.4 Source-specific QA/QC and verification

No source-specific QA/QC and verification.

3.13.5 Source-specific recalculations

There have been no source-specific recalculations in comparison to the previous submission.

3.13.6 Source-specific planned improvements

No source-specific improvements planned.

3.14 Oil and natural gas [CRF category 1B2]

3.14.1 Category description

The fugitive emissions – mostly CH_4 – from category 1B2 comprise non-fuel combustion emissions from flaring and venting, emissions from oil and gas production, emissions from gas transport (compressor stations) and gas distribution networks (pipelines for local transport) and oil refining.

The fugitive CO_2 emissions from refineries are included in the combustion emissions reported in category 1A1b. In addition, the combustion emissions from exploration and production are reported under 1A1c.

From the 2007 submission the Process emissions of CO_2 from a hydrogen plant of a refinery (about 0.9 Tg CO_2 per year) are reported in this category. Refinery data specifying these fugitive CO_2 emissions are available from 2002 onwards and re-allocated from 1A1b to 1B2a-iv for 2002 onwards.

CO_2 from gas flaring (including the venting of gas with high carbon dioxide content) and methane from gas venting/flaring are identified as key sources (see Table 3.1).

Activity data and emission factors

Gas production of which about 50% is exported, and gas transmission varies according to demand – i.e. in cold winters more gas is produced – which explains the peak in 1996. The length of the gas distribution network is still gradually expanding as new neighborhoods are being built; mostly using PVC and PE, which are also used to replace cast iron pipelines (see Table 3.44 in NIR 2005). There is very little oil production in the Netherlands. The emission factors of CO_2 and CH_4 from oil and gas production, in particular for venting and flaring, have been reduced significantly and are now about 25% of the 1990 level. This is due to the implementation of environmental measures to reduce venting and flaring by optimizing the utilization of energy purposes of produced gas that was formerly wasted.

The Process emissions of CO_2 from a hydrogen plant of a refinery are obtained from the environmental report.

For gas distribution, the IEF gradually decreases as the share of grey cast iron pipelines decreases due to gradual replacement and expansion of the network. The present share is about 6%; in 1990 this was still 11%.

3.14.2 Methodological issues
Country-specific methods comparable with the IPCC Tier 3 method are used to estimate the emission of fugitive CH_4 and CO_2 emissions from 'Oil and Gas Production and Processing' (1B2) (Grontmij. 2000). The emissions for CH_4 from gas venting and flaring are plant-specific.

The IPCC Tier 3 method for CH_4 from 'Gas Distribution' (1B2) is based on two country-specific emission factors of 610 m3 (437 Gg) methane for grey cast iron and 120 m3 (86 Gg) for other materials per 1000 km of pipeline due to leakages; the emission factors are based on seven measurements of leakage per hour on grey cast iron at one pressure level and on 18 measurements at three pressure levels for other materials (PVC, steel, nodular cast iron and PE) and subsequently aggregated to factors for the material mix in 2004. From 2004 onwards the gas distribution sector will annually record the number of leaks found per material, and any future possible trends in the emission factors will be derived from these data. Fugitive emissions of methane from refineries in category 1B2 are based on a 4% share in total VOC emissions reported in the annual environmental reports of the Dutch companies (Spakman et al., 2003), for more information see the monitoring protocols listed in Section 3.1.

3.14.3 Uncertainty and time-series consistency

Uncertainty
The uncertainty in CO_2 emissions from gas flaring and venting is estimated to be about 50%, while the uncertainty in methane emissions from oil and gas production (venting) and gas transport and distribution (leakage) is estimated to be 25% and 50% in annual emissions, respectively. The uncertainty in the emission factor of CO_2 from gas flaring and venting (1B2) is estimated at 2%. This uncertainty takes the variability in the gas composition of the smaller gas fields into account for flaring; for venting. this uncertainty accounts for the high amounts of CO_2 gas produced at a few locations, which is then processed and the CO_2 extracted and subsequently vented. For CH_4 from fossil fuel production (gas venting) and distribution, the uncertainty in the emission factors is estimated to be 25% and 50%, respectively. This uncertainty refers to the changes in reported venting emissions by the oil and gas production industry over the past years and to the limited number of measurements made of gas leakage per leak for different types of materials and pressures, on which the Tier 2 methodology for methane emissions from gas distribution is based.

Time-series consistency
A consistent methodology is used to calculate emissions throughout the whole time-series.

3.14.4 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures which are discussed in Chapter 1.

3.14.5 Source-specific recalculations
There have been no source-specific recalculations in comparison to the previous submission.

3.14.6 Source-specific planned improvements
There is no source specific improvement planned.

Industrial processes [CRF Sector 2]

4

- Major changes in sector 2 Industrial Processes compared to the National Inventory Report 2008
  Emissions: Mainly due to the reduction in N_2O emissions from the Chemical industry, the total greenhouse gas emissions in this sector decreased by 16% in 2007 compared to 2006. Emissions in the period 1990-2006 did not change compared to the previous NIR
  Key sources: 2A7 Other minerals (CO_2) and 2B5 Caprolactam production (N_4O)now non key;.
  Methodologies: There have been no methodological changes in this sector. Improved information on activity data came available in the sources " limestone use in Iron and steel production"," HFC emissions from Handling activities" and "the use of HFCs and SF_6". As a result the emissions of these sources have been changed for a number of years.

4.1 Overview of sector

Emissions of greenhouse gases in this sector include all non-energy-related emissions from industrial activities (including construction) and all emissions from the use of the F-gases HFCs, PFCs and SF_6 (i.e. including their use in other sectors). Greenhouse gas emissions from fuel combustion in industrial activities are included in the Energy sector. Fugitive emissions of greenhouse gases in the Energy sector (i.e. not relating to fuel combustion) are included in IPCC category 1B Fugitive emissions. The main categories (2A–G) in the CRF sector 2 Industrial processes are discussed in the following Sections.

The following protocols on www.greenhousegases.nl describe the methodologies applied for estimating emissions of CO_2, CH_4, N_2O and F-gases of Industrial processes in the Netherlands:

- Protocol 9053: CO_2 , CH_4 and N_2O from Process emissions: fossil fuels;
- Protocol 9064: CO_2 , CH_4 and N_2O from Process emissions and product use;
- Protocol 9065: N_2O from Nitric acid production (2B2);
- Protocol 9066: N_2O from Caprolactam production (2B5);
- Protocol 9067: PFCs from Aluminum production (2C3);
- Protocol 9068: HFC23 from HCFC22 production (2E1);
- Protocol 9069: HFCs from Handling (2E3);
- Protocol 9070: HFCs from Stationary refrigeration (2F1);
- Protocol 9071: HFCs from Mobile air conditioning (2F1);
- Protocol 9072: HFCs from Foams (2F2);
- Protocol 9073: HFCs from Aerosols (2F4);
- Protocol 9076: SF_6 from Electrical equipment (2F8);
- Protocol 9075: SF_6 and PFCs from Semiconductor manufacturing (2F7);
- Protocol 9074: SF_6 from Sound-proof windows (2F9).

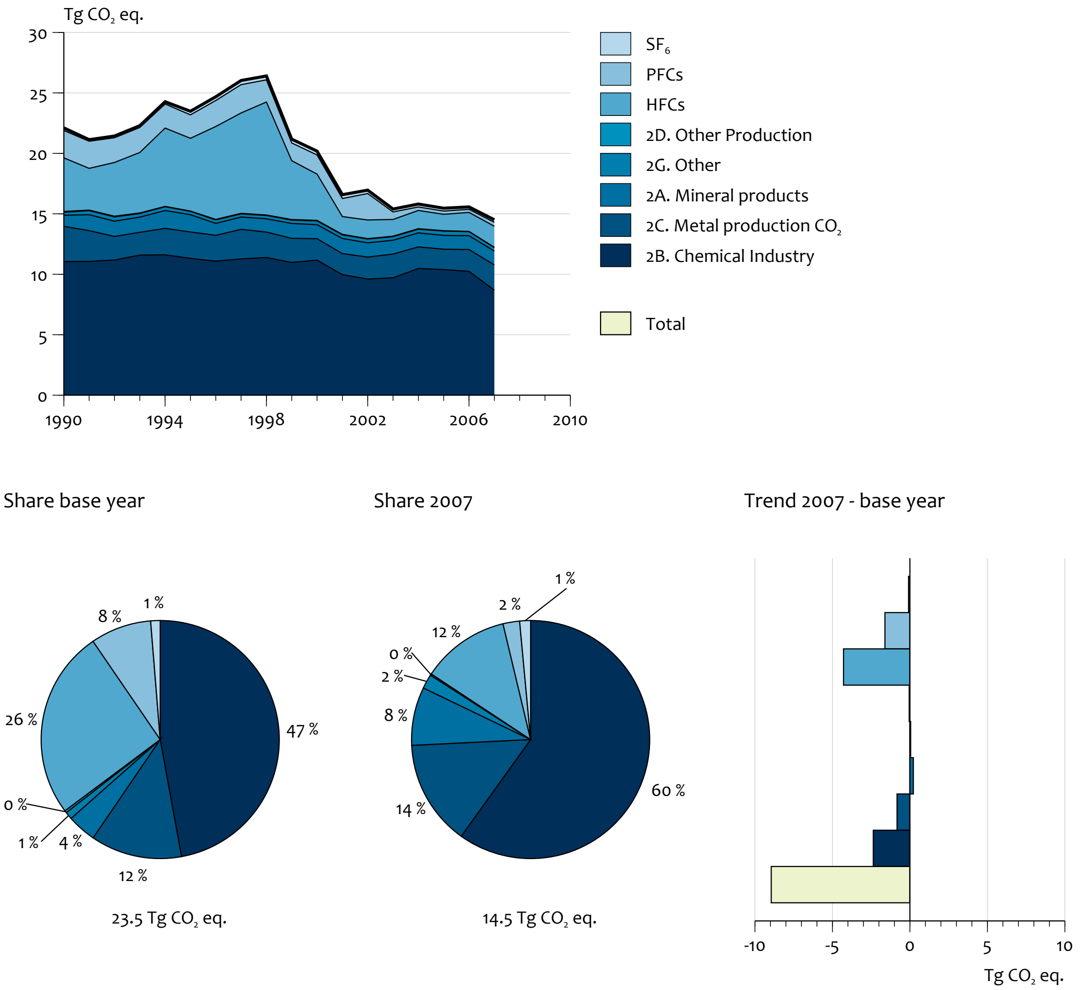
Key sources
The key sources in this sector are presented in Table 4.1. Annex 1 presents all sources identified in the Industrial processes sector in the Netherlands. CO_2 emissions from production of other minerals and N_2O emission from caprolactam production are no longer a key source. Nitric Acid production is a major key source in terms of level and trend. Other key sources are CO_2 emissions from Ammonia production, CO_2 emissions from steel and aluminum production, HFC emissions from Substitutes for ozone-depleting substances and CO_2 emission from use of non-limestone minerals.

Overview of shares and trends in emissions
Figure 4.1 and Table 4.1 show the trends in total greenhouse gas emissions from the sector Industrial processes.

In 2007 Industrial processes contributed 7% to the total national greenhouse gas emissions (without LULUCF) in comparison to 11% in the base year. The sector is a major source of N_2O emissions in the Netherlands, accounting for 31% of the national total N_2O emissions.

Category 2B Chemical industry contributes most to emissions from this sector. Compared to the base year, total CO_2 equivalent greenhouse gas emissions of the sector declined by 2.4 Tg to 8.7 Tg CO_2 eq in 2007 (–21%). CO_2 emissions from Industrial processes decreased 9% during the period 1990–2007. N_2O emissions decreased 32% in the same period. Total emissions of fluorinated gases (F-gasses) have been strongly reduced.

Figure 4.1



In 2007, total greenhouse gas emissions in the sector decreased by 7% or 1.1 Tg CO_2 eq compared to 2006. CO_2 emissions increased by 2% or 0.1 Tg CO_2. HFC and PFC emissions showed an increase of 11% or 0.2 Tg CO_2 eq and 28% or 0.1 Tg CO_2 eq , while SF_6 emissions remained at the same level as last year. The N_2O emissions decreased by -23% or 1.5 Tg CO_2 eq in 2007.

4.2 Mineral products [2A]

4.2.1 Source category description

General description of the source categories

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

- 2A1 Cement clinker production: CO_2 emissions;
- 2A3 Limestone and dolomite use: CO_2 emissions;
- 2A4 Soda ash production and use: CO_2 emissions;
- 2A7 Other (the production of glass and other production and use of minerals): CO_2 emissions.

CO_2 emissions from 2A2 Lime production, 2A5 Asphalt roofing and 2A6 Road paving with asphalt are not estimated. For more information see Annex 5.

Overview of shares and trends in emissions

Total CO_2 emissions in category 2A increased from 0.9 Tg in 1990 to 1.1 Tg in 2007(see Table 4.1). The increased emissions during the period 1990-2007 are related to the increased production levels during that period.

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocols on the website www.greenhousegases.nl.

Activity data are based on the following sources:

- Cement clinker production: the environmental reports (MJVs) of the single Dutch company are used.
- Limestone and dolomite use: environmental reports are used for emission data. Activity data on plaster production for use in desulphurising installation for power plants are based on the environmental reports of the coal-fired power plants. Data on the consumption of limestone and dolomite are based on statistical information obtained

Contribution of the main categories and key sources in CRF sector 2 Industry.

Table 4.1

Sector/category	Gas	Key[1]	Emissions in base year		Emissions in 2007		Change 2007 - 2006	Contribution to total in 2007 (%)		
		Level, Trend, Non Key	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Gg	By sector	Of total gas	Of total CO_2 eq
2 Industry	CO_2			7.8		7.2	133.6		4%	3%
	CH_4		14.1	0.3	14.4	0.3	0.3		1.8%	0.1%
	N_2O		22.9	7.1	15.5	4.8	-4.7		31%	2%
	HFC			6.0		1.7	171.2		100%	0.8%
	PFC			1.9		0.3	70.5		100%	0.2%
	SF_6			0.3		0.2	0.0		0%	0.0%
	All			23.5		14.5	-1,064.4			7%
2A. Mineral Products	CO_2			0.9		1.1	5.2	8%	0.7%	0.6%
2B. Chemical industry	CO_2			3.7		3.6	-95.2	25%	2.1%	2%
	N_2O		22.9	7.1	15.5	4.8	-4.7	34%	31%	2%
	All					8.7	-1,546.1	61%	4%	4%
2B1 Emissions from ammonia production	CO_2	L1		3.1		3.0	-55.3	21%	2%	1%
2B2 Emissions from nitric acid production	N_2O	L,T	20.4	6.3	13.9	4.3	-4.2	30%	28%	2.1%
2B5 Emissions from caprolactam production	N_2O		2.5	0.8	1.6	0.5	-0.5	3%	3%	0.2%
2B5 Other chemical product manufacture	CO_2	L		0.6		0.6	-39.9	4%	0.4%	0.3%
2C. Metal Production	CO_2			2.9		2.1	268.6	14%	1.2%	1.0%
	PFC			1.9		0.1	39.4	1%	31%	0.0%
	All			4.8		2.2	308.0	15%		1.1%
2C1 Iron and steel production (carbon inputs)	CO_2	L1,T1		2.5		1.6	251.8	11%	1.0%	0.8%
2C3 PFC emissions from aluminum production	PFC	T		1.9	0.1	0.1	39.4	0.7%	31%	0.0%
2D. Other Production	CO_2			0.1		0.0	9.3	0.2%	0.0%	0.0%
2E. Production of halocarbons and SF_6	HFC			5.8		0.3	-51.1	2%	15%	0.1%
2E1 HFC-23 emissions from HCFC-22 manufacture	HFC	T		5.8		0.2	-38.1	2%	14%	0.1%
2F. Consumption of Halocarbons and SF_6	HFC			0.2		1.5	222.3	10%	85%	0.7%
	PFC			0.0		0.2	31.1	2%	69%	0.1%
	SF_6			0.3	0.0	0.2	0.0	0%	0%	0.0%
	All			0.6		1.9	265.2	13%		0.9%
2G. Other	CO_2			0.2	0.3	0.3	-54.4	2%	0.2%	0.1%
	N_2O		0.0	0.0	0.0	0.0	0.0	0%	0%	0.0%
	All				0.3	0.3	-54.4	2%	0.1%	0.1%
Total National emissions	CO_2			159.3		172.7	146.9			
	CH_4		1,216.5	25.5		17.0	6.3			
	N_2O		65.2	20.2		15.6	-5.0			
	HFCs			6.0		1.7	171.2			
	PFCs			1.9		0.3	70.5			
	SF_6			0.3		0.2	11.8			
National Total GHG emissions (excl. CO_2 LUCF)	*All*			213.3		207.5	-1,004.5			

1) Base year for F-gases (HFCs, PFCs and SF_6) is 1995.

from Statistics Netherlands (CBS) and can be found on the website www.cbs.nl.

- Soda ash production and use: the environmental reports for data on the non-energy use of coke are used. For activity data on soda use, see following bullet Glass production;
- Glass production: activity data are based on data from Statistics Netherlands (CBS) and the trade organisation.

The following emission factors (EF) are used to estimate the CO_2 emissions from the different source categories:

- Cement clinker production: emission data obtained from the environmental report related to clinker production figures give an implied emission factor of 0.48 – 0,54 t/t clinker (IPCC Default =F 0.51 t/t clinker);
- Limestone use: EF=F 0.440 t/t (IPCC default);
- Dolomite use: EF=F 0.477 t/t (IPCC default);
- Soda ash production: EF=F 0.415 t/t (IPCC default);

- Glass production: Plant-specific EFs have been used for the years 1990 (0.13 t CO_2 /t glass), 1995 (0.15 t CO_2 /t glass) and 1997 (0.18 t CO_2 /t glass). For other years in the time series there were not enough data available for calculating plant-specific EFs. For the missing years 1991-1994 and 1996 the EFs have been estimated by interpolation. Because no further measurement data are available, the emission factor for 1998 – 2007 is kept at the same level as the EF of 1997 (0.18 t CO_2 /t glass).

4.2.2 Methodological issues
For all the source categories country-specific methodologies are used to estimate emissions of CO_2 , in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and emission factors are found in Protocols 9053 and 9064 on www.greenhousegases.nl, as indicated in Section 4.1.

- 2A1 Cement clinker production: the CO_2 emissions from this source category are based on (measured) data reported by the single company in the Netherlands that produces clinkers. CO_2 emissions from cement production included in this source category are correlated to clinker production, not cement production. About 35% of the cement clinker used for cement production is imported into the Netherlands; consequently, comparison with emission factors based on cement production data would provide the wrong impression.
- 2A3 Limestone and dolomite use: the CO_2 emissions from this source category are based on consumption figures for limestone use – derived from plaster production figures – for flue gas desulphurisation (FGD) with a wet process by coal-fired power plants and for apparent dolomite consumption (mostly used for road construction). No activity data are available to estimate other sources of limestone and dolomite use.
- 2A4 Soda ash production and use: only one company in the Netherlands is producing soda ash using the Solvay process. CO_2 emissions are calculated based on the non-energy use of coke, assuming the 100% oxidation of carbon.
- 2A7 Other: CO_2 emissions from this source category refer to Glass production. Emissions are estimated based on gross glass production data and a country-specific emission factors.

4.2.3 Uncertainties and time-series consistency

Uncertainties
The Tier 1 uncertainty analysis in Annex 7 shown in Tables A7.1 and A7.2 provides estimates of uncertainties according to IPCC source category.

Uncertainty estimates used in the Tier 1 analysis are based on the judgment of experts since no detailed information is available for assessing the uncertainties of the emissions reported by the facilities (Cement clinker production, Limestone and dolomite use and Soda ash production). The uncertainty in CO_2 emissions from cement production is estimated to be approximately 10% in annual emissions; for Limestone/dolomite use and other sources the uncertainty is estimated to be 25%, based on the relatively high uncertainty in the activity data.

Activity data for Soda ash use, Glass production and Limestone and dolomite use are assumed to be relatively uncertain (25%). The uncertainties of the IPCC default emission factors used for some processes are not assessed. However, as these are, minor sources for CO_2 this was not given any further consideration.

Time-series consistency
Consistent methodologies have been applied for all source categories. The time series involve a certain amount of extrapolation with respect to the activity data for *Soda ash use*, thereby introducing further uncertainties in the first part of the time series of this source.

4.2.4 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedure discussed in Chapter 1.

4.2.5 Source-specific recalculations
The new LULUCF data include now the use of limestone and associated CO_2 emissions in agriculture. To eliminate double counting , the emission from limestone use (as reported in 2.A.3) is now corrected. This reduced the CO_2 emission in 1990 with 44 Gg CO_2 eq and 29.7 Gg CO_2 eq in 2006.

4.2.6 Source-specific planned improvements
There are no source-specific improvements planned.

4.3 Chemical industry [2B]

4.3.1 Source category description

General description of the source categories
The national inventory of the Netherlands comprises emissions of greenhouse gases related to four source categories as belonging to this category:

- 2B1 Ammonia production: CO_2 emissions: in the Netherlands natural gas is used as feedstock for ammonia production. CO_2 is produced as a by-product during the chemical separation of hydrogen from the natural gas. During the process of ammonia (NH_3) production hydrogen and nitrogen are combined to react together to manufacture the ammonia. Only prompt process emissions from the ammonia/urea production are included in this source category. Emissions from the use of urea in domestic agricultural activities are included in category 5C (see Chapter 7).
- 2B2 Nitric acid production: N_2O emissions: the production of nitric acid (HNO_3) generates nitrous oxide (N_2O) as a by-product of the high-temperature catalytic oxidation of ammonia.
- 2B4 Carbide production: CH_4 emissions: petrol cokes are used during the production of silicon carbide; the volatile compounds in the petrol cokes form CH_4.
- 2B5 CO_2 and N_2O emissions from Other chemical product manufacture:
- Industrial gas production: hydrogen and carbon monoxide are produced mainly from natural gas used as chemical feedstock, but they can also be produced from petroleum coke and coke, during which processes CO_2 is produced.

Trend in N_2O emissions from Chemical industry processes (2B) (Units: Gg CO_2 eq). **Table 4.2**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
B2. Nitric acid production	6,330	6,278	5,898	5,341	5,032	5,060	5,617	5,659	5,597	4,305
B5. Other	766	805	936	863	897	954	923	705	662	497
Total	7,096	7,083	6,834	6,204	5,929	6,014	6,540	6,364	6,259	4,802

- Carbon electrode production: carbon electrodes are produced from petroleum coke and coke used as feedstock, during which processed CO_2 is produced.
- Activated carbon production: Norit is one of world's largest manufacturers of activated carbon, for which peat is used as carbon source and CO_2 is produced as by-product.
- Caprolactam production: N_2O emissions result from the production of caprolactam.
- Ethylene oxide production: CO_2 emissions result from the production of ethylene oxide.

Adapic acid (2B3) and calcium carbide (included in 2B4) are not produced in the Netherlands. CO_2 emissions resulting from the use of fossil fuels as feedstocks for the production of silicon carbide, carbon black, ethylene and methanol are included in the Energy sector (1A1a and 1A2c; see Sections 3.2.1. and 3.3.1. for more details).

Key sources

Ammonia production and Other chemical product manufacture are identified as key-sources for CO_2 emissions. Nitric acid production is a key-source for N_2O emissions (see Table 4.1).

Overview of shares and trends in emissions

Figure 4.2 shows the trend in CO_2 equivalent emissions from 2B 'Chemical industry' in the period 1990–2007. Table 4.1 gives an overview of shares in emissions of the main categories.

Emissions from this category contributed 5% to the total national greenhouse gas emissions (without LULUCF) in the base year and 4% in 2007. Nitric acid production is the most important source of N_2O emissions from industrial processes in the Netherlands. The contribution of N2O emissions from 2B 'Chemical industry' was 3% of the total national greenhouse gas emission inventory in the base year and 2% in 2007.

From 1990 to 2007, total greenhouse gas emissions in 2B 'Chemical industry' decreased by 21%, mainly due to reduction of N_2O emissions from the production of nitric acid. In 2007 total greenhouse gas emissions in 2B 'Chemical industry' decreased by 15% or 1,5 Tg CO_2 eq

Table 4.2 shows that N_2O emissions from the chemical industry remained rather stable between 1990 and 2000 – when there was no policy aimed at controlling these emissions.

From the 2002 submissions onwards the N_2O emission from the nitric acid production is based on measurements.

Until 2002, N_2O emissions from nitric acid production were based on default IPCC emission factors. N_2O emission measurements made in 1998 and 1999 have resulted in new emission factors. Because no measures haven been taken and the operation conditions did not change during the period 1990-1998, the emission factors obtained from the measurements have been used to recalculate the emissions for the period 1990-1998. Technical measures implemented at one of the nitric acid plants in 2001 resulted in an emission reduction of 9% compared to 2000. The decreased emission level in 2002 compared to 2001 is related to the decreased production level of nitric acid in that year. In 2003 emissions and production did not fluctuate, whereas in 2004 the increased emission level is once again related to the marked increase in production. In 2005 and 2006 the N_2O emissions of the nitric acid plants remained almost at the same level as in 2004. Technical measures implemented at all nitric acid plants in the third quarter of 2007 resulted in an emission reduction of 23% compared to 2006.

The decreased emission level of the caprolactam plant in 2005 compared to 2004 is related to the decreased production level in that year. In 2006 the N_2O emissions of the caprolactam plant remained almost at the same level as in 2005. A better process control and a lower production level resulted in an emission reduction of 25% in 2007 compared to 2006. After 2002 more accurate measurements were performed to estimate N_2O emissions from caprolactam production (2B5). Calculations of the pre-2003 emissions are based on a production-index series (real production data are confidential business information) over the period 1990-2004 and the 2003 and 2004 measurements from the company.

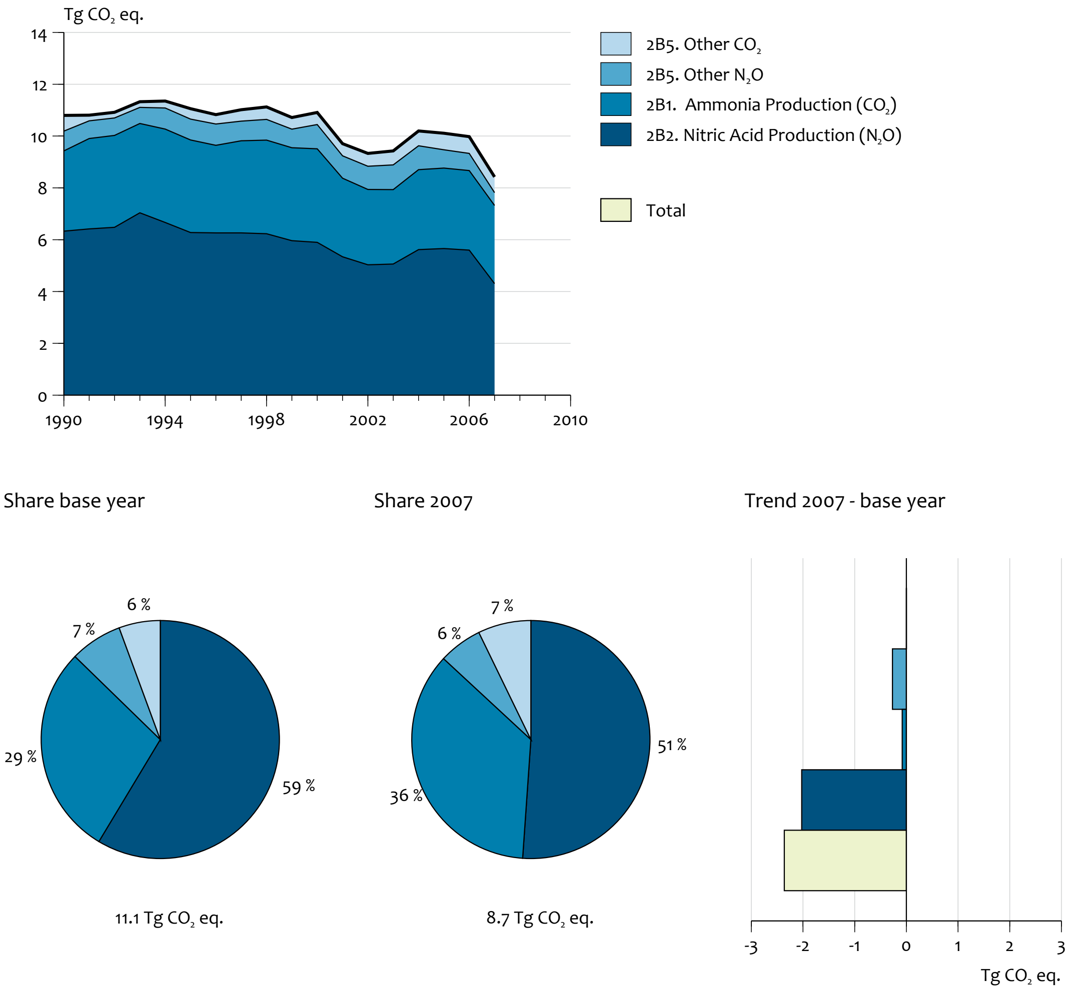
4.3.2 Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in monitoring protocols 9053, 9064, 9065 and 9066 on the website www.greenhousegases.nl.

Activity data are based on the following sources:

- Ammonia production: activity data on use of natural gas are obtained from Statistics Netherlands (CBS).
- Nitric acid production: activity data are confidential. Emissions are reported by the companies.
- Carbide production: silicon carbide production figures are derived from the Environmental Report (MJV) of the relevant company.
- Other: activity data on caprolactam production are confidential. Only emissions are reported by the companies. This year a production-index series over the period 1990-2005 were received from th company. For Ethylene oxide production only capacity data are available; therefore, a default capacity utilisation rate of 86% is used to estimate CO_2 emissions (based on Neelis et al., 2005). Activity data for estimating CO_2 emissions are based on data for feedstock use of fuels provided by Statistics Netherlands (CBS).

2B. Chemical Industry **Figure 4.2**



The emission factors used to estimate greenhouse gas emissions from the different source categories are based on:

- Ammonia production: a country-specific CO_2 emission factor is used. This emission factor is based on a 17% fraction of the carbon in the gas-feedstock not being oxidized during the ammonia manufacture and was calculated from the carbon contained in the urea produced (based on Neelis et al., 2003).
- Nitric acid production: plant-specific N_2O emission factors are used (which are confidential).
- Silicon carbide production: the IPCC default emission factor is used for CH_4.
- Other: plant-specific N_2O emission factors are used for Caprolactam production (confidential). A default emission factor of 0.45 tons CO_2 per ton of ethylene oxide production is used. Country-specific CO_2 emission factors are used to estimate the CO_2 emissions of the other source categories because no IPCC methodologies exist for these processes. For activated carbon an emission factor of 1 t/t Norit derived from the carbon losses from peat uses is used.

4.3.3 Methodological issues

For all the source categories of the chemical industry the methodologies used to estimate the greenhouse gas emissions are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). Country-specific methodologies are used for the CO_2 process emissions from the chemical industry. More detailed descriptions of the methods used and emission factors can be found in the protocols (9053, 9064, 9065 and 9066) described on the website www.greenhousegases.nl, as indicated in Section 4.1:

- 2B1 Ammonia production: a method equivalent to IPCC Tier 1b; the amount of natural gas used as feedstock and a country-specific emission factor are used to estimate CO_2 emissions. This emission factor is based on the assumption that the fraction of carbon in the gas-feedstock oxidized during the ammonia manufacture is 17%. This figure is based on reported carbon losses from urea production (Neelis et al., 2003).
- 2B2 Nitric acid production: an IPCC Tier 2 method is used to estimate N_2O emissions. The emission factors are based on plant-specific measured data which are confidential. The emissions are based on data reported by the nitric acid manufacturing industry and are included in the national Pollutant Release & Transfer Register (PRTR).

- 2B5 Other chemical products: N_2O emissions from 2B5 Other chemical industry, which mainly originate from Caprolactam production, are also based on emission data reported by the manufacturing industry (based on measurements). Emission factors and activity data are confidential.
- CO_2 emissions included in this source category are identified as a key source and based on country-specific methods and emission factors. These refer to the production of:
- Industrial gases: CO_2 emissions are estimated based on use of fuels (mainly natural gas) as chemical feedstock. An oxidation fraction of 20% is assumed, based on reported data in environmental reports from the relevant facilities.
- Carbon electrodes: CO_2 emissions are estimated based on fuel use (mainly petroleum coke and coke). A small oxidation fraction – 5% – is assumed, based on reported data in the environmental reports.
- Activated carbon: CO_2 emissions are estimated on the basis of the production data for Norit and by applying an emission factor of 1 t/t Norit. The emission factor is derived from the carbon losses from peat uses reported in the environmental reports. As peat consumption is not included in the national energy statistics, the production data since 1990 have been estimated based on an extrapolation of production level of 33 Tg reported in 2002. This is considered to be justified because this source contributes relatively little to the national inventory of greenhouse gases.
- Ethylene oxide: CO_2 emissions are estimated based on capacity data by using a default capacity utilization rate of 86% and applying an emission factor of 0.45 t/t ethylene oxide.

For the minor sources of CH_4 emissions included in this source category, IPCC Tier 1 methodologies and IPCC default emission factors are used.

4.3.4 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Annex 7 shown in Table A7.1 and A7.2 provides estimates of uncertainties according to IPCC source categories.

No accurate information is available for assessing the uncertainties of the emissions reported by the facilities (i.e. Ammonia, Nitric acid, Caprolactam production). Activity data are assumed to be relatively certain. The uncertainties in CO_2 emissions from Ammonia production and Other chemical products are estimated to be approximately 2% and 50%, respectively, in annual emissions. The uncertainty in the annual emissions of N_2O from Nitric acid production and Caprolactam production is estimated to be approximately 20%.

Time-series consistency

Consistent methodologies are used throughout the time series for the sources in this category.

4.3.5 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in Chapter 1.

Although ammonia and urea production data are considered confidential, international statistics such as UN, IFA and USGS do report production data for the Netherlands.

4.3.6 Source-specific recalculations

There have been no source-specific recalculations in comparison to the previous submission.

4.3.7 Source-specific planned improvements

There are no source-specific improvements planned.

4.4 Metal production [2C]

4.4.1 Source category description

General description of the source category

The national inventory of the Netherlands comprises emissions of greenhouse gases related to three source categories as belonging to 2C Metal production:

- 2C1 Iron and steel production: CO_2 emissions: The Netherlands has one integrated iron and steel plant (Corus, previously named 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. During the production of iron and steel, coke and coal are used as reducing agents in the blast and oxygen furnaces, resulting in the production of CO_2. In addition, CO_2 is produced as by-product from the use of limestone during the conversion from pig iron to steel. 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 CO_2 emissions are included in category 1B. The carbon content of the blast and oxygen furnace gases lost is included in source category 2C1.
- 2C3 Aluminum production: CO_2 and PFC emissions: in the Netherlands aluminum is produced at two primary aluminum smelters (Pechiney and Aldel). CO_2 is produced by the reaction of the carbon anodes with alumina and by the reaction of the anode with other sources of oxygen (especially air).
- The PFCs (CF_4 and C_2F_6) from the Aluminum industry are formed during the phenomenon known as the 'anode effect' (AE), which occurs when the concentration of aluminum oxide in the reduction cell electrolyte drops below a certain level.

2C2 Ferroalloys production and 2C4 Magnesium and aluminum foundries, both of which use SF_6 as a cover gas, do not occur in the Netherlands. No other sources of metal production (2C5) are identified in the inventory.

Implied emission factors for CF_4 and C_2F_6 from Aluminum production (Units: kg/Tg) (2C3) **Table 4.3**

Gas	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CF_4	1.02	1.10	0.53	0.52	0.83	0.19	0.04	0.03	0.03	0.04
C_2F_6	0.18	0.18	0.12	0.12	0.20	0.04	0.01	0.01	0.00	0.01

Key sources
Iron and steel production (carbon inputs) is identified as a key source for CO_2 emissions, Aluminum production as a key source for PFC emissions (see Table 4.1).

Overview of shares and trends in emissions
Table 4.1 gives an overview of shares in emissions of the main categories.

Total CO_2 emissions from 2C1 'Iron and steel production' decreased by 1.0 Tg during the period 1990–2007. In 2007 the CO_2 emissions remained at the same level as in 2006.

PFC emissions from primary 'Aluminum industry' (2C3) decreased by 1.8 Tg CO_2 eq between 1995 and 2007. Because in 2007 the number of anode-effects increased the PFC emissions increased by 63% compared to 2006.

Table 4.3 shows the trend in implied CF_4 and C_2F_6 emission factors (IEF) for aluminum production during the period 1990–2007. The largest company produces approximately two thirds of the national total production. The IEFs decreased by 97% between 1995 and 2007. In 1998 the smallest company switched from side feed to point feed; this switch was followed by the larger company in 2002/2003, thereby explaining the decreased IEF from this year onwards. The higher level of the IEF in 2002 is caused by specific process-related problems during the switching process by the larger producer.

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocols 9053, 9064 and 9067 on the website www.greenhousegases.nl.

Activity data are based on the following sources:
- Iron and steel production: data on coke production, limestone use and the carbon balance are reported by the relevant company (by means of an environmental report);
- Aluminum production: activity data and emissions are based on data reported in the environmental reports of both companies.

Emission factors used in the inventory to estimate greenhouse gas emissions are based on:
- Iron and steel production: EF (limestone use) = 0.440 tons CO_2 per ton (IPCC default); EF (blast furnace gas) = 0.21485 tons CO_2 per GJ (plant specific);
- Aluminum production: EF (consumption of anodes) = 0.00145 tons CO_2 per ton aluminum (plant specific; IPCC default = 0.0015 t/t aluminum).

EF for PFCs is plant-specific and confidential. Emissions of PFCs are obtained from the environmental reports of both companies.

4.4.2 Methodological issues
The methodologies used to estimate the greenhouse gas emissions for all source categories of metal production are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and emission factors are found in protocols 9053, 9064 and 9067 on the website www.greenhousegases.nl as indicated in Section 4.1:

Iron and steel production (2C1):
CO_2 emissions are estimated using a Tier 2 IPCC method and country-specific value for the carbon contents of the fuels. Carbon losses are calculated from coke and coal input used as reducing agents in the blast and oxygen furnaces, including other carbon sources such as limestone and the carbon contents in the iron ore (corrected for the fraction that ultimately remains in the steel produced):
- CO_2 from coke/coal inputs = amount of coke * EF_{coke} + amount of coal * EF_{coal} – (blast furnace gas + oxygen oven gas produced) * EF_{BFgas} (1a)
- CO_2 from limestone use = limestone use * ZF(limestone) * $EF_{limestone}$ (1b)
- CO_2 from ore/steel = (C-mass in ore, scrap and raw iron purchased – C-mass in raw steel)* 44/12 (1c)
- The same emission factors for blast furnace gas and oxygen furnace gas are used (see Annex 2).

Only the net carbon losses are reported in category 2C1. The carbon contained in the blast furnace gas and oxygen furnace gas produced as by-products and subsequently used as fuels for energy purposes is subtracted from the carbon balance and included in the Energy sector (1A1a and 1A2a; see Sections 3.2.2 and 3.2.3).

Data reported in the annual environmental reports (2000–2005) of Corus are used to calculate the CO_2 emissions from limestone use and iron ore/steel in the period 1990–2000. The amount of limestone stone was calculated from the average consumption in 2000–2005 per ton of crude steel produced. A similar calculation was made for the CO_2 from the carbon fractions in ore and crude steel.

Aluminum production (2C3)
A Tier 1a IPCC method (IPCC, 2001) is used to estimate CO_2 emissions from the anodes used in the primary production of aluminum, with aluminum production being as activity data. In order to calculate the IPCC default emission factor the stoichiometric ratio of carbon needed to reduce the aluminum ore to pure aluminum is based on the reaction $Al_2O_3 + 3/2C \rightarrow 2Al + 3/2\ CO_2$. This factor is corrected to include additional CO_2 produced by the reaction of the carbon anode with oxygen in the air. A country-specific emission factor of 0.00145 tons CO_2 per ton aluminum is used to estimate CO_2 emissions, and it has been verified that this value is within the range of the IPCC factor of 0.0015 and the factor

of 0.00143 calculated by the World Business Council for Sustainable Development (WBCSD) (WBCSD/WRI, 2004). PFC emissions from primary aluminum production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990–2007. Emission factors are plant-specific and are based on measured data.

4.4.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Annex 7 shown in Tables A7.1 and A7.2 provides estimates of uncertainties according to IPCC source category. The uncertainty in annual CO_2 emissions is estimated to be approximately 6% and 5% for Iron and steel production and Aluminum production respectively, whereas the uncertainty in PFC emissions from Aluminum production is estimated to be 20%. The uncertainty in the activity data is estimated at 2% for Aluminum production and 3% for Iron and steel production. The uncertainty in the emission factors for CO_2 is estimated at 5% and for PFC from Aluminum production at 20%.

Time-series consistency

The time series are based on consistent methodologies for the sources in this category. PFC emissions from the production of aluminum by the main company during the period 1990–1998 are based on the extrapolation of measured data from 1999, thereby increasing the uncertainties of the emissions during that period. It is assumed, however, that the emission factors reflect the plant specific circumstances better than the default emission factors used in previous reporting.

4.4.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures discussed in Chapter 1.

4.4.5 Source-specific recalculations

The 2005 and 2006 CO_2 emissions from the use of limestone during the conversion from pig iron to steel have been changed because improved activity data on the use of limestone came available. This reduced the CO_2 emission in 2005 and 2006 with approximately 30 Gg CO_2 eq.

4.4.6 Source-specific planned improvements

There are no source-specific improvements planned.

4.5 Food and drink production [2D]

4.5.1 Source category description

General description of the source category

This category comprises CO_2 emissions related to food and drink production in the Netherlands.

CO_2 emissions in this source category are related to the non-energy use of fuels; i.e. cokes used for the whitening of sugar. Carbon is oxidised during these processes, resulting in CO_2 emissions.

Key sources

This minor source is no key source for CO_2

Overview of shares and trends in emissions

Emissions vary at around 0.05 Tg, and are rounded off to either 0.1 or 0.0 Tg (see Table 4.1).

Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in monitoring protocol 9053 on the website www.greenhousegases.nl.

The activity data used to estimate CO_2 emissions from this source are based on national energy statistics from Statistics Netherlands (CBS) on Coke consumption. Emission factors are derived from the national default carbon content of coke (Corus, MJVs 2000-2007).

4.5.2 Methodological issues

The methodology used to estimate the greenhouse gas emissions complies with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the method used and the emission factors can be found in protocol 9053 on the website www.greenhousegases.nl, as indicated in Section 4.1.

CO_2 emissions are calculated based on the non-energy use of fuels by the food and drink industry as recorded in the national energy statistics, multiplied by an emission factor. The emission factor is based on the national default carbon contents of the fuels (see Annex 2), under the assumption that the carbon is fully oxidised to CO_2.

4.5.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Annex 7 shown in Tables A7.1 and A7.2 provides estimates of the uncertainties according to the IPCC source category. The uncertainty in the emissions of this category is estimated to be 5%. Since this is a very small emission source, the uncertainties in this category are not analysed further in more detail. Therefore, in the uncertainty analysuis and the keysource analysis the emissions in this category (2D) are combined with the emissions in category 2G (Other industrial emissions), see Section 4.8.

Time-series consistency

The time series is based on consistent methodologies and activity data for this source.

4.5.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures which are discussed in Chapter 1.

4.5.5 Source-specific recalculations

There have been no source-specific recalculations in comparison to the previous submission.

4.5.6 Source-specific planned improvements

There are no source-specific improvements planned.

4.6 Production of halocarbons and SF_6 [2E]

4.6.1 Source category description

General description of the source categories

The national inventory of the Netherlands comprises emissions of greenhouse gases related to the following source categories in this category:

- 2E1 Production of HCFC-22: HFC-23 emissions. HCFC-22 is produced at one plant in the Netherlands. Trifluormethane (HFC-23) is generated as a by-product during the production of chlorodifluormethane (HCFC-22) and emitted through the plant condenser vent.
- 2E3 Handling activities: emissions of HFCs. There is one company in the Netherlands that repackage HFCs from large units (e.g. containers) into smaller units (e.g. Cylinders) and in addition trading with HFCs. Besides this company there are a lot of companies in the Netherlands which are importing small units with HFCs and sell them in the trading areas.

Key sources

Production of HCFC-22 (HFC-23 emission) is a key source; see Table 4.1.

Overview of shares and trends in emissions

Table 4.1 gives an overview of shares in emissions of the main categories.

Total HFC emissions in category 2E were 5.8 Tg in 1995 and 0.3 Tg CO_2 eq in 2007, with HFC-23 emissions from HCFC-22 production being the major source of HFC emissions. HFC emissions from handling contributed 9% to the total HFC emissions from this category in 2007.

Table 4.4 shows the trend in HFC emissions from the categories HCFC-22 production and HFCs from handling activities for the period 1990–2007. The emissions of HFC-23 increased about by 35% in the period 1995–1998 due to the increased production of HCFC-22. However, in the period 1998–2000, the emissions of HFC-23 decreased by 69% following the the installation of a thermal afterburner at the plant.

The operation time of the thermal afterburner (84% in 2000; 95% in 2001; 93.6% in 2002) is the primary factor explaining the variation in emission levels during the period 2000–2002. The decreased emission (33%) in 2003 can be explained mostly by a lower production level. Despite a higher production level the emissions have remained stable because the operation time of the thermal afterburner increased from 92% in 2003 to 96% in 2004. The decreased emission (45%) in 2005 can be explained by a higher operation time of the thermal afterburner (97.1% in 2005) and a lower production level. Because of a higher production level the emission increased (40%) in 2006. The decreased emission (16%) in 2007 can be explained by a higher operation time of the thermal afterburner.

The significant emission fluctuations during the period 1992-2007 can be explained by the large variety in handling activities, which depends on the demand of the costumers.

Activity data and (implied) Emission factors

The activity data used to estimate emissions of F-gases from this category are based on confidential information provided by the manufacturers:

- Production of HCFC-22: production figures on HCFC-22 are confidential.
- Handling activities (HFCs): activity data used to estimate HFC emissions are confidential.
- (Implied) emission factors used to estimate the emissions of F-gases from this category are based on the following:
- Production of HCFC-22: Destruction factor of the thermal afterburner used is 99.99%.
- Handling activities (HFCs): the emission factors used are plant-specific and confidential, and they are based on 1999 measurement data. More detailed information on the activity data and emission factors can be found in the monitoring protocols 9068 and 9069 on the website www.greenhousegases.nl.

4.6.2 Methodological issues

The methodologies used to estimate the greenhouse gas emissions included in this category are in compliance with the ipcc *Good Practice Guidance* (IPCC, 2001). More detailed descriptions of the method used and emission factors can be found in the protocols 9068 and 9069 on website www.greenhousegases.nl as indicated in Section 4.1:

- *Production of HCFC-22* (2E1): this source category is identified as a key source for HFC-23 emissions. In order to comply with the ipcc *Good Practice Guidance* (IPCC, 2001), an IPCC Tier 2 method is used to estimate the emissions of this source category. HFC-23 emissions are calculated using both (measured) data obtained on the mass flow of HFC-23 produced in the process and a destruction factor to estimate the reduction of this HFC-23 flow by the afterburner.
- *Handling activities* (HFCs) (2E3): Tier 1 country-specific methodologies are used to estimate the *handling* emissions of HFCs. The estimations are based on emissions data reported by the manufacturing and sales companies.

4.6.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Annex 7 shown in *Tables A7.1* and *A7.2* provides estimates of uncertainties according to the IPCC source category.

The uncertainty in HFC emissions from *HCFC-22 production* is estimated to be about 15%, while the uncertainty in HFC emissions from *Handling activities* is estimated to be about 20%. The uncertainty in the activity data for these sources is estimated at 10%. The uncertainties in the emission factors for HFC-23 from *HCFC-22 production* and for HFC from *Handling activities* are estimated at 15% and 20%, respectively. These figures are all based on the judgments of experts.

Table 4.4

Trends in HFC-23 by-product emissions from the Production of HCFC-22 and HFC emissions from Handling activities (2E) (Units: Gg CO_2 eq)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
2E1. HFC-23	4,432	5,759	2,421	450	685	415	354	196	281	243
2E3. HFCs	NO	12	418	192	98	41	100	39	37	24
HFC Total	4,432	5,771	2,838	641	783	455	454	235	318	267

Table 4.5

Effects of correction of changes of HFCs from HFC emissions from Handling activities (2E) 1990-2006 (Units: Gg CO_2 eq)

		1990	1995	2000	2001	2002	2003	2004	2005	2006
2E3. HFCs	NIR2008	NO	12	418	192	98	41	100	39	48
	NIR2009	NO	12	418	192	98	41	100	39	37
	Difference	NO	0	0	0	0	0	0	0	-11

Time-series consistency
The time series is based on consistent methodologies and activity data for this source.

4.6.4 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures discussed in Chapter 1.

4.6.5 Source specific recalculations
More detailed information on activity data came available in the source HFC emissions from Handling activities. These changes were corrected in this submission (see table 4.5).

4.6.6 Source-specific planned improvements
There are no source-specific improvements planned for this category.

4.7 Consumption of halocarbons and SF_6 [2F]

4.7.1 Source category description

General description of the source categories
Halocarbons and SF_6 are released from the use of these compounds in different products. The national inventory of the Netherlands comprises emissions of greenhouse gases related to the following source category: 2F(1-4): Emissions from substitutes for Ozone- depleting substances.

The inventory comprises the following sources in this source category:
- 2F1-Stationary refrigeration: HFC emissions;
- 2F1-iMobile air conditioning: HFC emissions;
- 2F2-Foams: HFC emissions; (included in 2F9);
- 2F4-Aerosols: HFC emissions; (included in 2F9);
- 2F9-Other: HFC emissions;
- 2F6: PFC emissions from PFC use.

The inventory comprises the following source in this source category:
- 2F-Semiconductor manufacture (including SF_6 emissions);
- 2F9: SF_6 emissions from SF_6 use.

The inventory comprises the following sources in this source category:
- 2F8-Electrical equipment (included in 2F9);
- Sound-proof windows (included in 2F9);
- Electron microscopes (included in 2F9);
- 2F9-Other: SF_6 emissions.

Due to reasons pertaining to confidentiality, only the sum of the HFC emissions of 2F2 and 2F4 (included in 2F9) and of the SF_6 emissions of all source categories and 2F7 Semiconductor manufacturing is reported (included in 2F9).

Key sources
Emissions from Substitutes for ozone-depleting substances [2F(1-4)] are identified as a key source (see Table 4.1).

Overview of shares and trends in emissions
The contribution of F-gas emissions from category 2F to the total national inventory of F-gas emissions was 7% in the base year 1995 and 84% in 2007. This corresponds to 1.9 Tg CO_2 eq and accounts for 0.9% in the national total greenhouse gas emissions in 2007.

The level of HFC emissions increased by a factor of 6 in 2007 compared to 1995, mainly due to increased HFC consumption as a substitute for (H)CFC use. PFC emissions increased due to a higher production level of the Semiconductor manufacturing industry. And actual emissions of SF_6 remained rather stable during the period 1995–2007. Table 4.6 gives an overview of the trends in actual emissions from 1990-2007.

Activity data and (implied) emission factors
Detailed information on the activity data and emission factors can be found in the monitoring protocols 9070–9076 on the website www.greenhousegases.nl.

The activity data used to estimate the emissions of the F-gases are based on the following sources:
- Consumption data of HFCs (Stationary refrigeration, Mobile airconditioning, Aerosols and Foams) are obtained from annual reports from PriceWaterhouseCoopers.
- Activity data on the use of SF_6 and PFCs in Semiconductor manufacturing, Electrical equipment, Sound-proof windows and electron microscopes are obtained from different individual companies (confidential information).

Actual emission trends specified per compound from the use of HFCs, PFCs and SF_6 (2F) (Units: Gg CO_2 eq) Table 4.6

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
HFC-134a	NO	48	162	210	259	309	365	421	480	543
HFC-143a	NO	6	106	143	179	217	256	291	328	441
HFC-125	NO	7	87	119	149	180	212	241	271	304
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other HFCs [1)]	NO	188	636	357	172	216	219	170	169	183
HFC Total	NO	249	991	828	759	922	1,052	1,123	1,248	1,471
PFC use [2)]	18	37	193	163	120	180	179	178	194	226
SF6 use	217	301	319	323	283	243	246	238	202	214
Total HFC/PFC/SF6	236	587	1,503	1,314	1,161	1,345	1,477	1,539	1,645	1,910

Emission factors used to estimate the emissions of the F-gases in this category are based on the following sources:

- Stationary refrigeration, Mobile air conditioning, Aerosols and Foams: annual leak rates are based on surveys (De Baedts et al., 2001) and the literature.
- Semiconductor manufacturing: emission factors which are confidential information of the company.
- Sound-proof windows: EF used for production is 33% (IPCC default); EF (leak rate) used during the lifetime of the windows is 2% per year (IPCC default).
- Electron microscopes: emission factors are confidential information of the company.

4.7.2 Methodological issues

To comply with the IPCC Good Practice Guidance (IPCC, 2001) IPCC Tier 2 methods are used to estimate emissions of the sub-sources Stationary refrigeration, Mobile air conditioning, Aerosols, Foams and Semiconductor manufacturing.

The country-specific methods for the sources Sound-proof windows and Electron microscopes are equivalent to IPCC Tier 2 methods and from 2007 onwards the country-specific method for the source Electrical equipment is equivalent to the IPCC Tier 3 method.

More detailed descriptions of the methods used and emission factors can be found in the protocols 9070-9076 on the website www.greenhousegases.nl as indicated in Section 4.1.

4.7.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Annex 7 shown in Tables A7.1 and A7.2 provides estimates of the uncertainties according to the IPCC source category. The uncertainty in HFC emissions from HFC consumption is estimated to be 50%, and the uncertainties in PFC and SF_6 emissions are estimated to be about 25% and 55%, respectively. The uncertainty in the activity data for the HFC sources and for SF_6 and PFC sources is estimated at 10%, 50% and 5%, respectively. For the emission factors the uncertainties are estimated 50%, 25% and 25%. All of these figures are based on the judgments of experts.

Time series consistency

Consistent methodologies have been used to estimate emissions from these sources.

4.7.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures discussed Chapter 1.

4.7.5 Source-specific recalculations

More detailed information on activity data came available relating to the use of HFCs and SF_6. These changes were corrected in this submission (see table 4.7).

4.7.6 Source-specific planned improvements

There are no source-specific improvements planned for this category.

4.8 Other industrial processes [2G]

4.8.1 Source category description

The national inventory of the Netherlands comprises emissions of greenhouse gases related to four source categories in this category:

- Fireworks and candles: CO_2 , CH_4 and N_2O emissions;
- Degassing of drinking water: CH_4 emissions;
- Miscellaneous non-energy fossil fuel product uses, (e.g. lubricants and waxes); CO_2 emissions (about 0.2 Tg).

The CO_2 emissions reported in category 2G stem from the direct use of specific fuels for non-energy purposes, which results in partially or fully 'oxidation during use (ODU) of the carbon contained in the products – for example, lubricants, waxes and other fuels. With the exception of lubricants and waxes no other fuels are included in this category. Oxidation for mineral turpentine is included in Sector 3 (Indirect CO_2 of solvent use).

Key sources

There are no key sources identified from these source category (see also Annex 1).

Overview of shares and trends in emissions

The small CO_2 and CH_4 emissions remained rather constant between 1990 and 2007.

Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 9053 and 9064 on the website www.greenhousegases.nl.

Effects of changes in the use of HFCs and SF_6 (2E) 1990-2006 (Units: Gg CO_2 eq) **Table 4.7**

		1990	1995	2000	2001	2002	2003	2004	2005	2006
HFCs	NIR2008	NO	249	985	828	759	923	1,056	1,118	1,231
	NIR2009	NO	249	991	828	759	922	1,052	1,123	1,248
	Difference	NO	0	6	0	0	-1	-4	5	17
SF_6	NIR2008	217	301	320	325	286	248	251	250	215
	NIR2009	217	301	319	323	283	243	246	238	202
	Difference	0	0	-1	-2	-3	-5	-5	-12	-13

The activity data used are based on the following sources:

- Fireworks: data on annual sales from branch organization;
- Candles: average use of 3.3 kg per person (www.bolsius.com);
- Production of drinking water: Volume Statistics Netherlands (CBS);
- Fuel use: energy statistics obtained from Statistics Netherlands (CBS).

Emission factors:

- Fireworks: CO_2 : 43 t/t; CH_4: 0.78 t /t; N_2O: 1.96 t/t (Brouwer et al., 1995);
- Candles: 2.3 t/t (EPA, 2001);
- Production of drinking water: 2.47 tons CH_4 /106 m³;
- Use of fuels for production of lubricants: ODU factor of 50% (the IPCC default);
- Production of waxes: ODU factor of 100% (the IPCC default).

CO_2, CH_4 and N_2O emissions from Fireworks and candles showed a 'peak' in 1999 because of the millennium celebrations.

4.8.2 Methodological issues

The methodologies used to estimate the greenhouse gas emissions included in this category are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and the emission factors can be found in protocols 9053 and 9064 on the website www.greenhousegases.nl as indicated in Section 4.1:

- Fireworks and candles: country-specific methods and emission factors are used to estimate emissions of CO_2, CH_4 and N_2O.
- Degassing of drinking water: a country-specific methodology and emission factor are used to estimate the CH_4 emissions, which is the main source of CH_4 emissions in this category.
- Miscellaneous non-energy fossil fuel product uses (i.e. lubricants and waxes): a Tier 1 method is used to estimate emissions from lubricants and waxes using IPCC default emission factors.

4.8.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Annex 7 shown in Tables A7.1 and A7.2 provides estimates of the uncertainties according to IPCC source category.

The uncertainty in CO_2 emissions of other industrial processes is estimated to be approximately 20% (5% in activity data and 20% in emission factor), mainly due to the uncertainty in the ODU factor for lubricants. The uncertainty in the activity data – i.e. domestic consumption of these fuel types – is generally very large, since it is based on production-, import- and export figures.

The uncertainty in CH_4 emissions of other industrial processes is estimated to be 50% (10% in activity data and 50% in emission factor). The uncertainty in N_2O emissions of other industrial processes is estimated at 70% (50% in activity data and 50% in emission factor). All figures are based on the judgments of experts, since no specific monitoring data or literature is available for the current situation in the Netherlands.

Time-series consistency

Consistent methodologies and activity data have been used to estimate the emissions of these sources.

4.8.4 Source specific QA/QC and verification

The source categories are covered by the general QA/QC procedures discussed in Chapter 1.

4.8.5 Source specific recalculations

There have been no source-specific recalculations in comparison to the previous submission.

4.8.6 Source specific planned improvements

There are no source-specific improvements

Solvent and other product use [CRF Sector 3]

5

■ Major changes in Sector 3 Solvent and other product use compared to the National Inventory Report 2008
Emissions: No changes.
Key sources: There are no changes in the key source allocation in this sector.
Methodologies: There have been no methodological changes in this sector.

5.1 Overview of sector

Emissions of the greenhouse gases in this sector include indirect emissions of CO_2 related to the release of non-methane volatile organic compounds (NMVOCs) with the use of solvents and a wide range of other fossil carbon-containing products (e.g. paints, cosmetics, cleaning agents etc). In addition, this sector includes N_2O emissions originating from the use of N_2O as anesthesia and as a propelling agent in aerosol cans (for example cans with cream).

The Netherlands has three source categories in this IPPC Common Reporting Format (CRF) sector:
- 3A, 3B, 3D "Solvents and other product use": indirect CO_2 emissions (related to NMVOC)
- 3D "Anaesthesia": N_2O emissions
- 3D "Aerosol cans": N_2O emissions

This sector comprises non-combustion emissions from households, services, hospitals, research- and governmental institutions etc, except for the following emissions:
- use of F-gases (HFCs, PFCs and SF_6). In accordance with the IPCC Reporting Guidelines F-gases are included in 2 "Industrial processes" (thus including their use in the Residential and Commercial sectors)
- direct non-energy use of mineral oil products (e.g. lubricants, waxes, etc.). These are included in 2G "Industrial processes"
- several minor sources of CH_4 emissions from non-industrial, non-combustion sources. These are included in Sector 2G because the CRF does not permit methane emissions to be included in Sector 3

The following emission from the manufacturing industry is also included in this Chapter:
- Indirect CO_2 emissions from 3C "Chemical products, manufacture and processing". These NMVOC emissions are included in categories 3A, 3B and 3D.

The following protocol, which can be accessed on www.greenhousegases.nl, describes the methodologies applied for estimating CO_2 and N_2O emissions from solvent and product use in the Netherlands:
- Protocol 9064: CO_2, N_2O en CH_4 from Other process emissions and product use.

Overview of shares and trends in emissions

Table 5.1 shows the contribution of the emissions from Solvent and other product use in the Netherlands. Total greenhouse gas emissions from Solvent and product use in the Netherlands were 0.5 Tg CO_2 eq in 1990 and 0.2 Tg CO_2 eq in 2007.

Total emissions of the sector declined by 60% between 1990 and 2003, and remained quite stable between 2003 and 2007. CO_2 emissions from the sector decreased by 57% between 1990 and 2007, mainly due to decreasing indirect emissions from paints that resulted from the implementation of an emission reduction program for NMVOC (KWS2000). N_2O emissions fell by 85% from 1990 to 2007 due to the better dosing of anesthesia in hospitals and other medical institutions. Total N_2O emissions have declined since 1990 by 67%.

Key sources

Solvent and product use is a minor source of greenhouse gas emissions. No key sources are included in this sector. The most relevant sources are indirect CO_2 emissions from paint application and the use of N_2O for anesthesia in hospitals.

Contribution of main categories and key sources in CRF Sector 3 **Table 5.1**

Sector/category	Gas	Key	Emissions base-year (1990)		Emissions 2006		Emissions 2007		Change 2007 - 2006		Contribution to total in 2007 (in %)	
		Level, Trend	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Gg CO_2 eq	By sector	Of total gas	Of total CO_2 eq
3 Solvent and other product use	CO_2			0.3		0.1		0.1	-6.5		0.1%	0.1%
	N_2O		0.73	0.2	0.26	0.1	0.25	0.1	0.0		0.5%	0.0%
	All			0.5		0.2		0.2	-11.0			0.1%
3A. Paint application	CO_2			0.2		0.1		0.1	-2.5	29%	0.0%	0.0%
3A. Paint application	All		212	0.2	62	0.1	59	0.1	-2.5	29%		0.0%
3B. Degreasing and drycleaning	CO_2			0.0		0.0		0.0	0.0	1%	0.0%	0.0%
3B. Degreasing and drycleaning	All		4.24	0.0		0.0		0.0	0.0	1%		0.0%
3D. Other	CO_2			0.1		0.1		0.1	-4.0	33%	0.0%	0.0%
	N_2O		0.73	0.2	0.26	0.1	0.25	0.1	0.0	37%	0.5%	0.0%
3D1 Anaesthesia	N_2O		0.65	0.2	0.12	0.0	0.10	0.0	0.0	15%	0.2%	0.0%
3D3 Aerosol cans	N_2O		0.08	0.0	0.14	0.0	0.15	0.0	0.0	23%	0.3%	0.0%
3D. Other	All			0.3		0.2		0.1	-8.5			0.1%
Total National Emissions	CO_2			159.3		172.5		172.7	146.9		100.0%	
	N_2O		65	20.2	55	17.1	50	15.6	-5.0		100.0%	
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.3		208.5		207.5	-1002.9			

5.2 Indirect CO_2 emissions from Solvents and product use (Paint application [3A], Degreasing and dry cleaning [3B] and Other [3D])

5.2.1 Source category description

CRF source category 3A Paint application includes the indirect CO2 emissions of solvents from the use of both industrial paints and paints used by households and professional painters. Indirect emissions from the use of solvents in degreasing and dry cleaning are included in CRF source category 3B, which covers the use of solvents for cleaning and degreasing of surfaces, the dry cleaning of clothing and textiles and the degreasing of leather.

Activity data and implied emission factors

Detailed information on the activity data and emission factors of NMVOC estimates can be found in the monitoring protocol 9064 on the website www.greenhousegases.nl.

Activity data: consumption data and NMVOC contents of products are mainly provided by trade associations, such as the VVVF (for paints), the NCV (for cosmetics) and the NVZ (for detergents). The consumption of almost all solvent-containing products has increased since 1990. However, the general NMVOC content of products (especially paints) has decreased over the past years, resulting in a steady decline in NMVOC emissions since 1990 (see Section 2.4). Due to the increased sales of hairspray and deodorant sprays NMVOC emissions have increased slightly in recent years. It is assumed that the NMVOC contents of these products have remained stable.

Emission factors: it is assumed that all NMVOC in the product is emitted (with the exception of some cleaning products and methylated spirit, which are partly broken down in sewerage treatment plants after use, or used as fuel in BBQs or fondue sets (methylated spirit). The carbon contents of NMVOC emissions are documented in the monitoring protocol on the website www.greenhousegases.nl.

5.2.2 Methodological issues

Country-specific carbon contents of the NMVOC emissions from 3A Paint application, 3B Degreasing and dry cleaning and 3D Other product use are used to calculate indirect CO_2 emissions. The monitoring of NMVOC emissions from these sources differs per source. Most of the emissions are reported by branch organizations (e.g paints, detergents and cosmetics). The indirect CO_2 emissions from NMVOCs are calculated from the average carbon contents of the NMVOC in the solvents.

Category	3A	3B	3D
C-content NMVOC	0.72	0.16	0.69

The carbon content of degreasing and dry cleaning is very low due to the high share of chlorinated solvents (mainly tetrachloroethylene used for dry cleaning). The emissions are then calculated as follows:

CO_2 (in Gg) = Σ{NMVOC emission in subcategory i (in Gg) x C-fraction subcategory i} x 44/12

The fraction of organic carbon (i.e. of natural origin) in the NMVOC emissions is assumed to be negligible.

5.2.3 Uncertainty and time-series consistency

Uncertainty

These sources do not affect the overall total or the trend in the direct greenhouse gas emissions. The uncertainty of indirect CO_2 emissions is not explicitly estimated for this category, but it is expected to be fairly low. Based on the expert judgment, the uncertainty in the NMVOC emissions is estimated to be 25%, and the uncertainty in the carbon contents is estimated at 10%, resulting in an uncertainty in CO_2 emissions of approximately 27%.

Time-series consistency

Consistent methodologies have been applied for all source categories. As the quality of the activity data used was not uniform throughout the complete time-series, some extrapolation of the data was required. It is assumed that the accuracy of the estimates is not significantly affected by this. The emission estimates for the source categories are expected to be reasonably good.

5.2.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures discussed in Chapter 1.

5.2.5 Source-specific recalculations

There were no recalculations in this sector.

5.2.6 Source-specific planned improvements

There are no source-specific improvements planned.

5.3 Miscellaneous N_2O emissions from solvents and product use (use of N_2O for anesthesia [3D1] and N_2O from aerosol cans [3D3])

5.3.1 Source category description

Emissions of N_2O from the use of Anesthesia are included in 3D1. Emissions of N_2O from aerosol cans are included in category 3D3.

Activity data and implied emission factors

Detailed information on the activity data and emission factors of N_2O estimates are found in the monitoring protocol 9064 on the website www.greenhousegases.nl.

Activity data: The major hospital supplier of N_2O for anesthetic use reports the consumption data of anesthetic gas in the Netherlands annually. The Dutch Association of Aerosol Producers (NAV) reports data on the annual sales of N_2O-containing spray cans. Missing years are then extrapolated on the basis of this data. Domestic sales of cream in aerosol cans have shown a strong increase since 2000. The increase is reflected in the increased emissions in these years.

Emission factors: The emission factor used for N_2O in anesthesia is 1 kg/kg. Sales and consumption of N_2O for anesthesia are assumed to be equal each year. The emission factor for N_2O from aerosol cans is estimated to be 7.6 g/can (based on data provided by one producer), and is assumed to be constant over time.

5.3.2 Methodological issues

Country-specific methodologies are used for the N_2O sources in Sector 3. Since the emissions in this source category are from non-key sources for N_2O, the present methodology complies with the IPCC Good Practice Guidance (IPCC, 2001). A full description of the methodology is provided in the monitoring protocol 9064 on the website www.greenhousegases.nl.

5.3.3 Uncertainties and time-series consistency

Uncertainties

These sources do not affect the overall total or trend in the Dutch emissions of direct greenhouse gases. For N_2O emissions, the uncertainty is estimated to be approximately 50% based on the judgment of experts. Uncertainty in the activity data of N_2O use is estimated to be 50% and that of the emission factor to be 0% (all gas is released)

Time-series consistency

Consistent methodologies have been applied for all source categories. The quality of the activity data needed was not uniform for the complete time-series, requiring some extrapolation of data. This is not expected to introduce significant problems with the accuracy of the estimates. The estimates for the source categories are expected to be quite good.

5.3.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures discussed in Chapter 1.

5.3.5 Source-specific recalculations

There are no source-specific recalculations compared to the previous submission.

5.3.6 Source-specific planned improvements

There are no source-specific improvements planned.

6

Agriculture [CRF Sector 4]

■ Major changes in the Agriculture sector with respect to the National Inventory Report (NIR) 2008

Emissions: Compared to 2006, nitrous oxide (N_2O) emissions decrease as a result of a decreasing fertilizer use and methane (CH_4) emissions increase as a result of higher feed intake and a shift towards more stable manure instead of pasture manure.

Key sources: The key source classification in this NIR has not been changed compared to the previous NIR.

Methodologies: As a result of error correction feed intake of female cattle has been recalculated. Changes in feed intake also result in changes in N-excretion. These recalculations effect CH_4 from enteric fermentation, N_2O from manure management and direct and indirect N_2O emissions. New statistical data also showed a change towards more manure storage below the stable resulting in a recalculation of the CH_4 emission factor for manure storage. Sinds 2006 Dutch figures for manure production and N-excretion from horses and ponies are available. CH_4 emissions from manure and N_2O emissions have been recalculated. Due to these recalculations nitrous oxide (N_2O) and methane (CH_4) emissions for the years 1990-2006 are higher.

6.1 Overview of the sector

Emissions of greenhouse gases from "Agriculture" include all anthropogenic emissions from the agricultural sector, with the exception of emissions from fuel combustion and carbon dioxide (CO_2) emissions by land use in agriculture. These emissions are included in 1A4c "Agriculture/forestry/fisheries" (Section 3.6) and in 5 "Land Use, Land Use Change and Forestry" (LULUCF Sections 7.3 and 7.4).

In the Netherlands three source categories occur in the agricultural sector:
- 4A "Enteric fermentation": CH_4 emissions
- 4B "Manure management": CH_4 and N_2O emissions
- 4D "Agricultural soils": N_2O emissions

The other Intergovernmental Panel on Climate Change (IPCC) categories – 4C "Rice cultivation", 4E "Prescribed burning of savannas", 4F "Field burning of agricultural residues" and 4G "Other" – do not occur in the Netherlands. Open fires/burning in the field is prohibited by law and therefore negligible in practice.

Manure management (4B) includes all emissions from confined animal waste management systems (AWMS). CH_4 emissions from animal manure produced in the meadow during grazing are included in category 4B "Manure management"; N_2O emissions from this source are included in category 4D2 "Animal production". These different approaches are in accordance with IPCC Guidelines (IPCC, 2001).

Methane emissions from agricultural soils are regarded as natural, non-anthropogenic emissions and therefore are not included.

The following protocols on www.greenhousegases.nl describe the methodologies, activity data and emission factors applied in estimating N_2O and CH_4 emissions in the agricultural sector in the Netherlands:
- Protocol 9077: CH_4 from Enteric fermentation (4A)
- Protocol 9078: N_2O from Manure management (4B)
- Protocol 9079: CH_4 from Manure management (4B)
- Protocol 9080: N_2O from Agricultural soils: indirect emissions (4D)
- Protocol 9081: N_2O from Agricultural soils: direct emissions and emissions from animal production (4D).

Overview of shares and trends in emissions

Table 6.1 shows the contribution of the agricultural source categories to the total national greenhouse gas inventory. This table also presents the key sources identified in the agricultural sector as specified by trend or level, or both.

Contribution of main categories and key sources in Agriculture — Table 6.1

Sector/category	Gas	Key	Emissions base-year		Emissions 2006		Emissions 2007		Change 07 – 06	Contribution to total in 2007 (%)		
		Level, Trend, Non-key	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Tg CO_2 eq	By sector	Of total gas	Of total CO_2 eq
4. Agriculture	CH_4		501.7	10.5	421.1	8.8	426.3	9.0	0.1	49	53	4.3
	N_2O		38.5	11.9	30.8	9.6	30.6	9.5	-0.1	51	61	4.6
	All			22.5		18.4		18.4	0.0	100		8.9
4A. Enteric fermentation	CH_4		359.0	7.5	297.5	6.2	300.8	6.3	0.1	34	37	3.0
4A1 Cattle	CH_4	L,T	323.0	6.8	265.6	5.6	268.4	5.6	0.1	31	33	2.7
4A Swine	CH_4	NK	20.9	0.4	17.0	0.4	17.5	0.4	0.0	2	2	0.2
4A2-13 Other animals	CH_4	NK	15.2	0.3	14.9	0.3	15.0	0.3	0.0	2	2	0.2
4B. Manure management	CH_4		142.6	3.0	123.6	2.6	125.4	2.6	0.0	14	16	1.3
	N_2O	L	2.6	0.8	2.7	0.8	2.8	0.9	0.0	5	6	0.4
	All			3.8		3.4		3.5	0.1	19		1.7
4B1 Cattle	CH_4	L	74.8	1.6	69.2	1.5	70.0	1.5	0.0	8	9	0.7
4B8 Swine	CH_4	L	54.3	1.1	50.6	1.1	51.5	1.1	0.0	6	6	0.5
4B9 Poultry	CH_4	T2	13.0	0.3	3.1	0.1	3.1	0.1	0.0	0	0	0.0
4B2-7, 10-13 Other animals	CH_4	NK	0.5	0.0	0.7	0.0	0.7	0.0	0.0	0	0	0.0
4D Agriculture soils	N_2O		35.9	11.1	28.1	8.7	27.7	8.6	-0.1	47	55	4.1
4D1 Direct soil emissions	N_2O	L,T2	15.1	4.7	15.6	4.9	15.7	4.9	0.0	26	31	2.3
4D2 Animal production on agricultural soils	N_2O	L,T	4.7	1.4	2.1	0.7	1.9	0.6	-0.1	3	4	0.3
4D3 Indirect emissions	N_2O	L,T	16.0	5.0	10.3	3.2	10.1	3.1	-0.1	17	20	1.5
Total national emissions (excl. Int bunkers)	CH_4		1,216.5	25.5	801.5	16.8	807.9	17.0	0.1		100	
	N_2O		65.2	20.2	55.3	17.1	50.3	15.6	-1.5		100	
National Total GHG emissions (excl. CO_2 LUCF)	All			213.3		208.5		207.5	1.0			100

1) Key sources: L = Level; T= Trend; 1 = Tier 1; 2 = Tier 2.

Numbers of animals in 1990–2007 (1000 heads) (CBS, 2009). — Table 6.2

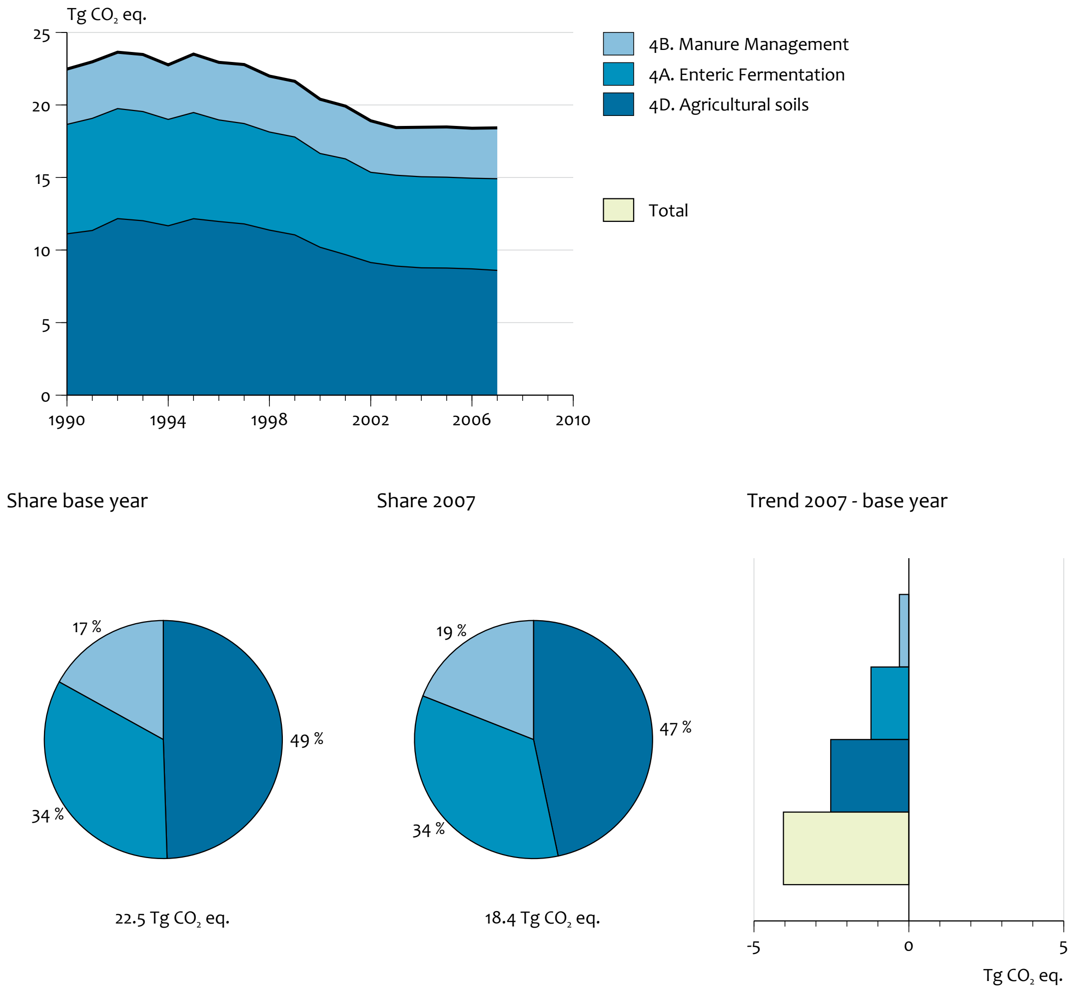
Animal type	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Cattle	4,926	4,654	4,070	4,028	3,858	3,759	3,767	3,799	3,745	3,763
- Mature dairy cattle	1,878	1,708	1,504	1,539	1,486	1,478	1,471	1,433	1,420	1,413
- Mature non-dairy cattle	120	146	163	161	151	144	145	152	143	144
- Young cattle	2,929	2,800	2,403	2,328	2,222	2,137	2,151	2,214	2,182	2,206
Sheep	1,702	1,674	1,308	1,289	1,186	1,185	1,236	1,363	1,376	1,369
Goats	61	76	179	219	255	274	282	292	310	324
Horses	70	100	118	120	121	126	129	133	128	134
*Pigs (*1000)*	13.9	14.4	13.1	13.0	11.6	11.2	11.2	11.3	11.4	11.7
*Poultry (*1000)*	95.6	92.2	107.2	103.4	104.0	74.9	88.5	95.9	94.7	96.0

In 2007, CO_2 equivalent emissions from Sector 4 "Agriculture" contributed 8.8% to the total national emissions (without LULUCF) compared to 11% in 1990. In 2007, emissions of CH_4 and N_2O from agricultural sources accounted for 53% and 61% of the national total CH_4 and N_2O emissions. Category 4A "Enteric fermentation" is the main source of CH_4 emissions and category 4D "Agricultural soils" is the largest source of N_2O emissions included in this sector.

Total greenhouse gas emissions from Agriculture decreased by approximately 18% between 1990 and 2007, from 22.5 Tg CO_2 eq in 1990 to 18.4 Tg CO_2 eq in 2007 (see also Figure 6.1). This decrease was largely the result of decreasing numbers of livestock, a decreased application of animal manure and a decreased use of synthetic fertilizers.

Compared to 2006, nitrous oxide (N_2O) emissions decrease as a result of a decreasing fertilizer use and methane (CH_4)

4. Agriculture Figure 6.1



emissions increase as a result of higher feed intake and a shift towards more stable manure instead of pasture manure.

Overview of trends in activity data

Livestock numbers are the primary activity data used in the calculation of CH_4 and N_2O.

Activity data for the livestock numbers are based on the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl, in Annex 12 Table A12.1 and in background documents (e.g. Van der Hoek and Van Schijndel, 2006). Table 6.2 presents an overview.

For cattle, three categories are distinguished:

- mature dairy cattle: adult cows for milk production
- mature non-dairy cattle: adult cows for meat production
- young cattle: mix of different age categories for breeding and meat production, including adult male cattle

Between 1990 and 2007 (dairy) cattle, pig and sheep numbers decreased by 25, 16 and 20% respectively, while poultry numbers remained fairly constant. Goat numbers increased by a factor 5 and horse numbers nearly doubled in this period.

For mature dairy cattle, the decrease in numbers can be explained as follows. Milk production per cow increased between 1990 and 2007, a development which has resulted from both genetic changes in cattle (due to breeding programmes) and the change in amount and composition of feed intake. Total milk production in the Netherlands is determined mainly by European Union (EU) policy on milk quotas, which remained unchanged in the same period. In order to comply with the unchanged milk quota, animal numbers of mature dairy cattle had to decrease to counteract the effect of increased milk production per cow. Between 1990 and 2007 the numbers of young (dairy) cattle follow the same trends as those of adult female cattle – namely, a decrease.

The Netherlands' manure and fertilizer policy also influences livestock numbers. Young cattle, pig and poultry numbers in particular decreased as a result of the introduction of measures such as buying up part of the pig and poultry production rights (ceilings for total phosphate production by animals) by the government and lowering the maximum nutrient application standards for manure and fertilizer. For pigs and young cattle the decreasing trend of the past has levelled off in the last couple of years. For pigs, it changed into a slight increase since 2004.

The increased number of swine in 1997 was a direct result of the outbreak of classical swine fever in that year (Annex 12 Table A12.1). In areas where this disease was present, the transportation of pigs, sows and piglets to the slaughter-house was not allowed, so the animals had to remain on the pig farms for a relatively long period (accumulation of pigs).

An increase in the number of poultry is observed between 1990 and 2002. In 2003, however, poultry numbers decreased by almost 30% as a direct result of the avian flu outbreak. In the years after 2003 the poultry population recovered to a large extent and reached a level of 8% below the 2002 level in 2007.

The increase in the number of goats might be explained as an effect of the milk quota for cattle. As result of the milk quota for cattle and the market development for goat milk products, farmers tend to change their management towards goats.

6.2 Enteric fermentation [4A]

6.2.1 Source category description

Methane emissions from Enteric fermentation are produced as a by-product of the digestive process in which carbohydrates are broken down by micro-organisms into simple molecules under anaerobic conditions. Both ruminant (e.g. cattle, sheep and goats) and non-ruminant animals (e.g. pigs and horses) produce CH_4, although ruminants produce more CH_4 per unit of feed intake than non-ruminants due tot differences in the type of digestive system. Ruminant livestock have an expansive chamber, the rumen, at the forepart of their digestive tract that supports intensive microbial fermentation of their diet. This yields several nutritional advantages including the capacity to digest cellulose in their diet but it is also accompanied by much higher methane production.

Buffalo and camels do not occur in the Netherlands. The emissions from llamas, mules and donkeys are negligible and, therefore, not taken up in the inventory. Enteric fermentation methane emission from poultry is not estimated due to the lack of data on CH_4 emission factors for this animal category. The IPCC Guidelines do not provide a default emission factor for this animal category. Other countries do not estimate emissions from poultry either.

Overview of shares and trends in emissions

In 2007 Enteric fermentation accounted for 34% of the total greenhouse gas emissions from the agricultural sector (see Table 6.1). In the Netherlands, CH_4 emissions from Enteric fermentation are related particularly to cattle; this source contributed substantially (89%) to the CH_4 emissions from Enteric fermentation in 2007. The second largest CH_4 emission source in category 4A is swine (6%). 4A Other consists of sheep, goats and horses, and accounts for 5%.

CH_4 emissions from Enteric fermentation decreased from 7.5 Tg CO_2 eq to 6.3 Tg (–16%) between 1990 and 2007, with CH_4 emissions from Enteric fermentation by cattle and swine decreasing by 17% and 16%, respectively. From 2006 to 2007 a rather small increase indicates a stabilisation.

Activity data and emission factors

Trends in CH_4 emission from Enteric fermentation are explained by a change in animal numbers, a change in emission factor or both.

Detailed information on data sources for activity data and emission factors can be found in the following monitoring protocol:

- Protocol 9077: CH_4 from Enteric fermentation (4A)

All relevant documents concerning methodology, emission factors and activity data are published on the website www.greenhousegases.nl. Table 6.2 (in Section 6.1) presents an overview of animal numbers. In Annex 12 Tables A12.1, A12.2 and A12.3 show the activity data for all animal categories and emission factors for cattle.

For swine, sheep, goat and horses, default IPCC emission factors are used (1.5, 8, 5 and 18 kg/animal respectively). Changes in emissions for these animal categories are therefore explained entirely by changes in animal numbers. To a great extent this is also the case for cattle, but the total decrease in CH_4 emission is lower due to an increase in implied emission factor (IEF).

Trends in cattle IEF

The emission factors for three cattle categories are calculated annually. For mature dairy cattle a Tier 3 approach is used to calculate the CH_4 production per cow per year on the basis of data on the share of feed components and their chemical nutrient composition (Smink et al, 2005). For mature non-dairy and young cattle a Tier 2 approach is used to calculate the CH_4 production per animal per year on the basis of data on the feed intake (Smink, 2005). For more information on the methods and the recalculation used see Section 6.2.2 and Section 6.2.5.

Table 6.3 shows the implied emission factors (IEFs) of the different cattle categories reported. The implied emission factor for young cattle is an average of several subcategories (Annex 12 Table A12.3)

For both mature dairy and mature non-dairy cattle, IEFs increased primarily as a result of an increase in total feed intake during the period 1990–2007. For dairy cattle, a change in the feed nutrient composition partly counteracted this effect (see Section 6.2.2). For young cattle the IEF decrease between 1990 and 2007 can be explained by a decrease in the average total feed intake due to a shift towards a higher share of meat calves in the young cattle population (Annex 12 Table A12.1).

Comparison of cattle IEF with IPCC defaults

Table 6.4 shows that the mature dairy cattle IEF follows the increasing trend in milk production. Compared to the default IPCC IEF of 118 kg CH_4 per cow for mature dairy cattle (at a milk production rate of 6700 kg per cow per year), the IEF used in the Netherlands is slightly lower.

Implied emission factors for methane emissions from enteric fermentation specified according to CRF animal category (Units: kg CH_4/animal.year) **Table 6.3**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Mature dairy cattle	110	116	120	122	120	123	125	126	128	129
Mature non-dairy cattle	65	66	67	67	67	72	72	71	71	73
Young cattle	37	37	35	35	35	35	35	34	34	34

Table 6.4 Milk production (kg milk/cow.year) and IEF (kg CH_4/animal.year) for mature dairy cattle **Table 6.4**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Milk production	6050	6580	7416	7336	7187	7494	7415	7568	7744	7879
IEF for methane	110	116	120	122	120	123	125	126	128	129

In 1997 for instance, a milk production of about 6800 kg per year per cow led to an emission factor of 117 kg per animal per year, less than 1% lower than the default of 118 kg per animal per year. An explanation of the difference can be found in the data on feed intake and nutrient composition used to calculate the methane emission factor for mature dairy cattle (Bannink, 2009). With increasing milk production per cow a decrease in the amount of CH_4 emission per litre milk (from 0.018 to 0.016 kg CH_4 per litre milk) can be seen.

For mature non-dairy cattle, the higher IEF (compared to the IPCC default value of 48 per animal) for the Netherlands can be explained by the higher total feed intake per adult non-dairy cow. The relatively large share of meat calves for white and rose veal production explains the relatively low IEF for young cattle compared to the IPCC default value (Annex 12 Table A12.1).

6.2.2 Methodological issues

A detailed description of the method, data sources and emission factors is found in the protocol on www.greenhouse-gases.nl, as indicated in Section 6.2.1. A specified description with more details on data and data sources on cattle used in calculations until 2006 can be found in Smink et al. (2005) and Smink (2005). In 2009 a recalculation has been carried out for the whole timeseries (see Section 6.2.5, Bannink, 2009 and Van Bruggen 2009).

Emissions from enteric fermentation are calculated from activity data on animal numbers and the appropriate emission factors.

CH_4 emission = ΣEF_i (kg CH_4/animal$_i$) * [number of animals (per livestock category$_i$)]

Cattle

The emission factors for cattle are calculated annually for several subcategories of dairy and non-dairy cattle. For mature dairy cattle a country-specific method based on a Tier 3 methodology is followed; for the other cattle categories, the calculation is based on a country-specific Tier 2 methodology.

The feed intake of cattle, which is estimated from the energy requirement calculation used in the Netherlands, is the most important parameter in the calculation of the CH_4 emission factor for cattle. For instance for dairy cows the energy requirement expressed as feed unit of lactation (or VEM in Dutch) is calculated on the basis of total milk production and feed composition. For young cattle the energy requirement is calculated on the basis of total weight gain and feed composition.

The intake of grass silage, maize silage, wet by-products, concentrates and grass products is estimated from national statistics found at www.cbs.nl (Van Bruggen, 2009). More information on the Netherlands VEM system is presented in Smink et al. (2005) and Bannink (2009).

Mature dairy cattle

The CH_4 emission from enteric fermentation by mature dairy cattle is calculated by a Tier 3 approach using dynamic modelling (Smink et al., 2005). The model of Mills et al. (2001) is employed, including updates (Bannink et al., 2005a,b). This model is based on the rumen model of Dijkstra et al. (1992). It has been developed for dairy cows and is therefore not suitable for all cattle categories. The model calculates the gross energy (GE) intake and CH_4 emission factor (per cow per year) on the basis of data on the share of feed components (grass silage, maize silage, wet by-products and concentrates) and their chemical nutrient composition (sugars, NDF, et cetera). Data on the share of feed components are found at www.cbs.nl (Van Bruggen, 2009). Data on the chemical nutrient composition are provided by Blgg (a leading laboratory in the Dutch agricultural and horticultural sector with sampling, analytical and advisory activities; www.blgg.com). Data used between 1990 and 2004 are presented in Smink et al. (2005), while data for 2005, 2006 and 2007 are published by Bannink (2007, 2008 and 2009) (via www.prtr.nl).

Young cattle and non-dairy cattle

The methane emission factor (EF) for enteric fermentation by non-dairy and young cattle is calculated by multiplying the gross energy (GE) intake by a methane conversion factor (Smink, 2005). Changes in GE intake are based on changes in the total feed intake and on the share of feed components. Data on the amounts of feed components, expressed as dry matter (DM) intake are found at www.cbs.nl (Van Bruggen, 2009) and in Annex 12 Table A12.2 Gross Energy intake can be found.

The equation for calculating the EF (in kg per animal per year) is:

$EF = (MCF * GE * 365\ day/yr) / 55.65\ MJ/kg\ CH_4$

Where:
EF: Emission factor (kg $CH_4.y^{-1}$ per animal)
MCF: Methane conversion factor; fraction of the gross energy of feed intake converted to CH_4
GE: Gross energy intake ($MJ.d^{-1}$ per animal)

Where:
- GE intake = Dry Matter (DM) intake × 18.45 MJ/kg DM (IPCC, 2001)
- MCF = 0.04 for white veal calves and 0.06 for the other categories of young cattle and mature non-dairy cattle (IPCC, 2001)

Other livestock
Emission factors for the source categories swine, sheep, horses and goats are based on default IPCC Tier 1 EF(IPCC, 1997).

The share in total CH_4 enteric fermentation emissions by these other livestock categories (sheep, goats, horses and swine) is less than 10% of the total CH_4 enteric fermentation emissions. According to IPCC good practice guidance (GPG), no Tier 2 method is needed if the share of a source category is less than 25–30% of the total emission by a key source category.

As already mentioned in Section 6.2.1, enteric fermentation emission from poultry is not estimated due to a lack of data on CH_4 emission factors for this animal category.

6.2.3 Uncertainty and time-series consistency

Uncertainty
The Tier 1 uncertainty analysis shown in Annex 7 provides estimates of uncertainty according to IPCC source categories. The uncertainty of CH_4 emissions from enteric fermentation from cattle sources is based on the judgements of experts and is estimated to be about 15% in annual emissions, using a 5% uncertainty for animal numbers (Olivier et al.,2009) and 15% for the emission factor (Bannink, 2009). The uncertainty in the emission factor for swine and other animals is estimated to be 50% and 30%, respectively (Olivier et al.,2009)

Time-series consistency
A consistent methodology is used throughout the time-series see also Section 6.2.5. Emissions are calculated from animal population data and emission factors. The animal population data are collected in an annual census and published by Statistics Netherlands over a long period of time (several decennia). Emission factors are either constant (default IPCC) or are calculated from feed intake data collected by an annual survey published by Statistics Netherlands.

The compilers of the activity data strive to use consistent methods to produce the activity data. The time-series consistency of these activity data is therefore very good due to the continuity in the data provided.

6.2.4 Source-specific QA/QC and verification
This source category is covered by the general QA/QC procedures discussed in Chapter 1.

6.2.5 Source-specific recalculations
The methane emission factors for enteric fermentation from cattle have been recalculated due to error corrections.

In 2005 an error was made while a new method to calculate the feed intake by cattle was applied. Feed intake is the basis for the calculation of the methane emission factor from enteric fermentation by cattle. The new method was only applied to the years starting from 2003 and no recalculations were carried out for the period 1990-2002. Furthermore, in 2003 energy requirement by dairy cattle was raised by 10%. Recent insights showed that energy requirement by dairy cattle should have been raised by 12%. Also, the feed intake data for all cattle categories were not corrected for feed losses. All these errors have been corrected in the NIR2009. Recalculation of the feed intake leads to an increase in CH_4 emission factor for dairy cattle of 1 to 3% for the years 1990-2002. This is the net effect of change in feed intake with 4 to 8% and a decrease by feed losses of 3-5%. After 2002 the recalculation leads to a decrease in emission factor for dairy cattle with 1-2%. This is the net effect of change in feed intake with 1 to 2% and a decrease by feed losses of 3%. For mature non-dairy cattle and young cattle the emission factor decreases over the whole time period due to the feed losses. Due to these error corrections CH_4 emissions increased by about 0.01 Tg in 1990 and decrease about 0.06 Tg CO_2 eq. in 2006.

Please note that the above changes also effect the emissions in 4B and 4D (Sections 6.3.6 and 6.4.6).

6.2.6 Source-specific planned improvements
There are no source-specific improvements planned.

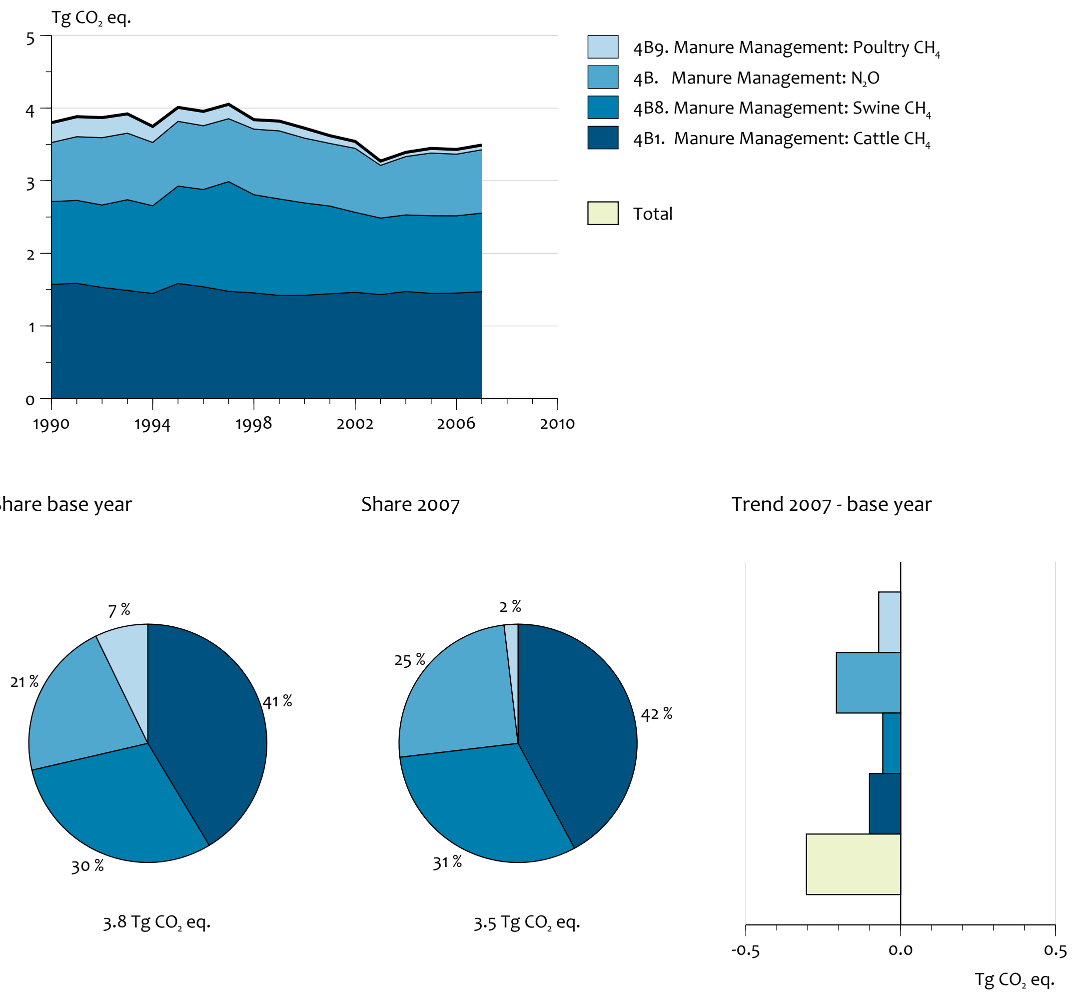
6.3 Manure management [4B]

6.3.1 Source category description
Both CH_4 and N_2O are emitted during the handling or storage of manure from cattle, pigs, poultry, sheep, goats and horses. These emissions are related to the quantity and the composition of the manure, and to the manure management system types and conditions. For instance, in comparison to anaerobic conditions, aerobic conditions in the manure management system will in general increase N_2O emissions and decrease CH_4 emissions. Furthermore, longer storage times and higher temperatures will increase CH_4 emissions compared to shorter storage times and lower temperatures.

Buffalo and camels do not occur in the Netherlands, and the numbers of llamas, mules and donkeys are negligible and therefore not estimated. Three animal manure management systems are distinguished for emission estimates of both CH_4 and N_2O: liquid and solid manure management systems and manure produced in the meadow while grazing.

4B. Manure Management

Figure 6.2



In accordance with IPCC Guidelines, N_2O emissions from manure produced in the meadow during grazing are not taken into account in the source category Manure management (see Section 6.1), but are included in the source category Agricultural soils (Section 6.4).

Overview of shares and trends in emissions

In 2007, Manure management accounted for 19% (CH_4 and N_2O) of the total greenhouse gas emissions from the agricultural sector (Table 6.1 and Figure 6.2). In the Netherlands CH_4 emissions from Manure management are particularly related to cattle and swine manure management, which, in 2007, contributed 8% and 6%, respectively, to the total greenhouse gas emissions in the agricultural sector. Poultry is a minor key source for CH_4 emissions by manure management. Furthermore, N_2O emissions from Manure management contribute 5% of the total greenhouse gas emissions from the agricultural sector.

Between 1990 and 2007, the emission of CH_4 from Manure management decreased by 12%. Emissions from cattle, swine and poultry decreased by 6%, 5% and 76%, respectively during this period. From 2006 to 2007, the emission of CH_4 from Manure management slightly increased.

The emissions of N_2O from Manure management increased 7% between 1990 and 2007, from 2.6 to 2.8 Gg N_2O in 2007 (Table 6.1). The relatively large decrease in N_2O emissions from solid manure in 2003 is a direct result of the decrease in poultry animal manure. This decrease was due to the reduction in the number of poultry animals that followed the avian flu epidemic. In 2004 and 2005, N_2O emissions increased once again following the recovery of poultry animal numbers, while in 2006 the emission decreased as a consequence of lower poultry numbers. In 2007 emissions increased as a result of increasing animal population and higher N excretion per animal.

Activity data and (implied) emission factors

Detailed information on data sources (for activity data and emission factors) can be found in the following monitoring protocols:

- Protocol 9079: CH_4 from Manure management (4B)
- Protocol 9078: N_2O from Manure management (4B)

More details and specific data (activity data and emission factors), including data sources (emission factors), are documented in the background documents. All relevant documents concerning methodology, emission factors and

CH_4 implied emission factor (kg/head.year) for Manure management as specified by animal category, 1990–2007 **Table 6.5**

Animal type	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Cattle										
- mature dairy cattle	27.70	30.48	33.15	33.15	35.70	35.70	37.50	37.50	38.34	39.19
- mature non-dairy cattle	3.23	3.53	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
- young cattle	7.66	8.18	7.18	7.35	7.25	6.98	6.76	6.63	6.52	6.42
Swine 1)	3.90	4.43	4.61	4.41	4.50	4.49	4.50	4.50	4.46	4.42
Swine excl piglets	6.22	7.25	7.55	7.54	7.59	7.57	7.57	7.54	7.55	7.55
- fattening pigs	4.97	6.08	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32
- breeding swine	11.39	12.24	12.86	12.95	13.03	12.87	12.98	12.96	12.99	12.95
Poultry	0.14	0.10	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.03

1) IEF is calculated on basis of total pig numbers, including piglets numbers. However, manure production by piglets is accounted for in manure production by adult breeding swine.

activity data are published on the website www.greenhousegases.nl.

Activity data on animal numbers can be found on the website www.cbs.nl, in Annex 12 Table A12.1 and in a background document (Van der Hoek and Van Schijndel, 2006). Emission factor data can be found in Annex 12 Tables A12.3 til A12.8.

The decreased CH_4 emission from swine between 1990 and 2007 results from the decrease in their animal numbers and manure production (Annex 12 Tables A12.1 and A12.8). The decrease is less than expected due to an increase in emission factor (Annex 12 Table A12.7). For mature non-dairy cattle and young cattle emissions decrease only as a result of animal numbers and a small increase in emission factor. For mature dairy cattle the decrease in CH_4 emission is much lower than the decrease in animal numbers as a consequence of a higher IEF. For poultry the large decrease in CH_4 emissions between 1990 and 2007 can only be explained by the lower IEF.

The slightly increased N_2O emission from Manure management between 1990 and 2007 is explained by an increase in IEF partly counteracted by a decrease in nitrogen (N) excretion in the stable.

CH_4 implied emission factors (IEF) for Manure management

The CH_4 IEF for Manure management is calculated annually for all animal categories. A Tier 2 approach is used based on country-specific data on animal manure production per animal, on manure characteristics (like organic matter (OM) content) and (liquid) manure storage conditions. For more information on methodology see Section 6.3.2 and 6.3.5.

Table 6.5 shows the implied emission factors for Manure management specified by the animal categories that contribute the most to CH_4 emissions.

Trends in IEF

Mature dairy cattle

The IEF for manure management of mature dairy cattle increased between 1990 and 2007 because the increased milk production in that period (Table 6.4) is accompanied by an increase in manure production per cow and an increase in organic matter content of cattle manure. Both developments result from a higher feed intake. A third development concerns the shift in the proportion of the two dairy manure management systems (liquid manure in the stable and manure production in the meadow). The share of the amount of liquid stable manure increased between 1990 and 2007, while simultaneously the amount of manure produced in the meadow during grazing was reduced (Annex 12 Table A12.8). This is a consequence of the increase of the average time period dairy cattle are kept indoors. An explanation for this is the increase in average farm size. Since large herds are difficult to collect for indoor milking, farmers tend to keep the animals indoors for 365 days per year. With stable manure showing a 17-fold higher emission factor for CH_4 emissions, the shift to more stable manure increased the methane emission per cow (Annex 12 Table A12.7, Van der Hoek and Van Schijndel, 2006).

In short, between 1990 and 2007 the increase in the manure production per cow and in the organic matter content of dairy cattle manure combined with a shift to more stable manure resulted in an increased methane emission from manure management per cow.

Poultry

For poultry, the substantial decrease in CH_4 IEF of manure management between 1990 and 2007 mainly explains the CH_4 emission decrease. This decrease can be explained by a shift in the proportion of the two poultry manure management systems (solid and liquid manure) in this period. The proportion of the solid manure system increased between 1990 and 2007 from approximately 40% to more than 90%. So the liquid manure system was almost completely replaced by the solid manure system. Compared to the liquid manure system the CH_4 emission factor for the solid system is about 15-fold lower (Annex 12 Table A12.7). Overall, this leads to a substantially decreased IEF, which in combination with only a slight increase in animal numbers fully explains the decrease in CH_4 emissions (Van der Hoek and Van Schijndel, 2006).

Swine

Compared to 1990, the IEF of swine manure management (based on total swine numbers, including piglets), increased in 1993 and 1997 as a result of storage of manure under higher temperature (increased storage capacity below stable) and in 1995 due to increasing Volatile Solids (Annex 12 Table A12.4 and A12.5). There are inter-annual changes not explained by this. These changes can be explained by looking at emissions

N_2O implied emission factor for Manure management and total N-excretion per animal manure management system, 1990-2007 (Units: mln kg/year and kg N_2O/kg manure) **Table 6.6**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total N-excretion	506.5	508.1	424.5	414.4	399.7	380.0	375.7	385.8	382.5	398.6
-liquid system	445.2	438.5	350.5	343.0	325.5	321.5	308.5	312.8	310.8	325.4
-solid storage	61.3	69.6	74.1	71.4	74.2	58.5	67.1	72.9	71.6	73.2
N_2O emission manure management	2.63	2.88	2.88	2.78	2.84	2.34	2.60	2.78	2.74	2.81
N_2O IEF manure management	0.0052	0.0057	0.0068	0.0067	0.0071	0.0062	0.0069	0.0072	0.0072	0.0071

factors of underlying swine categories. The calculation method for CH_4 emissions from swine manure management is based on the liquid manure production of adult breeding swine (in which manure production by piglets is accounted for). So presenting the underlying IEFs gives a better understanding of the inter-annual changes.

For fattening pigs the 22% increase in IEF between 1990 and 1995 is explained by a 4% decrease in manure production per animal combined with a 20% increase in organic matter (OM) content of the manure and a higher storage temperature. The 4% decrease in IEF between 1997 and 1998 is explained by a 4% decrease in manure production per animal. These changes are mainly the result of a change in liquid manure handling. In order to decrease the liquid manure volume, the mixing of rinsing water with manure was prevented as much as possible. As a consequence not only manure volume decre-ased, but also an increase in the OM concentration of manure occurred. A higher OM content results in a higher emission factor.

The inter-annual changes in the IEF for breeding pigs' manure are explained by inter-annual changes in the relative amount of different swine categories. Furthermore, between 1999 and 2000 a 2% decrease in manure production per animal occurred as a result of a change in liquid manure handling. In order to decrease the manure volume, the mixing of rinsing water with manure was prevented as much as possible.

For more details see Van der Hoek and Van Schijndel (2006) and Annex 12 Tables A12.4 til A12.8.

Comparison with IPCC default methane emission factor

The emission factors per animal type used by the Netherlands cannot be compared directly to the IPCC default values because of the assumptions on the share of the different animal manure management systems underlying the IPCC defaults.

Also the values of one of the underlying parameters per manure management system, Volatile Solids (VS), also called Organic Matter (OM) per animal type are not directly comparable. The Netherlands approach differs from the IPCC method in that the Netherlands uses the VS content of the manure (kg VS per kg manure) instead of volatile solids VS produced per animal per day (kg per head per day) in the IPCC calculation equations. By multiplying the VS per kg manure with the manure production per year, the annual VS production in manure in the Netherlands can be compared with the annual VS production underlying the default IPCC emission factors. More details are presented in Annex 12. Compared to the IPCC default MCF values, the Netherlands MCF values for liquid manure systems of swine (1990-1996) and cattle are slightly lower because part of the manure is stored under cooler conditions. For solid manure systems, the Netherlands uses a MCF of 1.5% for all animal categories (see Section 6.3.2); for manure production in the meadow, it uses the IPCC default MCF value.

N_2O implied emission factor (IEF) for Manure management

Emission factors for N_2O from Manure management represent the IPCC default values for liquid and solid management systems, 0.001 and 0.02 respectively.

Table 6.6 shows that the N_2O emissions from Manure management increased between 1990 and 2007, mainly as a consequence of the increase in the N_2O IEF. The explanation is that between 1990 and 2007 the proportion of the total solid manure N excretion increased. Compared to the liquid manure system, the N_2O emission factor for the solid system is 20-times higher, which explains the increased overall IEF. This increased IEF was not fully counteracted by the decrease in de total N excretion and therefore has led to a small increase in N_2O emissions.

The N_2O emissions of solid manure decreased in 2003 as a direct result of the decrease in poultry manure production. This decrease was due to the reduction in poultry numbers that followed the avian flu epidemic (see also Section 6.1 Table 6.2).

6.3.2 Methodological issues

Methane emissions from animal manure

A Tier 2 approach is followed for CH_4 emission calculations. The amounts of manure (in kg) produced are calculated annually for every manure management system per animal category. Country-specific CH_4 emission factors are calculated for all three manure management systems for every animal category on a Tier 2 level. These calculations are based on country-specific data on:

- manure characteristics: organic matter (OM) and maximum CH_4 producing potential (Bo)
- manure management system conditions (storage temperature and period) for liquid manure systems, which determine the methane conversion factor (MCF)

The amount of manure produced is calculated by multiplying manure production factors (in kg per head per year) by animal numbers. Detailed descriptions of the methods can be found on the website www.greenhousegases.nl. More specified data on Manure management are based on statistical information on manure management systems found at www.cbs.nl (Van Bruggen, 2009). These data are also documented in Van der Hoek and Van Schijndel (2006) and in Annex 12 Table A12.8.

For the methane conversion factor (MCF) for solid manure systems and manure produced in the meadow, IPCC default values are used. The IPCC guidelines recommend a MCF value of 0.01 for stored solid cattle manure and MCF = 0.015 for stored solid poultry manure. However, literature shows that CH_4 emissions from stored solid cattle manure are probably higher (see Van der Hoek and Van Schijndel, 2006). For this reason the Netherlands set the MCF value for stored solid cattle manure equal to the MCF for stored solid poultry manure. The IPCC guidelines recommend a MCF value of 0.01 for manure produced in the meadow. This value is used in the CH_4 emission calculations.

Although the approach of the method applied by the Netherlands for CH_4 calculations differs slightly from the IPCC method, it is in accordance with the IPCC GPG. The Netherlands uses a country-specific emission factor for a specific animal category, which is expressed as the amount of CH_4 emitted per kg animal manure per year, whereas in the IPCC method the emission factor is expressed as the amount of methane (in kg) emitted per animal per year.

Since the CH_4 emissions from manure management from cattle, swine and poultry are key sources (see Table 6.1), the present country-specific Tier 2 methodology fully complies with the IPCC Good Practice Guidance (IPCC, 2001).

Nitrous oxide emissions from animal manure

For the manure management systems and animal categories distinguished, the total N content of the manure produced – also called N excretion – (in kg N) is calculated by multiplying N excretion factors (kg .y^{-1} per head) and animal numbers. Activity data are collected in compliance with a Tier 2 method. However, N_2O emission factors used for liquid and solid manure management systems are IPCC defaults. The method used is fully in compliance with the IPCC Good Practice Guidance (IPCC, 2001), which is required for this key source. N_2O emissions from manure produced in the meadow during grazing are not taken into account in the source category manure management. In accordance with the IPCC guidelines, this source is included in the source category agricultural soils (see Section 6.1 and 6.4).

6.3.3 Uncertainty and time-series consistency

Uncertainty

The Tier 1 uncertainty analysis shown in Annex 7 provides estimates of uncertainty according to IPCC source categories. The uncertainty in the annual CH_4 and N_2O emissions from manure management from cattle and swine is estimated to be approximately 100% . The uncertainty in the amount of animal manure (10%) is based on a 5% uncertainty in animal numbers and a 5–10% uncertainty in excretion per animal. The resulting uncertainty of 7–11% was rounded off to 10%. The uncertainty in the CH_4 emission factors for Manure management, based on the judgments of experts, is estimated to be 100% (Olivier et al.,2009).

Time-series consistency

A consistent methodology is used throughout the time-series. The time-series consistency of the activity data is very good due to the continuity in the data provided.

6.3.4 Source-specific QA/QC

This source category is covered by the general QA/QC procedures, discussed in Chapter 1.

6.3.5 Source-specific recalculations

CH_4 and N_2O emission for manure management of horses and ponies have been recalculated. Since 2006, excretion volumes and N excretion per animal are calculated for horses and ponies separately and in line with the calculation of the other animal categories (Van Bruggen, 2009). The 2006 data are used for the years 1990-2005. This has resulted in slightly lower emissions.

The methane emission factors for manure management for pigs and poultry have been recalculated on basis of new data on the storage capacity below the stables and in outside storage facilities. The CH_4 emission factors for pigs and poultry have been increased. This is due to an increase in the manure storage temperature as a consequence of the longer period manure is stored below the stable. The effect of this recalculation (including the decrease in manure volume of horses and ponies) is about +0.03 Tg CO_2 eq for 1990 and +0.2 Tg CO_2 eq for the years from 1997.

The recalculation of feed intake mentioned in Section 6.2.5 (enteric fermentation) leads to a recalculation on manure N excretion by cattle (Van Bruggen, 2009). Due to this recalculation the N_2O emission from manure management has increased. The effect of the recalculation is minor and is included in the figures given in 6.2.6. Implementing these data together with new data on N-excretion by horses and ponies has resulted to a very small increase of the N_2O emission in 1990 and a very small decrease in 2006.

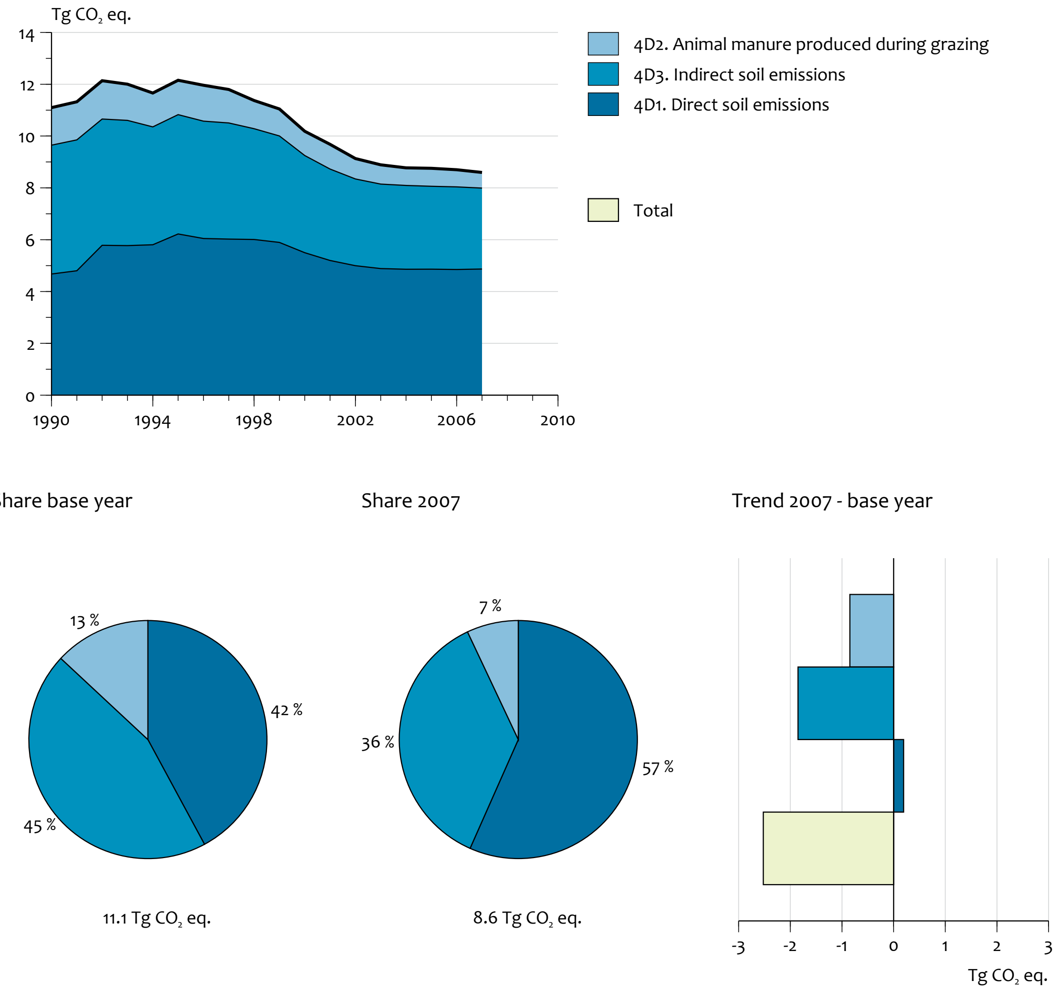
Please note that the above changes also effect the emissions in 4D (see Section 6.4.5)

6.3.6 Source-specific planned improvements

A possible technical measure to prevent methane emissions due to Manure management is manure treatment in an anaerobic digester. In 2007 0,6% of the total liquid stable manure has been treated in an anaerobic digester is (www.cbs.nl). The Netherlands will examine future needs and possibilities in this area to include anaerobic treatment in the methodology and to extend calculations.

4D. Agricultural soils

Figure 6.3



6.4 Agricultural soils [4D]

6.4.1 Source category description

In the Netherlands this source consists of the N_2O source categories specified in Table 6.1:

- Direct soil emissions from the application of synthetic fertilizers, animal manure and sewage sludge to soils, and from N-fixing crops, crop residues and the cultivation of histosols (4D1);
- Animal production – i.e. animal manure produced in the meadow during grazing (4D2);
- Indirect emissions from N leaching and run-off, and from N deposition (4D3).

Overview of shares and trends in emissions

In 2007, agricultural soils contributed 47% to the total greenhouse gas emissions in the agricultural sector. Direct and indirect N_2O emissions and emissions from animal production in the meadow contributed 26%, 17% and 3%, respectively, to the total greenhouse gas emissions in the agricultural sector.

Total N_2O emissions from Agricultural soils decreased by 23% between 1990 and 2007 (see Figure 6.3). Direct emissions increased by 4%, while indirect emissions and emissions from animal manure produced in the meadow decreased 37 and 58%, respectively.

This decrease is caused by a relatively high decrease in N-input to soil (from manure and chemical fertilizer application and animal production in the meadow), partly counteracted by the increased IEF in this period that resulted from a shift from the surface spreading of manure to the incorporation of manure into soil as a result of ammonia policy.

Key sources

Both direct and indirect N_2O soil emissions are level and/or trend key sources (see Table 6.1).

Activity data and (implied) emission factors

Detailed information on data sources (for activity data and emission factors) can be found in the following monitoring protocols:

- Protocol 9080: N_2O from Agricultural soils: indirect emissions (4D)
- Protocol 9081: N_2O from Agricultural soils: direct emissions and emissions from animal production (4D)

Nitrogen flows related to N_2O emissions from soils **Table 6.7**

	1990	1995	2000	2005	2006	2007	Change 2007 - 1990
Nitrogen fertilizer consumption	412.4	405.8	339.5	279.2	287.8	257.5	-38%
of which ammonium fertilizer	3.6	11.2	6.6	30.6	42.9	17.2	382%
NH3-N emission during application	11.2	10.5	9.2	9.8	10.9	9.9	-12%
Net fertilizer to soil	401.1	395.3	330.3	269.4	276.9	247.6	-38%
Nitrogen excretion by animals	694.4	680.1	549.2	479.0	471.2	479.7	-31%
Nitrogen excretion in animals houses	506.5	508.1	424.5	385.8	382.5	398.6	-21%
of which in solid form	61.3	69.6	74.1	72.9	71.6	73.2	19%
of which in liquid form	445.2	438.5	350.5	312.8	310.8	325.4	-27%
NH_3-N emission in animal houses	73.2	73.5	60.2	49.8	48.6	50.1	-32%
Net available manure for application	433.3	434.6	364.3	336.0	333.9	348.5	-20%
Nitrogen in manure exported abroad	6.4	22.1	14.7	14.9	15.8	15.8	147%
NH_3-N emission during application	98.3	51.4	36.8	32.5	30.6	33.8	-66%
Net animal manure to soil	328.6	361.2	312.8	288.6	287.5	299.0	-9%
Nitrogen excretion in meadow	188.0	171.9	124.6	93.3	88.7	81.1	-57%
NH_3-N emission in meadow	13.0	11.9	8.5	7.1	6.4	6.1	-53%
Gross nitrogen available for soil (total manure prod. + fertilizer - export)	1100.4	1063.8	873.9	743.3	743.2	721.4	-34%
Nitrogen fixation in arable crops	7.8	4.9	4.7	4.5	4.6	4.5	-43%
Nitrogen in crop residues left in field	36.4	34.9	34.1	32.1	30.1	29.6	-19%
Nitrogen in histosols	52.4	52.4	52.4	52.4	52.4	52.4	0%
Nitrogen in sewage sludge on agric. land	5.0	1.5	1.5	1.2	1.1	1.0	-80%
Atmospheric deposition agr. NH3-N em	195.9	147.5	115.1	99.5	96.9	100.3	-51%
Nitrogen lost through leaching and run off	330.1	319.1	262.2	223.0	223.0	216.4	-34%

More details and specific data (activity data and emission factors), including data sources (emission factors), are documented in background documents. All relevant documents concerning methodology, emission factors and activity data are published on the website www.greenhousegases.nl.

The calculation of N_2O emissions from Agricultural soils is based on various activity data, e.g. animal numbers (see Section 6.1) and nitrogen flows. For an overview of data sources see NIR 2006, the protocols or the background document (Van der Hoek et al., 2007). The activity data and emission factors can also be found in Annex 12 Tables A12.10, A2.11 and A12.12.

Nitrogen flows

Table 6.7 present the N flows from synthetic fertilizers consumption and from animal manure production and application in the Netherlands (Annex 12 Table A12.10 gives N flows for all years). About 85% of the manure N collected in the stable and in storage is applied to soils. A small portion of the manure N (approximately 1–4%) is exported; while approximately 13-15% is emitted as ammonia during storage.

The total amount of gross N available for soil (total manure production and fertilizer minus export) applied to agricultural soils (including production of animal manure in the meadow) decreased by approximately 34% between 1990 and 2007. This is explained by the Netherlands manure and fertilizer policy, aimed at reducing N leaching and run-off. This policy regulates the amount of manure production and its application by the introduction of measures such as pig and poultry production rights and maximum nutrient application standards for manure and fertilizer.

Of the manure N applied to the soil between 1990 and 2007 the part emitted as ammonia (NH3) decreased from 23 to 10%, due to a change in the method of animal manure application to agricultural soils. Before 1991 manure was applied to the soil by spreading on the surface of grasslands and arable land. Initiated by the Netherlands' policy to reduce ammonia emissions, this practice changed in 1991 into manure incorporation into the soil (e.g. shallow injection or ploughing in), resulting in lower NH_3 emissions. Ultimately, between 1990 and 2007 the part of the N in manure and synthetic fertilizer emitted as NH_3 (in the stable and during, storage, grazing and application to the field) decreased from approximately 18% to 13%.

About 30% of the total nitrogen flow to the soil is subject to leaching and run-off (default IPCC Fracleach factor).

The decrease in indirect N_2O emissions is fully explained by the decrease in N lost by atmospheric deposition and by leaching and run-off. The decrease in N_2O emissions from animal manure produced in the meadow is also entirely reflected in the decrease in N-input to soil by this source. The 4% increase in direct N_2O emissions can mainly be explained

Direct and animal production N_2O implied emission factors for Agricultural soils by CRF category (Units: kg N/kg N-input) **Table 6.8**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Nitrogen input from applic. of synthetic fertilizers	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Nitrogen input from manure applied to soils	0.011	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Nitrogen input from animal production	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Emission factors for direct N_2O emission from soils, expressed as kg N_2O-N per kg N supplied **Table 6.9**

Source	Default IPCC	Mineral soils	Organic soils	Reference
Nitrogen fertilizer	0.0125			
Ammonium fertilizer		0.005	0.01	4
Other fertilizers		0.01	0.02	1,4
Animal manure application	0.0125			
Surface spreading		0.01	0.02	1
Incorporation into soil		0.02	0.02	1
Sewage sludge	0.0125	0.01		2
Biological nitrogen fixation crops	0.0125	0.01		1
Crop residues	0.0125	0.01		2
Cultivation of organic soils (histosols)			0.02	2,3
Animal manure during grazing	0.02			
Faeces		0.01	0.01	1
Urine		0.02	0.02	1

by the 34% decrease in the direct N-input to soil by manure and chemical fertilizer application in combination with a 39% increase of the IEF.

Implied emission factor
Table 6.8 shows the implied emissions factors (IEF) for N_2O emissions from Agricultural soils for the most important sources. For (direct) soil emissions by manure application to soil a 77% increase in the IEF occurs in the period 1990–2007, which is caused by an ammonia policy driven shift from the surface spreading of manure to the incorporation of manure into the soil. Combined with a 9% decrease in net N manure input to soil (see Table 6.7), this explains the 61% increase in N_2O from manure application.

6.4.2 Methodological issues
Direct and indirect N_2O emissions from agricultural soils, as well as N_2O emissions by animal production in the meadow are estimated using country-specific activity data on N-input to soil and NH3 volatilisation during grazing, manure management (stable and storage) and manure application. Most of these data are estimated at a Tier 2 level (or higher). The present methodologies fully comply with the IPCC Good Practice Guidance (IPCC, 2001). For a description of the methodologies and data sources used, see the monitoring protocols on www.greenhousegases.nl. A full description of the methodologies is provided in Van der Hoek et al. (2007), with more details in Kroeze (1994). An overview of the emission factors used is presented in Table 6.9. Default IPCC emission factors are included for comparison.

Direct N_2O emissions
The IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions for two soil types (organic and inorganic soils). Emissions from the application of synthetic fertilizer have been estimated for two types of synthetic fertilizers (ammonium phosphate/sulphate and other synthetic fertilizers). Emissions from animal manure application are estimated for two types of manure application methods (surface spreading and incorporation into soil).

The country-specific emission factors are lower for mineral soils (e.g. 0.01 kg N/kg N-input) and higher for organic soils (0.02 kg N/kg N-input) compared to the IPCC default of 0.0125 kg N/kg N-input. A higher emission factor of 0.02 kg N/kg N-input is also used for manure incorporation into soil.

The higher value for incorporation is explained by two mechanisms. Incorporation of animal manure into the soil produces less ammonia emission and hence more reactive nitrogen enters the soil. Furthermore, the animal manure is more concentrated (e.g. hot spots) in comparison with surface spreading and hence the process conditions for nitrification and denitrification can be more suboptimal.

A recent review of the literature showed that in most experiments with simultaneous surface spreading and incorporation the latter produces higher nitrous oxide emissions. It was, however, not possible to derive a new emission factor for incorporation or shallow (sod) injection (Kuikman et al., 2006). Therefore it was decided not to change the existing emission factors.

Animal production
The IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions from animal production. The country specific method uses total animal production minus ammonia emission from pasture (Kroeze,1994). For Animal production

a distinction is made between N in urine and N in faeces. The country-specific emission factors are lower for faeces (0.01 kg N/kg net N-input) compared to the IPCC default of 0.02 kg N/kg N-input. For urine the emission factor is 0.02 kg N/kg net N-input. This means that on gross N-input the emission factor is a little lower compared to the IPCC default of 0.02 kg N/kg gross N-input. The emission factor for urine is higher than for faeces because the ratio mineral nitrogen/total nitrogen is higher in urine than in faeces, leading to faster nitrification and denitrification in urine-affected spots. Furthermore, urine penetrates faster into the soil than faeces, which enhances the lack of sufficient oxygen in the soil for the nitrification process. Together with the higher mineral nitrogen ratio in urine, it is clear that urine creates a higher potential for suboptimal conditions for nitrification and denitrification than faeces.

Indirect N_2O emissions
The IPCC Tier 1 method is used to estimate indirect N_2O emissions. Indirect N_2O emissions resulting from atmospheric deposition are estimated using country-specific data on NH_3 emissions (estimated at a Tier 3 level). IPCC default values are used for N_2O emission factors because of the lack of country-specific data.

Indirect N_2O emissions resulting from leaching and run-off N emissions are estimated using country-specific data on total N-input into soil (estimated at a Tier 2 level). IPCC default values are used for the fraction of N-input to soil that leaches from the soil and ends up partly as N_2O emissions from groundwater and surface water (Fracleach) and for the N_2O emission factors. The main reason to use IPCC defaults is that direct and indirect N_2O emissions in the Netherlands partially originate from the same soils and sources. In the Netherlands no experimental data are available to evaluate the value of the emission factor for indirect emissions.

6.4.3 Uncertainty and time-series consistency

Uncertainty
The Tier 1 uncertainty analysis, shown in Annex 7, provides estimates of uncertainty according to IPCC source categories. The uncertainty in direct N_2O emissions from Agricultural soils is estimated to be approximately 60%. The uncertainty in indirect N_2O emissions from N used in agriculture is estimated to be more than a factor of 2 (Olivier et al.,2009).

Time-series consistency
Consistent methodologies are used throughout the time series. The time-series consistency of the activity data is very good due to the continuity in the data provided.

6.4.4 Source-specific QA/QC
This source category is covered by the general QA/QC procedures discussed in Chapter 1.

6.4.5 Source-specific recalculations
N_2O emission from soils have been recalculated on basis of recalculated manure N excretion data (see Section 6.3). Due to this recalculation the N_2O emission increases by 0.3 Tg CO_2 eq in 1990 compared to previous submissions and 0.1 Tg CO_2 eq in 2006.

6.4.6 Source-specific planned improvements
The specific characteristics of the Netherlands agricultural soils (with relatively high water tables) justify the calculation of the “fracleach” and the emission factors on the basis of country-specific data. Therefore, the Netherlands will examine the needs and possibilities of extending calculations in the future in order to improve the methodology.

A higher emission factor than the IPCC default is used for the incorporation of manure into soil. However, the findings of a survey on N_2O emission factors for the field-scale application of animal manure abroad did not provide the necessary underpinning for an update of long-term average N_2O emission factors for this source in the Netherlands (Van der Hoek et al., 2007). Consequently, research is carried out now to gain an insight into this.

7

Land use, land use change and forestry [CRF Sector 5]

- Major changes in the LULUCF sector compared to the National Inventory Report (NIR) 2008

Emissions: The reported emissions for LULUCF over the period 1990-2007 are lower compared to the earlier submissions (reported here is 97% and 93% of the emissions in 1990 and 2006, respectively). The lower emissions for LULUCF reflects the impact of major improvements implemented in 2008.
Key sources: CO_2 emissions from 5C2 land converted to grassland now key source, CO_2 emissions from 5F2 land converted to other land now non key source.
Methodologies: No changes in methodology have been made. The lower emission is the net result of major improvements in data used. These are: a new land use change matrix, transitions between the distinguished forest categories, harvest values fully in accordance with FAO data, carbon in litter now included, dynamic growth rate for 'trees outside forest', forest biomass carbon from 2000 and on now based on the full MFV dataset, soil carbon emissions from conversion of other land to the other land use categories (forest land, grassland etc.) and vice versa are removed, losses of litter and dead wood reported for forest land converted to other land use categories, new subcategory 'open water' under wetland (used only for 'wetland remaining wetland') causing less area change from and to 'other land'.

7.1 Overview of sector

This chapter describes the 2007 greenhouse gas inventory for the Land Use, Land Use Change and Forestry (LULUCF) sector. It covers both sources and sinks of the greenhouse gas CO_2 from land use, land use change, forestry and of liming of agricultural land. The emission of nitrous oxide (N_2O) from land use is included in the "Agriculture" sector (category 4D) and the emission of methane (CH_4) from wetlands is not estimated due to the lack of data. All other emissions from forestry and land use can be considered to be negligible.

Land use in the Netherlands is dominated by agriculture (57%), settlements (13%), forestry (10%, including trees outside forests) and 2% comprises dunes, nature reserves, wildlife areas and heather. The remaining area (19%) in the Netherlands is open water. The soils in the Netherlands are dominated by mineral soils, mainly sandy soils and clay soils (of fluvial or marine origin). Organic soils, used mainly as meadowland or hayfields, cover about 8% of the land area. The Netherlands has an agricultural system with intensive land use characterized by high inputs of nutrients and organic matter. The agricultural land is used as grassland (51%), arable (25%), fodder maize (12%) and the remaining agricultural land is used for horticulture, fallow, fruit trees, etc. Grassland and fodder maize are cultivated in rotation. About 80% of the grasslands are permanent grasslands (of which 5% are high nature value grassland); the remaining 20% is temporary grassland. Since 1990, the agricultural land area has decreased by about 5%, mainly because of conversion to settlements/ infrastructure and nature.

The LULUCF sector in the Netherlands is calculated to be a net source of CO_2, amounting in 2007 to 2.5 Tg CO_2 equivalents. The LULUCF sector being a net source is due to the contribution of carbon emitted from cultivation and draining of peat soils, which exceeds the sequestration of carbon in forestry. The LULUCF sector is responsible for 1.2% of total greenhouse gas emission in the Netherlands.

The structure of this Section and of the main submission for the National Inventory Report and Common Reporting Format (CRF) tables is based on the categories of the CRF tables at the 9th Conference of Parties to the United Nation's Framework Convention on Climate Change (UNFCCC).

The Sector 5 Report Tables in the CRF format have been submitted using the CRF Reporter.

7.2 Methods

7.2.1 Methods
The methodology of the Netherlands to assess the emission from LULUCF is based on the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance: a carbon stock change approach based on inventory data subdivided into appropriate pools and land use types and a wall-to-wall approach for the estimation of area per category of land use. The information on the activities and land use categories used covers the entire territorial (land and water) surface area of the Netherlands.

The inventory comprises six classes: Forest Land; Cropland; Grassland; Wetlands; Settlements and Other Land. There is also a category emissions which includes emissions from land use related activities such as liming. The changes in land use (“remaining” or “converted”) are presented in a 6 x 6 matrix, which is fully in accordance with the approach described in the IPCC guidelines. To better match available national maps and databases on land use the category “Forest Land” is an aggregation of two main subdivisions: Forest (according to the Kyoto definition) and Trees outside Forest to better match the available national maps and databases on land use. The category “Grassland” is the aggregation of two main subdivisions: Grasslands and Nature. The latter subdivision includes heather, peat land and moors. All categories are relevant in the Netherlands.

The carbon cycle of managed forests and wood production systems is considered in the calculations of the relevant CO_2 emissions. The carbon stocks in soils from a single stratified measurement campaign for the various types of land use are used to calculate the carbon stocks from land use categories. For the Netherlands, it is assessed that the impact of land use in terms of loss of soil carbon is relatively small given the high use of fertilizers and animal manures. Calculations with appropriate simulation models show that net carbon accumulates in soil (Chardon et al., 2009; Hanegraaf et al., 2009). In reporting we take a conservative approach and report no net changes in the carbon stocks in the Netherlands due to land and soil management and cultivation practices over the period 1990 – 2007. Ongoing research is aimed to further underpin whether specific land conversions are a source of soil carbon or not and is not directed to quantify the magnitude of soils as sinks in the Netherlands.

7.2.2 Data
In this NIR 2009, the changes in land use are based on comparing detailed topographical data and maps that best represent the land use in 1990 and 2004. In the 2008 submission the calculation was based on 1990 and 2000. The 2004 dataset on land use was especially developed to support any temporal and spatial developments in land use and especially designed to support policy in the field of nature conservation (Kramer, in prep). In the future, updates of the digital land use map will be available on a regular basis and these will fit the needs of the future LULUCF calculations with the aim to present up-to-date and accurate information on land use and land use changes. In this NIR, not only have we used of a more recent map, any changes in land use over the period 1990–2004 were also checked in detail (Kramer, 2009). Omissions due methodological reasons (e.g. legend, classification, gridding) were manually adjusted in favor of a correct representation of the changes in land use over the period 1990–2004. The sum of all land use categories is constant over time. Any changes from 2004 and onwards have been obtained by linear extrapolation.

7.2.3 Recalculations
As a result of comments made during the 2007 UNFCCC review, the decision was made to improve the wall-to-wall approach, use the latest land use information data set and drop the use of correction factors used to match the results of the matrix with observations in the field. The improvements made did not lead to a change in methodology because the method used to observe and quantify the changes in land use remained unchanged. The detailed analysis of the changes in land use between 1990 and 2004 has resulted in an improved 1990 data set on land use, land use data up to 2004 instead of 2000 and a linear extrapolation from 2004 onwards.

Due to the implementation of the new land use change matrix, the activity data for all subcategories has changed. Observed changes in land use, as they occurred during the period 1990-2007 (incl. extrapolation for 2005-2007), show that the area used for settlements and infrastructure increased by 191,000 ha to 624,000 ha, the area for forest (including trees outside forest) increased by 11,000 ha to 395,000 ha and the area of grassland (including nature) and cropland decreased by 218,000 ha to 2,326,000 ha. The area wetlands (reed marshes, small and large open water bodies and ditches) increases slightly by 18,000 ha to 811,000 ha. The change in land use from grassland (excl. nature) and cropland to settlements, forest land and nature is approximately 4% of the total territorial area over the period 1990-2004.

Quantitave changes between 2008 and 2009 submissions occurred in all land use categories and almost all subcategories with the update of the land use change matrix with recent and new activity data. In addition, a series of improvements in calculations were implemented that changed (implied) emission factors for Forest Land as well as categories of land changing to or from Forest Land to other categories. Finally, some changes were implemented that affected the inclusion of (sub) categories and the location in the CRF tables and the way of reporting of carbon stock changes. This also affected the distribution and total amount of reported carbon stock changes. In view of the many changes that occur simultaneously, the submissions 2008 and 2009 are compared in detail for the categories, except category Other (‘liming’).

Due to major changes in the location in the CRF tables of reporting of emissions (e.g. disaggregation of deforestation from Grasslands to all land use categories) only few land use categories remain the same between 2008 and 2009 submissions. The actual changes can be summarized in four catego-

Specification of the quantitative differences between submission 2008 and submission 2009 (Units: Gg CO_2) **Table 7.1**

	Difference between submission 2008 and 2009 for reporting years (in Gg CO_2)	
CRF 2008-CRF 2009 for:	1990	2006
Soil emissions associated with conversions to and from other land	**225.02**	**225.02**
Deforestation	-168.20	-414.73
Forest Land remaining Forest Land	23.50	69.54
Land converted to Forest land	-10.13	294.14
Total CRF 2008 – total CRF 2009	70.19	173.98

ries (see table 7.1): 1) Soil emissions associated with conversions to and from Other Land 2) Deforestation 3) Forest Land remaining Forest Land and 4) Land converted to Forest Land. Below these four major categories of changes are specified in more detail.

Ad 1) according to the GPG-LULUCF carbon stored in land allocated to Other Land need not be reported. In previous submissions, a quite broad definition of Other Land was used, and the *soil emissions associated with conversion to and from other land* were assumed to change between reported categories and other land (not reported). Therefore, significant emissions were reported which did not actually reflect changes in carbon in soil, but rather the reporting status of carbon in soil (reporting required or not). This was deemed not realistic. In the 2009 submission a more narrow definition of Other Land is used, and the reporting of "administrative emissions" was stopped. The omission of "administrative" reporting of carbon stock changes associated with changes to and from Other Land causes 225 Gg CO_2 less emission, both in 1990 and 2006.

Ad 2) The emissions associated with deforestation are 168 Gg CO_2 (1990) to 415 Gg CO_2 (2006) higher in the 2009 submission compared to the 2008 submission. Both the emission factor and the activity data have changed and double counting of wood harvest from deforestation and regular harvest is avoided in the 2009 submission. The area deforested has increased with 12,5% compared to the 2008 submission, and this explains between 40% (1990) and 17% (2006) of the difference between the submissions. The remaining 60% to 83% is explained by 1) additional emissions from removal of dead wood (0,45 – 3 Mg C ha^{-1}) and litter (29 – 36 Mg C ha^{-1}) with deforestation: this adds between 29 Gg C ha^{-1} and 39 Mg C ha^{-1} to the implied emission factor for deforestation of Forests according to the Kyoto definition, and between 23 and 28,5 Mg C ha^{-1} (i.e. an increase of between 30 and 40%) to the implied emission factor for the conversion of all Forest Land to any other land use category and by 2) a change from one mean emission factor for decrease of living biomass (70,99 Mg C ha^{-1}) in the 2008 submission to an emission factor for decrease of living biomass based on the estimates for biomass originating from the simple bookkeeping model used for Forest Land remaining Forest Land. This new emission factor increases from 15% lower than the old value in 1990 to 15% higher in 2006 and reflects the built-up of growing stock in Dutch forests.

Ad 3) The changes in emissions associated with Forest Land remaining Forest Land are relatively minor. The emissions are almost 24 Gg CO_2 (1990) to 70 Gg CO_2 (2006) lower in the 2009 submission. They are the net result of several changes occurring at the same time, with varying and opposing effects. The main effects are due to changes in emission factors as the changes in activity data range from less than 0,5% for 1990 to about 10% for 2006. The decrease in emission factor for carbon stock change due to biomass increase in living biomass is primarily due to the change in methodology on how to deal with missing values between 1990 and 2000 for the Hosp data and the inclusion of new plot data from the MFV inventory (collected in 2004 and 2005) for 2000 and onwards. For Trees outside Forest, a constant emission was reported in the 2008 submission, based on the average growth rate in 'Forests according to the definitions' (FAD), and was not updated based on changing activity data. This resulted in changes in the implied emission factor that reflected changes in the activity data. In the 2009 submission, the IEF of carbon stock change due to biomass increase for 'Trees outside forest' is set equal to the IEF for biomass increase in FAD and changes with changes in growth rate of the FAD (independent of changes in activity data).

The decrease in emission factor for carbon stock change due to biomass decrease is an effect of avoiding double counting of wood harvest from deforestation and regular harvests. In earlier submissions, the error by double counting was assumed smaller than the uncertainty of harvest figures. Subtracting wood harvests from deforestation from national harvest figures decreased the carbon stock change due to biomass loss with 360 Gg CO_2 in 1990 up to 860 Gg CO_2 in 2006. Additionally, a switch was made from in country but discontinuously available harvest estimates to annual estimates based on the FAO statistics. This resulted in various and unsystematic differences between the 2008 and 2009 submissions over the time series.

The change in emission factor for carbon stock change due to a change in dead organic matter is between a 7% decrease (1990) and 5% increase (2006). The carbon stock change due to a change in dead organic matter is entirely caused by dead wood, as changes in litter are not reported for Forest Land remaining Forest Land. The calculation of the storage of carbon in dead wood is affected by both the change in how to deal with missing values as – after 2000- the update of the MFV inventory with the full set of plots. There is also an effect of changed harvest values on standing stock, with lower harvest estimates leading to higher standing stocks and (at a constant mortality rate) higher inputs into the dead wood pool.

Table 7.2 Contribution of main categories and key sources in Sector 5 LULUCF

Sector/category	Gas	Key	Emissions base year (1990)	Emissions 2006	Emissions 2007	2007-2006	Contribution to total in 2007 (%)		
Key sources		Level, Trend, Non-Key	Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq	Gg CO_2 eq	By sector	Of total gas	Of total CO_2 eq
5. Total land use categories	CO_2		2.6	2.4	2.5	136.8	100	1.4	1.2
5A. Forest land	CO_2		-2.5	-2.9	-2.7	131.1	-35		
5A1. Forest Land remaining Forest Land	CO_2	L,T	-2.5	-2.4	-2.2	191.6	-28		
5A2. Land converted to Forest Land	CO_2	L,T	0.0	-0.5	-0.6	-60.5	-7		
5B. Cropland	CO_2		0.0	0.0	0.0	0.8	0.6		
5B1. Cropland remaining Cropland	CO_2								
5B2. Land converted to Cropland	CO_2	NK	0.0	0.0	0.0	0.8	0.6		
5C. Grassland	CO_2		4.6	4.8	4.8	8.9	62		
5C1 Grassland remaining Grassland	CO_2	L	4.2	4.2	4.2	0.0	55		
5C2. Land converted to Grassland	CO_2	L,T2	0.4	0.5	0.5	8.9	7.0		
5D. Wetlands	CO_2								
5D1. Wetlands remaining Wetlands	CO_2								
5D2. Land converted to Wetlands	CO_2	NK							
5E. Settlements	CO_2		0.2	0.3	0.3	4.9	3.8		
5E1. Settlements remaining Settlements	CO_2								
5E2. Land converted to Settlements	CO_2	NK	0.2	0.3	0.3	4.9	3.8		
5F. Other Land	CO_2		0.0	0.0	0.0	0.4	0.3		
5F1 .Other Land remaining Other Land	CO_2			0.0	0.0	0.0	0.0		
5F2. Land converted to Other Land	CO_2	NK	0.0	0.0	0.0	0.4	0.3		
5G. Other	CO_2	NK	0.2	0.1	0.1	-10.0	0.9		
Total National CO_2 Emissions (incl. CO_2 LULUCF)	CO_2		161.9	174.9	175.2	283.7			
National Total GHG emissions (incl. CO_2 LULUCF)	All		214.6		210.9				

1) Absolute value 2007 (sinks and sources total: 8395 Gg)

Ad 4) The emissions are almost 10 Gg CO_2 (1990) higher to 294 Gg CO_2 (2006) lower in the 2009 submission The difference in emissions associated with re/afforestation caused by a 0,6% (1990) to a 27% (2006) increase in cumulative re/afforestation rate and an emission factor that reflects the age distribution of the re/afforested areas. The new emission factor ranges between 20% (1990) and 180% (2006) of the old emission factor, and will attain a constant value 20 years after 1990 with 3,25 Mg C ha^{-1}.

If these four categories are add up the net differences between the 2008 and 2009 submissions are 70 Gg CO_2 (1990) lower and 174 Gg CO_2 (2006) lower.

The methodologies applied for estimating CO_2 emissions and removals of the land use change and forestry in the Netherlands will be described in the updates of the two protocols (see also the website at www.greenhousegases.nl):

- Protocol 9082: CO_2 from forest (5A)
- Protocol 9083: CO_2 from total land use categories (5B-5G)

Table 7.2 shows the sources and sinks in the LULUCF sector in 1990 and 2007. For 1990 and 2007, the total net emissions are calculated at approximately 2.6 $TgCO_2$ and 2.5 $TgCO_2$ respectively, with the major source being CO_2 emissions from the decrease in carbon (C) stocks in organic soils and peat lands due to cultivation and watermanagement: 4.2 $TgCO_2$, included in 5C1 "Grassland remaining grassland". The major sink is the storage of carbon in forests: - 2.7 $TgCO_2$, this includes the emissions from "Forest Land remaining forest land" (5A1) and "Land converted to Forest Land" (5A2). Sector 5 "Land use, land use change and forestry" (LULUCF) accounted for 1.4% of the total national CO_2 emission in 2007.

7.3 Forest Land [5A]

7.3.1 Source category description

This category includes emissions and sinks of CO_2 caused by changes in forestry and other woody biomass stock. All forests in the Netherlands are classified as temperate forest, with 30% of the forests being coniferous, 22% broad-leaved and the remaining area a mix of both. The share of mixed and broad-leaved forests has grown in recent decades (Dirkse et al., 2003).

The category includes two subcategories: 5A1 "Forest Land remaining Forest Land" and 5A2 "Land converted to Forest Land". The first category includes estimates of changes in the carbon stock from different carbon pools in the forest. The second category includes estimates of the changes in land use from mainly agricultural areas into forest land since 1990.

Definition

The land use category "Forest Land" is defined as all land with woody vegetation consistent with thresholds used to defined forest land in the national GHG inventory, sub divided into managed and unmanaged units and also by ecosystem type as specified in IPCC Guidelines. It also includes systems with vegetation that currently fall below, but are expected to exceed the threshold of the forest land category (IPCC, 2003, 2006).

The Netherlands has chosen to define the land use category “Forest Land” as all land with woody vegetation, now or expected in the near future (e.g. clearcut areas to be replanted, young afforestations. This is further stratified in:

- “Forest” or “Forest according to the Kyoto definition” (FAD), i.e. all forest land which complies to the following (more strict than IPCC) definition chosen by the Netherlands for the Kyoto protocol: forests are patches of land exceeding 0.5 ha with a minimum width of 30 m, with tree crown cover at least 20% and tree height at least 5 meters, or, if this is not the case, these thresholds are likely to be achieved at the particular site. Roads in the forest less than 6 meters wide are also considered to be forest. This definition conforms to the FAO reporting and was chosen within the ranges set by the Kyoto protocol.
- “Trees outside Forests” (TOF), i.e. wooded areas that comply with the previous forest definition except for their surface (=< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads, fields etc… These areas comply to the GPG-LULUCF definition of Forest Land (i.e. they have woody vegetation) but not to the strict forest definition that The Netherlands applies.

7.3.2 Methodological issues

Removals and emissions of CO_2 from changes in forestry and woody biomass stock are estimated based on country-specific Tier 2 methodology. The approach chosen follows the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The basis assumption is that the net flux can be derived from converting the change in growing stock volume in the forest into carbon. Detailed descriptions of the methods used and emission factors can be found in the protocol 9082 on the website www.greenhousegases.nl, as indicated in Section 7.1.

The Netherlands’ National System follows the carbon cycle of a managed forest and wood products system. The pools are distinguished by above-ground biomass, below-ground biomass, litter, dead wood, and soil organic carbon. Changes in the carbon stock are calculated for above-ground biomass, below-ground biomass and dead wood and litter in forests. Calculations for the living biomass carbon balance are carried out at the plot level.

Living biomass

The following steps are taken to calculate the net carbon flux in living biomass. First, the age of the stand and the limit of dominant height are calculated, followed by a calculation of the height and expected volume in the next year. Based on the expected volume for the next year and from the number of trees, the average tree volume for the next year is derived. The next step is the calculation of the average diameter of the tree in the next year. The above-ground and below-ground total biomass is derived using the equations from the COST E21 database. The desired net flux is derived from the difference in tree mass between two years, the basic wood density and the carbon content of the dry mass. This last step is represented in the following equation:

$$\Delta C(trees)_{plot} = \frac{(M_{tree}(t) - M_{tree}(t+1))}{\Delta t} \times N_{trees} \times F_{carbon}$$

with:

$\Delta C(trees)_{plot}$	Net C flux in living biomass per plot (kg C ha^{-1} y^{-1})
$M_{tree}(t)$	Total tree biomass at time t (kg DW)
N_{trees}	Number of trees (ha^{-1})
F_{carbon}	Carbon content (kg C kg^{-1} DW)
ΔT	Time between t and t+1 (years)

Thinning

Thinning was carried out in all plots that met the criteria for thinning (age > 110 years or growing stock more than 300 m^3 ha^{-1}). The number of trees thinned was based on the volume harvested, and the net carbon flux due to thinning is then calculated from the average biomass of a single tree and the carbon content of the dry mass.

Deadwood

The net carbon flux to dead wood is calculated as the remainder of the input of dead wood due to mortality minus the decay of the dead wood. Leaves and roots were not taken into account for the build up of dead wood. The mortality rate was assumed to be a fixed fraction of the standing volume (0.4% $year^{-1}$), and the current stock of dead wood volume is assumed to be 6.6% of the living wood volume (based on data from Timber Production Statistics and Forecast (HOSP) and the MFV). A net build up may exist, since Dutch forestry only began to pay attention to dead wood a decade ago.

The following equations are used to calculate the net carbon flux to dead wood:

$$\Delta C(deadwood)_{plot} = OutC(deadwood)_{plot} - InC(deadwood)_{plot}$$

$$InC(deadwood)_{plot} = M_{tree}(t) \times N_{tree} \times F_{carbon} \times F_{mortality}$$

$$OutC(deadwood)_{plot} = \left(\frac{V_{dead\_S}}{TBP_S} + \frac{V_{dead\_L}}{TBP_L} \right) \times WD_{dead} \times F_{carbon}$$

with

$\Delta C(deadwood)_{plot}$	Net C flux in dead wood mass per plot (kg C $ha^{-1}y^{-1}$)
$OutC(deadwood)_{plot}$	C input into dead wood from dying trees (kg C $ha^{-1}y^{-1}$)
$InC(deadwood)_{plot}$	C loss per plot due to decomposition of dead wood (kg C $ha^{-1}y^{-1}$)
$M_{tree}(t)$	Total living tree biomass at time t (kg DW)
N_{tree}	Number of living trees (ha^{-1})
F_{carbon}	Carbon content of dry mass (kg C kg^{-1} DW)
$F_{mortality}$	Mortality ($year^{-1}$)
V_{dead_sl}	Volume of standing/lying dead wood

TBP_{SL}	Period for total decay of dead wood, standing and lying
WD_{dead}	Density of dead wood

Litter
The carbon stock change from changes in the litter layer was estimated using a stock change method at national level. Data for litter layer thickness and carbon in litter were available from five different datasets. None of these datasets could be used exclusively. Therefore, a stepwise approach was used to estimate the national litter carbon stock and change therein in a consistent way. Additional, selected forest stands, on poor and rich sands, were intensively sampled with the explicit purpose to provide conversion factors or functions.

Non of the available datasets could be used exclusively. Therefore, a stepwise approach was used to estimate the national litter carbon stock and change therein in a consistent way. After which a hierarchy was developed to accord mean litter stock values to any of the sampled plots of the available forest inventories (HOSP and MFV). The difference between 2004 and 1990 was estimated and a mean annual rate of carbon accumulation was calculated. A Monte Carlo uncertainty analysis was carried out and showed that the result was considered the more conservative.

Activity data
Activity data on land use and land use change are derived from the land use maps and the land use change matrix. Carbon content is based on the soil map of the Netherlands (scale 1:50,000) combined with results of LSK, a national random check of map units that provides detailed descriptions of soil profiles. The random check was implemented both nationwide and on a stratified scale, combining main categories and/or symbol units in order to produce a more homogenous classification with respect to landscaping, soil formation or parent material. Within this framework, this random check was meant to provide further quantitative information for the existing soil maps.

Activity data on forests is based on forest inventories carried out in 1988–1992 (HOSP data) and in 2001–2002 and 2004–2005 (MFV data). HOSP data, which includes plot level data (in total 2007 plots, about 400 per year) for growing stock volume, increment, age, tree species, height, tree number and dead wood, was used for the 1990 situation. Forward calculation using this data was applied to the year 1999. Additional data on felling, final cut and thinning was used to complete the data set. MFV plot level data (in total 3622 plots, with same items as HOSP) was applied to the years 2000–2004. In addition, in order to assess the changes in activity data, databases with tree biomass information, with allometric equations to calculate above-ground and below-ground biomass and with forest litter, as well as wood harvest statistics, soil carbon estimations and high-resolution topographical maps of 1990 and 2004 were used. See the website at www.greenhousegases.nl for more details on activity data.

Implied emission factors
The total emissions from the tree component after deforestation is calculated by multiplying the total area deforested with the average carbon stock in living biomass, above- as well as below ground (Nabuurs et al., 2005) and the average carbon stock in dead organic matter and litter. Thus it is assumed that with deforestation, all carbon stored in above- and below ground biomass as well as in dead wood and litter is lost to the atmosphere. National averages are used as there is no record of the spatial occurrence of specific forest types.

The average carbon stock in living biomass follows the calculations from the gapfilled forest inventory data. The calculated emission factors show a progression over time. The EF for biomass is 60.4 Mg C ha^{-1} in 1990 and increase to 81.1 Mg C ha^{-1} in 2007. The EF for litter is 29.0 Mg C ha^{-1} in 1990 and increase to 34.3 Mg C ha^{-1} in 2007 and the EF for dead wood is 0.45 Mg C ha^{-1} in 1990 and increase to 2.62 Mg C ha^{-1} in 2007. The systematic increase in average standing carbon stock reflects the fact that annual increment exceeds annual harvests in The Netherlands.

The IEF for biomass increase in land converted to either FAD or TOF reflects the age distribution of the re/afforested areas and will attain a constant value 20 years after 1990.

Non CO_2 emisions in forest land
N_2O emissions might occur as a result of using fertilizer in forests or from drainage. Both management practices are rarely applied in forestry in the Netherlands. Thus, it is assumed that N_2O emissions are irrelevant in forests. CH_4 emissions resulting from forest fires are considered to be negligible because fires seldom occur.

7.3.3 Source-specific recalculations
The changes in emissions associated with "Forest Land remaining Forest Land" and "Land converted to Forest Land" are the net result of several changes occurring at the same time, with varying and opposing effects as explained in detail in the previous Section

The change in activity data for both subcategories is extremely small for 1990. However, the total surface was decreased as the subcategory "Heather"(called "Nature" in the protocols) was moved to Grassland. Over time, the difference between the submissions increases for subcategories.

The area of Forest Land remaining Forest Land showed a linear decrease over time. Land converted to Forest Land is reported in this category for 20 years, and as such any increases in Forest Land remaining Forest Land due to afforestation will be reflected in activity data only from 2010 on. The calculation/copying error of the subcategory "Land converted to Forest Land" in the 2008 submission is the main cause of the increase in difference between the 2008 and 2009 submissions rather than the difference in land use change rates or a change in calculation.

CO_2 emissions/removals from changes in forest and other woody biomass stocks (IPCC category 5A) (Units: Gg CO_2) **Table 7.3**

	1990	1995	2000	2005	2007
5A Forest Land	-2532	-2798	-2670	-2871	-2742
5A1 Forest Land remaining Forest Land of which	-2.529	-2739	-2448	-2414	-2167
Live trees	-3745	-3509	-3505	-3308	-3247
Harvest	1745	1257	1528	1337	1513
Trees outsideForest	-211	-180	-160	-132	-121
Dead wood	-307	-307	-311	-312	-311
5A2 Land converted to Forest Land (Afforestion)	-3	-59	-222	-457	-575

In previous submission, the IEF for biomass increase in land converted to either FAD or TOF was assumed to be half the rate of biomass increase in FAD remaining FAD. However, a check using actual data from the forest inventories Hosp and MFV forced us to reject this assumption. The new EF for land converted to FAD reflects the age distribution of the re/afforested areas and will attain a constant value 20 years after 1990. Furthermore, in previous submissions the emissions for land converted to Forest Land were reported aggregated into one value under "other land". From the 2009 submission on, emissions are reported on the disaggregated level of subcategory (FAD, TOF) of Forest Land for each land use category converted to Forest land.

7.3.4 Uncertainty and time-series consistency

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The analysis combines uncertainty estimates of the forest statistics, land use and land use change data (topographical data) and the method used to calculate the yearly growth in carbon increase and removals. The uncertainty in the CO_2 emissions from 5A1 "Forest Land remaining Forest Land" is calculated at 67%. The uncertainty in the CO_2 emission from 5A2 "Land converted to Forest Land" is calculated at 63%. See Olivier et al. (2009) for details.

The uncertainty in implied emission factors of 5A1 "Forest Land remaining Forest Land" concerns forest and trees outside the forest. As the methodology and data sets used are the same for both sources, the uncertainty calculation is performed for forests and the result is considered to be representative for trees outside forests as well.

The uncertainty in the implied emission factor of increment in living biomass is calculated at 13% (rounded off to 15% in the calculation spreadsheet). The uncertainty in the implied emission factor of decrease in living biomass is calculated at 30%. The uncertainty in the net carbon flux from dead wood is calculated at 30% (rounded off to 50% in the Tier 1 calculation spreadsheet)

Uncertainty in implied emission factor of 5A2 'Land converted to Forest Land'

For the increment in living biomass, the same data and calculations are used as for 5A1 "Forest Land remaining Forest Land" and, therefore, the same uncertainties are used in the Tier 1 calculation spreadsheet.

For soil carbon stock changes after land use change it is assumed that the average carbon stock in the soil under the new and old land use is the same (Groot et al., 2005). Therefore, the uncertainty is the uncertainty of the change in carbon content in mineral soil, which is calculated at 38% (rounded off to 50% in the Tier 1 calculation spreadsheet); see Section 7.3.3.

Uncertainty in activity data in categories 5A1 and 5A2

The activity data used is area change, calculated by comparing two topographic maps. The uncertainty of one topographic map is estimated at 5% (expert judgment). Therefore, the uncertainty in comparing two topographic maps is theoretically 5 × 5 = 25%. This is without doubt an overestimation, as not all land use may change over a decade.

Time-series consistency

The updated time series for category 5A shows an average of about 2.800 Gg CO_2 yr^{-1} and with a range from 2.500 Gg CO_2 yr^{-1} to 3.000 GgCO_2 yr^{-1} over the period 1990-2007 (see table 7.3). The figures in category 5A1 show the net result of the sequestration in live trees, in trees outside forest, dead wood and litter and the emission from harvest. The figures for live trees and harvest only change slightly over time, with no clear direction. The figures for afforestation steadily increase since 1990 and have reached in 2007 a sequestration level of 575 Gg CO_2 yr^{-1}.

7.3.5 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in Chapter 1.

7.4 Cropland [5B]

7.4.1 Source category description

The source category 5B "Cropland" includes only the emissions of CO_2 from 5B2 "Land converted into Cropland".

The land use category "Cropland" is defined as all arable and tillage land, including rice-fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category (IPCC, 2003).

The Netherlands has chosen to define croplands as arable lands and nurseries (including tree nurseries). Intensively managed grasslands are not included in this category and are reported under Grasslands. For part of the agricultural land, rotation between cropland and grassland is frequent, but data on where exactly this is occurring are as yet lacking. Currently, the actual situation on land use in the topographical map is leading, here all land with agricultural crops and classified as arable lands at the time of recording reported under Cropland and lands with grass vegetation at the time of recording classified as Grassland.

Activity data and (implied) emission factors

The activity data is derived from the land use maps and the land use change matrix. Carbon content is based on the soil map of the Netherlands (scale 1:50,000) combined with results of LSK, a national random check of map units that provides detailed descriptions of soil profiles (Groot et al., 2003). The random check was implemented both nationwide and on a stratified scale, combining main categories and/or symbol units in order to produce a more homogenous classification with respect to landscaping, soil formation or parent material. Within this framework, this random check was meant to provide further quantitative information for the existing soil maps.

7.4.2 Methodological issues

The type of land use is determined using digitized and digital topographical maps (scale: 1:10,000), which allows the land use matrix to be completed according to the recommendations in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The years 1990 and 2004 are based on observations of land use; the values for the period in between are obtained through linear interpolations, and the values for the years after 2004 are obtained by means of extrapolation. For more information on the methodology see the description on land use and the land use change matrix in Chapter 7.2.

More detailed descriptions of the methods used and emission factors can be found in the protocols 9082 and 9083 on the website www.greenhousegases.nl.

7.4.3 Source-specific recalculations

The differences in activity data of Cropland remaining Cropland are entirely due to the implementation of the new land use change matrix. Additionally, this year the area of organic soil was reported for the land use category Forest Land, Cropland and Grassland. For this, an overlay was made between the land use maps and a map with organic soils in The Netherlands (Kuikman et al., 2005).

In the previous submissions, the area converted from Forest Land to Cropland was reported at a highly aggregated level under Forest Land converted to Grasslands. However, from the 2009 submission on the land converted from Forest Land is reported at a highly disaggregated level from each subcategory of Forest Land to each other category of land use. This adds an annual emission of 34,68 Gg CO_2 (1990) to 46,90 Gg CO_2 (2006) to the category land converted to Cropland.

In the 2009 submission a more narrow definition of Other Land is used, and the reporting of “administrative emissions” was stopped. This removed an emission of -35,57 Gg CO_2 from the category land converted to Cropland.

7.4.4 Uncertainty and time-series consistency

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source categories. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The uncertainties in the Dutch analysis of carbon levels depend on the collective factors with which the calculations are implemented (calculation of the organic substances in the soil profile and the conversion to a national level) and data on land use and land use change (topographical data). The uncertainty in the CO_2 emissions from 5B2 “Land converted to Cropland” is calculated at 56%; see Olivier et al. (2009) for details.

Uncertainty in the implied emission factor of 5B2 Land converted to Cropland

The uncertainty in the implied emission factor of 5B2 “Land converted to Cropland” refers to the change in carbon content of mineral soils. The uncertainty in the change in the carbon content of mineral soils is calculated to be 38% (rounded off to 50% in the Tier 1 calculation spreadsheet, since it is the order of magnitude that is important).

Uncertainty in activity data

The activity data used is area change, calculated by comparing two topographic maps. The uncertainty of one topographic map is estimated to be 5% (expert judgment). Therefore, the uncertainty for comparing two topographic maps is theoretically 5 × 5 = 25%. This is without doubt an overestimation as not all land use may change over a decade.

Time-series consistency

The yearly emission of CO_2 due to the conversion of land converted tot cropland shows a small yearly increase from 35 GgCO_2 in 1990 to 48 GgCO_2 in 2007.

7.4.5 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in Chapter 1.

7.5 Grassland [5C]

7.5.1 Source category description

The source category 5C “Grassland” includes only the emissions of CO_2 from 5C1 “Grassland remaining Grassland” and 5C2 “Land converted into Grassland”. The source category 5C1 is by far the most important source of CO_2 within the sector LULUCF.

Definition

The land use category "Grassland" is defined as rangeland and pasture land that is not considered as croplands. It also includes vegetation that falls below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastoral systems, subdivided into managed and unmanaged consistent with national definitions. (IPCC, 2003). It is stratified in:

- "Grasslands", i.e. all areas predominantly covered by grass vegetation (whether natural, recreational or cultivated)
- "Nature", i.e. all natural areas excluding grassland (natural grasslands and grasslands used for recreation purposes). It mainly consists of heathland, peat moors and other nature areas. Many have the occasional tree as part of the typical vegetation structure. This category was in the previous submissions a subcategory within Forest land

The Netherlands currently reports under grassland any type of terrain which is predominantly covered by grass vegetation. No distinction is made between intensively and extensively managed grasslands for agriculture and natural grasslands. However, the potential and the need for this is currently under discussion. Apart from pure grasslands, all orchards (with standard fruit trees, dwarf varieties or shrubs) are included in the category grasslands. They do not conform to the forest definition, and while agro-forestry systems are mentioned in the definition of Croplands, this is motivated by the cultivation of soil under trees. However, in The Netherlands the main undergrowth of orchards is grass. We therefore chose to report them as grasslands. As for grasslands no change in above-ground biomass is reported, the carbon stored in these trees is not reported.

Activity data and (implied) emission factors

The activity data is derived from the land use maps and the land use change matrix. Carbon content is based on the soil map of the Netherlands in combination with results of LSK, a national random check of map units that provides detailed descriptions of soil profiles (see Section 7.3.1). The activity data for organic soils is based on soil maps (1:50,000 for the period 1960–1990), recent inventories on organic soils (2001–2003), profile information from LSK and data on field levels in 1990 and 2000.

7.5.2 Methodological issues

For information on the methodology to assess land use and land use change see Chapter 7.2. A country-specific Tier 2 method is used to estimate CO_2 emissions from the cultivation (and drainage) of organic soils (Grassland remaining Grassland).

For grassland, CO_2 emissions resulting from subsidence of peat land as a direct result of oxidation of peat due to managed drainage are included. The CO2 emission of 5C1 "Grassland remaining Grassland" is calculated and based on observations on yearly subsidence rates for various types of peat and available information on the extent of drainage and subsequent soil carbon losses through oxidation for each peat type and drainage level (Kuikman et al., 2005). In this category all managed and cultivated land on organic soils is included whether the land use and cover is grassland (85%) or otherwise. The country-specific method used is based on the recommendations given in the IPCC 2003 Good Practice Guidance (IPCC, 2003). Uncertainty in the decrease in the area of organic soils in past decades – in particular, the estimate for 1990 – has led to the conclusion that the area can best be considered constant despite the likelihood that the area is still decreasing albeit at a low rate since 1990. The area used is 223,000 ha and equals the observed area of organic soils and is thus a conservative estimate. The 2003 stated area of organic soils with the relevant water management conditions and measures and the calculated loss of organic matter gives an averaged implied emission factor of 19.04 ton CO_2/ha (Kuikman, 2005). For the period 1990-2007, the emissions from organic soils under grassland are based on the fixed area and implied emission factor value. Both are the result of analysis of the developments in a range of different peat lands (including water and soil management). The area used sofar conflicts to some extent with the results for grassland on organics soils in the land use change matrix. The matrix shows a 4% smaller area and overtime a very slight decrease in area. As long as the loss of carbon cannot be verified and calculated on an annual bases (based on accurate condition data e.g. temperature and water management) the use of specific area figures for subsequent years into the matrix would introduce pseudo accuracy. Therefore we have decided not to change the calculation methodology nor the overall area of cultivated organic soils as outlined in Kuikman et al, 2005. More detailed descriptions of the methods used and emission factors can be found in protocols 9082 and 9083 on the website www.greenhousegases.nl.

7.5.3 Source-specific recalculations

The change in activity data for the subcategory Grasslands of the category "Grassland remaining Grassland" is extremely small for 1990. In 2006, the difference is slightly more but still entirely due to the implementation of the new land use change matrix. However, the total surface of Grassland remaining Grassland was increased as the subcategory "Nature" (called "Heather" in the 2008 submission) was moved from Forest Land to Grassland (in order to comply to internationally accepted interpretation of the definition of Forest Land).

Additionally, this year the area of organic soil was reported for the land use category Forest Land, Cropland and Grassland. For this, an overlay was made between the land use maps and a map with organic soils in The Netherlands (Kuikman et al., 2005).

Despite the addition of the subcategory "Nature" to the category Grassland, the activity data for "Land converted to Grassland" are lower in the 2009 submission. This is almost completely due to the implementation of the new land use change matrix. The addition of area associated with the subcategory "Nature" (i.e. 0,37 kha year-1) was more than compensated for by the "loss" of 0,763 kha year-1 that was reported under other land use categories in 2009 due to disaggregating the area of Forest Land converted to other land use categories.

In the 2008 submission, all Forest Land converted to other land use categories was reported as Forest land converted to Grassland, and this amounted to 2,042 kha year^{-1}. In 2009, only the area of Forest Land actually converted to Grassland (Grasslands or Nature) were reported here, and this was equal to 1,279 kha year^{-1}.

In the previous submissions, the total emissions associated with Forest Land converted from to other land use categories (531,51 Gg CO_2) was reported completely under Grassland. However, from the 2009 submission on the land converted from Forest Land is reported at a highly disaggregated level from each subcategory of Forest Land to each other category of land use. As such, only the emission associated with an actual conversion to Grassland (not any other land use category) was reported under Grassland. This resulted in an emission of between 394,47 Gg CO_2 (1990) and 533,38 Gg CO_2 (2006) for Forest land converted to Grassland. The increase in emissions over time is due to a change in emission factor for deforestation over time.

In the 2009 submission a more narrow definition of Other Land is used, and the reporting of "administrative emissions" was stopped. This removed an emission of -337,52 Gg CO_2 from the category land converted to Grassland.

7.5.4 Uncertainty and time-series consistency

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to the IPCC source category. The uncertainty for the CO_2 emissions in categories 5C1 Grassland remaining Grassland and 5C2 Land converted to Grassland is calculated to be 56%; see Olivier et al. (2009) for details.

Uncertainty in the implied emission factor of 5C1 Grassland remaining Grassland

The uncertainty for the oxidation of organic soils in category 5C1 is calculated at 55%. Combined with the 38% uncertainty of the change in carbon content of mineral soils (see Section 7.3.3), the overall uncertainty in the implied emission factor for category 5C1 will probably remain in the 50% range (50% used in the Tier 1 calculation spreadsheet).

Uncertainty in the implied emission factor of 5C2 Land converted to grassland

For the uncertainty of 5C "Land converted to Grassland", reference is made to the description of 5B2 "Land converted to Cropland" (Section 7.3.3). The calculation for "Land converted to Grassland" is based on the same assumptions as those made for 5B2 "Land converted to Cropland" and are, therefore, identical. The uncertainty is estimated to be 38% (50% used in the Tier 1 calculation spreadsheet).

Uncertainty in activity data of categories 5C1 and 5C2

The activity data used is area change, calculated by comparing two topographic maps. The uncertainty of one topographic map is estimated to be 5% (expert judgment). Therefore, the uncertainty in comparing two topographic maps is theoretically 5 × 5 = 25%. This is without doubt an overestimation as not all land use may change over a decade.

Time-series consistency

The yearly source of CO_2 that results from the drainage of organic soils is 4.246 GgCO_2. The yearly emission of CO_2 due to the conversion of forest land to grassland shows a steady increase from 394 GgCO_2 in 1990 to 542 GgCO_2 in 2007.

7.5.5 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in Chapter 1.

7.6 Wetland [5D]

7.6.1 Source category description

The source category 5D "Wetland" includes only CO_2 emissions from 5D1 "Wetland remaining Wetland" and 5D2 "Land converted to Wetland".

Definition

The land use category "Wetland" includes land that is covered or saturated with water for all or part of the year and does not fall into the forest land, cropland, grassland or settlements categories. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged sub-divisions (IPCC, 2003). Though The Netherlands is a country with many wet areas by nature, many of these are covered by a grassy vegetation and those are included under grasslands. Some wetlands are covered by a more rough vegetation of wild grasses or shrubby vegetation, which is reported in the subcategory "Nature" of Grassland. Forested wetlands like willow coppice are reported in the subcategories FAD or TOF of Forest Land, depending on their surface.

In The Netherlands, only reed marshes and open water bodies are included in the Wetland land use category. This includes natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes. It includes bare areas which are under water only part of the time as a result of tidal influences, and very wet areas without vegetation. It also includes "wet" infrastructure for boats, i.e. waterways but also the water in harbours and docks.

Activity data and (implied) emission factors

The activity data is derived from the land use maps and the land use change matrix (see Section 7.3.2.). The carbon content of wetlands is not estimated and is set at zero in the land use change matrix.

7.6.2 Methodological issues

For information on the methodology to assess land use and land use change see Chapter 7.2. The emission of CH_4 from wetlands is not estimated due to the lack of data. More detailed descriptions of the methods used and the emission factors can be found in protocols 9082 and 9083 on the website www.greenhousegases.nl.

7.6.3 Source-specific recalculations

The total surface included in Wetlands remaining Wetlands increases from about 3 kha (1990) in the 2008 submission to about 800 kha in the 2009 submission. This is mostly due to the inclusion of the category “Open water” in Wetlands (about 770 kha). In previous submissions open water was included in Other Land. Additionally, the area of reed marsh was estimated in a much more precise and labour intensive way, which increased the area of reed marsh about 10-fold in the new land use matrix (Kramer et al., 2009).

The surface land converted to reed marsh could not be estimated in the land use matrix used for previous submission and was reported IE (Forest Land converted to Wetlands was included in Forest Land converted to Grassland) and NE. In the land use change matrix used for the 2009 submission, the annual rate of change towards the aggregated category Wetland is 2,23 kha.

In the previous submissions, the area converted from Forest Land to Wetland was reported at a highly aggregated level under Forest Land converted to Grasslands. However, from the 2009 submission on the land converted from Forest Land is reported at a highly disaggregated level from each subcategory of Forest Land to each other category of land use. This adds an annual emission of 40,29 Gg CO_2 (1990) to 54,48 Gg CO_2 (2006) to the category land converted to Wetland.

7.6.4 Uncertainty and time-series consistency

Uncertainties

For information on the uncertainty estimates, the reader is referred to Section 7.3.3, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency

The time-series shows a consistent small increase from 40 Gg CO_2 to 55 Gg CO_2 in 2007

7.6.5 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in Chapter 1.

7.7 Settlement [5E]

7.7.1 Source category description

This source category 5E “Settlement” includes only those CO_2 emissions from 5E1 “Settlements remaining Settlements” and 5E2 “Land converted to Settlements”.

Definition

The land use category “Settlements” includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories (IPCC, 2003). In The Netherlands, the main classes included are urban areas and transportation infrastructure, and built-up areas. Built-up areas include any constructed item, independent of the type of construction material, which is (expected to be) permanent, fixed to the soil surface and serves as place for residence, trade, traffic and/or labour. Thus it includes houses, blocks of houses and apartments, office buildings, shops and warehouses but also fuel stations and greenhouses. Urban areas and transportation infrastructure including all roads, whether paved or not, are included in the land use category “Settlements” with the exception of forest roads which are included in the official forest definition and category “Forest”. “Settlements” also includes train tracks, (paved) open spaces in urban areas, parking lots and graveyards. Though some of the latter classes are actually covered by grass, the distinction cannot be made based on maps. As even the grass graveyards are not managed as grasslands, inclusion in the land use category “Settlements” conforms better to the rationale of the land use classification

Activity data and (implied) emission factors

The activity data are derived from the land use maps and the land use change matrix. Estimates of carbon content are based on the soil map of the Netherlands in combination with results of LSK, a national random check of map units that provides detailed descriptions of soil profiles. There is a lack of information on the carbon content for most of the settlement grid cells. Consequently, the carbon content was calculated using a weighed average over all carbon stock classes within each land use category.

7.7.2 Methodological issues

For information on the methodology to assess land use and land use change see Chapter 7.2. The reporting is considered to be a Tier 2 level (see protocol 9083). Because there has been no change in soil carbon and, in any case, no loss of soil carbon was expected for the period 1990–2004, the emissions from 5E1 “Settlement land remaining Settlement” are set at zero. The category 5E2 “Land converted to Settlement” includes the conversion from mainly grassland, cropland and other land to settlements. More detailed descriptions of the methods used and the emission factors can be found in the protocols 9082 and 9083 on the website www.greenhousegases.nl, as indicated in Section 7.1.

7.7.3 Source-specific recalculations

The differences in activity data of “Settlements remaining Settlements” are entirely due to the implementation of the new land use change matrix.

In the previous submissions, the area converted from Forest Land to Settlements was reported at a highly aggregated level under Forest Land converted to Grasslands. However, from the 2009 submission on the land converted from Forest Land is reported at a highly disaggregated level from each subcategory of Forest Land to each other category of land use. This adds an annual emission of 212,14 Gg CO_2 (1990) to 286,97 Gg CO_2 (2006) to the category land converted to Settlements.

In the 2009 submission a more narrow definition of Other Land is used, and the reporting of “administrative emissions” was stopped. This removed an emission of -151,54 Gg CO_2 from the category land converted to Settlement.

7.7.4 Uncertainty and time-series consistency

Uncertainties
Uncertainty estimates are provided in Section 7.3.3, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency
The time-series shows a consistent increase from 212 Gg CO_2 to 292 Gg CO_2 in 2007

7.7.5 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures, as discussed in Chapter 1.

7.8 Other Land [5F]

7.8.1 Source category description
This source category 5F "Other Land" includes only CO_2 emissions from 5F1 "Other Land remaining Other Land" and 5F2 "Land converted to Other Land".

Definition
The land use category "Other Land" was included to allow the total of identified land to match the national area where data are available. It includes bare soil, rock, ice and all unmanaged land area that do not fall in any of the other five categories. (IPCC, 2003).

In general, Other Land does not hold a substantial amount of carbon. The Netherlands uses this land use category to report the surfaces of bare soil which are not included in any other category. In the Netherlands this refers mostly to almost bare sands and the earliest stages of succession from sand in the coastal areas (beaches, dunes and sandy roads) or uncultivated land alongside rivers. It does not include bare areas that emerge from shrinking and expanding water surfaces (these "emerging surfaces" are included in wetlands).

Activity data and (implied) emission factors
The activity data are derived from the land use maps and the land use change matrix. Carbon content is based on the soil map of the Netherlands in combination with results of LSK, a national random check of map units that provides detailed descriptions of soil profiles. The category "Other Land" consists of two main subcategories: "Other Land (dunes)" and "Other Land (water)".

7.8.2 Methodological issues
For information on the methodology to assess land use and land use change see Chapter 7.2. The land use category Other Land is introduced to allow wall-to-wall reporting of land areas even if not all land could be allocated to a land use category. The carbon stored in land allocated to Other Land need not be reported (as it is assumed that Other Land has no carbon). In previous submissions, a quite broad definition of Other Land was used, and the carbon in land converted to or from Other Land was assumed to change between reported and not reported. Therefore, large positive and negative emissions were reported which did not actually reflect changes in carbon in soil, but the reporting status of carbon in soil. This was deemed not realistic. In the 2009 submission a more narrow definition of Other Land is used, and the reporting of "administrative emissions" was stopped. More detailed descriptions of the methods used and the emission factors can be found in protocols 9082 and 9083 on the website www.greenhousegases.nl, as indicated in Section 7.1.

7.8.3 Source-specific recalculations
The total surface included in "Other Land remaining Other Land" decreases from about 815 kha (1990) in the 2008 submission to almost 40 kha in the 2009 submission. This is almost entirely due to the removal of the category "Open water" to Wetlands (about 770 kha). In previous submissions open water was included in Other Land. Additionally, some very small changes were associated with the implementation of the new land use change matrix (Kramer et al., 2009).

In the previous submissions, the area converted from "Forest Land to Other Land" was reported at a highly aggregated level under Forest Land converted to Grasslands. However, from the 2009 submission on the land converted from Forest Land is reported at a highly disaggregated level from each subcategory of Forest Land to each other category of land use. This adds an annual emission of 18,13 Gg CO_2 (1990) to 22,15 Gg CO_2 (2006) to the category land converted to Settlements.

In the 2009 submission a more narrow definition of Other Land is used, and the reporting of "administrative emissions" was stopped. This removed an emission of 749,65 Gg CO_2 from the category land converted to Other Land.

7.8.4 Uncertainty and time-series consistency

Uncertainties
For information on the uncertainty estimation, the reader is referred to Section 7.3.3, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency
The time-series shows a consistent small increase from 18 Gg CO_2 to 25 Gg CO_2 in 2007

7.8.5 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures, as discussed in Chapter 1.

7.9 Other [5G]

7.9.1 Source category description
The source category 5G "Other" includes only the emissions of CO_2 from the liming of agricultural land with limestone and dolomite. Limestone and dolomite are used in the agricultural sector to increase the chalk content of the soil.

Activity data and (implied) emission factors
The activity data is derived from agricultural statistics for total lime fertilizers (period: 1990–2005). Data available on the

CO_2 emissions from using limestone and dolomite in agriculture (Units: Gg CO_2) **Table 7.4**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
5G Other (liming of agricultural soils)	183	98	98	80	85	86	79	75	81	71

application of limestone and dolomite does not address its use on grassland and cropland separately.

7.9.2 Methodological issues

The reporting is considered to be at the Tier 2 level (see protocol 9083). Limestone ("lime marl") and dolomite ("carbonic magnesium lime") amounts, reported in CaO equivalents, are multiplied with the emission factors for limestone (440 kg CO_2/ton pure limestone) and for dolomite (0.477 tons CO_2 per ton pure dolomite). More detailed descriptions of the methods used and the emission factors can be found in protocols 9082 and 9083 on the website www.greenhousegases.nl, as indicated in Section 7.1.

7.9.3 Source-specific recalculations

Has not been recalculated

7.9.4 Uncertainty and time-series consistency

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source category. The uncertainty in the CO_2 emissions from 5G "Liming of soils" is calculated to be 25%. The uncertainty in the activity data is estimated to be 25%, and the uncertainty in emission factors is 1%. When considered over a longer time span, all carbon that is applied through liming is emitted.

Time-series consistency

The methodology used to calculate CO_2 emissions from limestone and dolomite for the period 1990–2007 is consistent over time. The use of chalk containing fertilizer in the Netherlands decreased from 265 million kg in 1990 to 101 million kg in 2007. Over that period the proportion of limestone more than doubled, from about 12% in 1990 up to almost 30% in 2006 and the proportion of dolomite decreased from about 35 to 40% in 1990 to levels below 30% in 2006 (the remaining 38% is earth foam). Although the figures for 2007 show a relative increase in the use of limestone and dynamite, in absolute figures the supply was 10% below the supply in 2006. The CO_2 emissions related to these fertilizers is 70 GgCO_2, which is 10 GgCO_2 less than in to 2006 (see Table 7.4).

7.9.5 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in Chapter 1.

8

Waste [CRF Sector 6]

■ Major changes in Waste sector compared to the National Inventory Report 2008
Emissions: In 2007, the total greenhouse gas emissions in this sector decreased further. Emissions in the period 1990-2006 did not change compared to the previous NIR.
Key sources: 6B N_2O emissions from waste water handling now key.
Methodologies: There is a methodological change in the calculation of N_2O emissions from urban waste water treatment facilities.

8.1 Overview of sector

The national inventory of the Netherlands comprises four source categories in the Waste sector:
- 6A Solid waste disposal: CH_4 (methane) emissions;
- 6B Wastewater handling: CH_4 and N_2O emissions;
- 6C Waste incineration: CO_2 emissions (included in [1A1a]);
- 6D Other waste: CH_4 emissions.

Carbon dioxide emissions from the anaerobic decay of landfilled waste are not included, since this is considered to be part of the carbon cycle and is not a net source. The Netherlands does not report emissions from waste incineration facilities in the Waste sector because these facilities also produce electricity or heat used for energetic purposes and, as such, these emissions are included in category 1A1a (to comply with IPCC reporting guidelines). Methodological issues concerning this source category are briefly discussed in Section 8.4.

The following protocols, which can be found on the website www.greenhousegases.nl, describe the methodologies applied for estimating CO_2, CH_4 and N_2O emissions of the Waste sector in the Netherlands (see also Annex 6):
- Protocol 9052: CO_2 from Waste incineration (included in 1A1a);
- Protocol 9084: CH_4 from Waste disposal (6A1);
- Protocol 9085: CH_4, N_2O from Wastewater treatment (6B);
- Protocol 9086: CH_4, N_2O from Industrial composting (6D);
- Protocol 9088: CO_2 CH_4 N_2O from Biomass (1A);

The Waste sector accounted for 3% of total national emissions (without LULUCF) in 2007 compared with 6% in 1990, with the emissions of CH_4 and N_2O accounting for 92% and 8% of CO_2 equivalent emissions from the sector, respectively. Emissions of CH_4 from waste – almost all (89%) from Landfills (6A) – accounted for 31% of the national total CH_4 emissions in 2007. The N_2O emissions from the Waste sector stem from domestic and commercial wastewater. The fossil-fuel related emissions from waste incineration, mainly CO_2, are included in the fuel combustion emissions from the Energy Sector (1A1) since all large-scale incinerators also produce electricity and/or heat for energetic purposes.

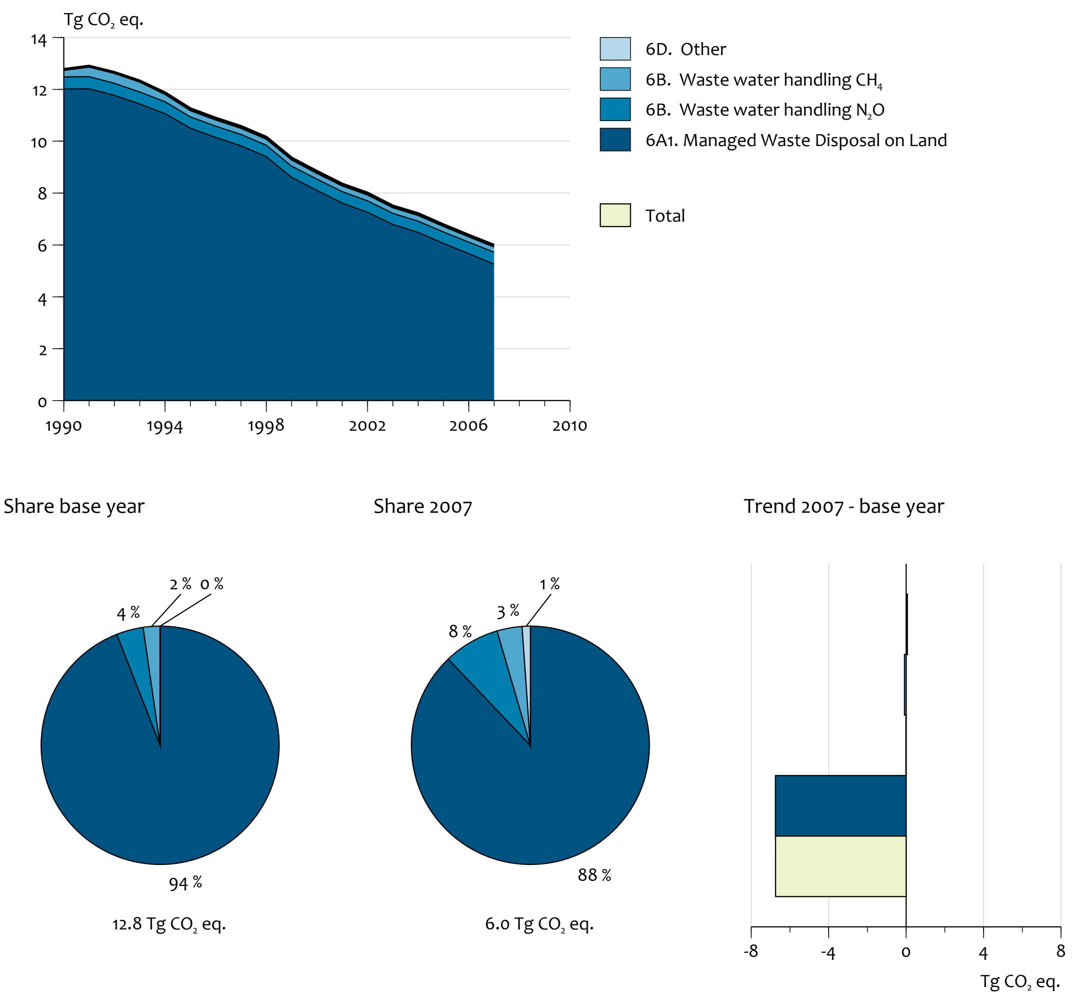
Emissions from the Waste sector decreased by 55% between 1990 and 2007 (see Figure 8.1), mainly due to a 56% reduction in CH_4 from Landfills (6A1 'Managed waste disposal on land). Between 2006 and 2007 the CH_4 emissions from landfills decreased by about 7%. The decreased methane emission from "Landfills" since 1990 is the result of:
- increasing recovery and recycling of waste for composting and/or incineration
- a considerable reduction in the amount of municipal solid waste (MSW) disposal at landfills
- a decreasing organic waste fraction in the waste disposed
- increasing methane recovery from the landfills (from 5% in 1990 to 23% in 2007) (see SenterNovem, 2008)

Table 8.1 shows the contribution of the emissions from the Waste sector to the total greenhouse gas emissions in the Netherlands and also presents the key sources in this sector specified by level, trend or both. The list of all (key- and non-key) sources in the Netherlands is shown in Annex 1. Total greenhouse gas emissions from the Waste sector decreased from 12.8 Tg CO_2 eq in 1990 to 6.0 Tg CO_2 eq in 2007. This decrease is mainly due to (SenterNovem, 2008):
- Increased recovery and recycling, resulting in a decreasing amount of solid waste disposed at landfills;
- A decreasing amount of organic waste disposed of at landfills;
- Increasing CH_4 recovery from landfills.

CH_4 emissions from landfills contribute the largest share to the greenhouse gas emissions of this sector. Category 6A1 Solid waste disposal sites (SWDS) is a key source specified by both level and trend , category 6B N_2O emissions from waste

6. Waste

Figure 8.1



water handling is a minor key source (L2) when uncertainties are taken into account (see Annex 1).

8.2 Solid waste disposal on land [6A]

8.2.1 Source category description

In 2007 there were 24 operating landfill sites as well as a few thousand older sites that are still reactive. CH_4 recovery takes place at 51 sites in the Netherlands. As a result of anaerobic degradation of the organic material within the landfill body, all of these landfills produce CH_4 and CO_2. Landfill gas comprises about 60% (vol.) CH_4 and 40% (vol.) CO_2. Due to a light overpressure, the landfill gas migrates into the atmosphere. On several landfill sites the gas is extracted before it is released into the atmosphere and subsequently used as an energy source or flared off. In both of these cases the CH_4 in the extracted gas is not released into the atmosphere. The CH_4 may be degraded (oxidized) to some extent by bacteria when it passes through the landfill cover; this results in a lower CH_4 concentration.

Anaerobic degradation of organic matter in landfills is a time-dependent process and may take many decades. Some of the factors influencing this process are known; some are not. Each landfill site has its own unique characteristics: concentration and type of organic matter, moisture and temperature, among others. The major factors determining the decreased net CH_4 emissions are lower quantities of organic carbon deposited into landfills (organic carbon content × total amount of land-filled waste) and higher methane recovery rates from landfills (see Sections 8.2.2 and 8.2.3).

The share of CH_4 emissions from landfills in the total national inventory of greenhouse gas emissions was 6% in 1990 and 3% in 2007. Between 1990 and 2007 CH_4 emissions have decreased by 56% to 250.5 Gg. This decrease is due to the increase in recovered CH_4 – from about 5% in 1990 to 24% in 2007 – but also to the decrease in methane produced in solid waste disposal sites.

In 2007 solid waste disposal on land accounted for 87% of the total emissions in the Waste sector and 3% of the total national CO_2 equivalent emissions (see Table 8.1).

The policy that has been implemented in the Netherlands is one directly aimed at reducing the amount of landfilled

Contribution of main categories and key sources in Sector 6 Waste **Table 8.1**

Sector/category	Gas	Key	Emissions base-year		Emissions 2006		Emissions 2007		Change 2007–2006	Contribution to total in 2007 (%)		
			Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Gg	Tg CO_2 eq	Gg	By sector	Of total gas	Of total CO_2 eq
6 Waste	CH_4		585.8	12.3	282.39	5.9	263.3	5.5	-19.0	92%	33%	3%
	N_2O		1.5	0.5	1.6	0.5	1.6	0.5	0.0	8%	3%	0.2%
	All			12.8		6.4		6.0	-387.0	100%		3%
6A. Solid Waste Disposal on Land	CH_4		571.9	12.0	269.7	5.7	250.5	5.3	-19.2	87%	31%	3%
6A1. Managed Waste Disposal on Land	CH_4	L.T	571.9	12.0	269.7	5.7	250.5	5.3	-19.2	87%	31%	3%
6B Waste water handling	N_2O	L2	1.5	0.5	1.4	0.4	1.5	0.5	0.0	8%	3%	0.2%
	CH_4		13.8	0.3	9.6	0.2	9.7	0.2	0.1	3%	1%	0.1%
	All			0.8		0.6		0.7	14.6	11%		0.3%
6D. Other	CH_4		0.06	0.0	3.1	0.1	3.2	0.1	0.1	1%	0.4%	0.0%
Total National Emissions	CH_4		1,216.5	25.5	801.5	16.8	807.9	17.0	6.4			
	N_2O		65.2	20.2	55.3	17.1	50.3	15.6	-5.0		100%	
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.3		208.5		207.5	-1,002.9			100%

waste. This policy requires enhanced prevention of waste production and the increased recycling of waste, followed by incineration. As early as the 1990s the government introduced bans on the use of certain categories of waste for land-filling; for example, the organic fraction of household waste. Another method implemented to reduce land-filling was to raise the landfill tax to comply with the increased costs of incinerating waste. Depending on the capacity of incineration, the government can grant exemption from these 'obligations'. Due to this policy the amount of waste used as landfill has decreased, thereby reducing emissions from this source category from more than 14 million tonnes in 1990 to 2 million tonnes in 2007.

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 9084 on the website www.greenhousegases.nl.

Activity data on the amount of waste disposed of at landfill sites are mainly based on the annual survey performed by the Working Group on Waste Registration at all the landfill sites in the Netherlands. This data can be found on the website www.uitvoeringafvalbeheer.nl and are documented in SenterNovem (2007). This document also contains the amount of CH_4 recovered from landfill sites yearly.

The implied emission factors correspond with the IPCC default values.

8.2.2 Methodological issues

A more detailed description of the method used and emission factors can be found in the protocol 9084 on the website www.greenhousegases.nl as indicated in Section 8.1.

In order to calculate the CH_4 emissions from all the landfill sites in the Netherlands, the simplifying assumption was made that all the wastes are assumed to be landfilled on one landfill site, an action that started in 1945. However, as stated above, characteristics of individual sites vary substantially. CH_4 emissions from this 'national landfill' are then calculated using a first-order decomposition model (first-order decay function) with an annual input of the total amounts deposited and the characteristics of the land-filled waste and the amount of landfill gas extracted. This is equivalent to the IPCC Tier 2 methodology. Since the CH_4 emissions from landfills are a key source, the present methodology is in line with the IPCC Good Practice Guidance (IPCC, 2001).

Parameters used in the landfill emissions model are as follows (until 2001 the fraction of methane in landfill gas was set at 60%; from 2002 and onwards the average fraction of CH_4 is determined yearly based on the composition of landfill gas at all sites with CH_4 recovery):

- total amount of land-filled waste
- fraction of degradable organic carbon (DOC) (see Table 8.2 for a detailed time-series)
- CH_4 generation (i.e. decomposition) rate constant (k): 0.094 up to and including 1989, decreasing to 0.0693 in 1995 and constant thereafter; this corresponds to half-life times of 7.4 and 10.0 years respectively (see Table 8.2 for a detailed time-series);
- CH_4 oxidation factor: 10%;
- fraction of DOC actually dissimilated (DOCF): 0.58; (see also (Oonk, 1994))
- CH_4 conversion factor (IPCC parameter): 1.0.

Trend information on IPCC Tier 2 method parameters that change over time is provided in Table 8.2. The change in DOC values is due to such factors as the prohibition landfilling of combustible wastes, whereas the change in k-values (CH_4 generation rate constant) is caused by a sharp increase in the recycling of vegetable, fruit and garden waste in the early 1990's. The integration time for the emission calculation is defined as the period from 1945 to the year for which the calculation is made.

Parameters used in the IPCC Tier 2 method that change over time (additional information on solid waste handling part [1]) **Table 8.2**

Parameter	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Waste generation rate [1] (kg/cap/day)	1.52	1.50	1.69	1.68	1.70	1.67	1.70	1.70	1.70	1.70
Fraction MSW disposed to SWDS	0.38	0.29	0.09	0.08	0.08	0.03	0.01	0.01	0.01	0.01
Fraction DOC in MSW	0.13	0.13	0.11	0.10	0.10	0.09	0.08	0.08	0.07	0.07
Fraction of waste incinerated	0.08	0.09	0.12	0.12	0.13	0.13	0.13	0.12	0.12	0.12
Fraction of waste recycled	0.63	0.75	0.80	0.80	0.80	0.81	0.83	0.84	0.84	0.84
CH_4 generation rate constant (k)	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Number of SWDS recovering CH_4	45	50	55	47	51	50	50	50	50	51
Waste incineration [2] (Tg)	3.9	4.7	7.1	7.5	8.2	8.2	7.9	7.1	7.1	7.2

1)Waste generation rate refers to MSW (muncipal solid waste), excluding inorganic industrial waste such as construction or demolition waste.
2) Waste incineration refers to the total amount of waste incinerated: municipal solid waste, industrial waste, commercial waste, sewage sludge e.a.

8.2.3 Uncertainty and time-series consistency

Uncertainty

The Tier 1 uncertainty analysis shown in Tables A7.1 and A7.2 of Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in CH_4 emissions of solid waste disposal sites is estimated to be approximately 35% in annual emissions. The uncertainty in the activity data and the emission factor are estimated to be 30% and 15%, respectively. For a more detailed analysis of these uncertainties, see Olivier et al.,2009.

Time-series consistency

The estimates for all years are calculated from the same model, which means that the methodology is consistent throughout the time-series. The time-series consistency of the activity data is very good due to the continuity in the data provided. Since 2002 the fraction of CH_4 in landfill gas is determined yearly based on the composition of the landfill gas of the sites recovering CH_4. It is expected that this will reflect the average fraction of CH_4 in the landfill gas better than the default used in previous inventories and slightly reduces uncertainties in the emission estimations of the post-2001 period. This "new" CH_4 fraction is only used to estimate methane in the recovered biogas and not for the generation of methane within the landfill site.

8.2.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in Chapter 1.

8.2.5 Source-specific recalculations

There are no source specific recalculations compared to the pervious submission.

8.2.6 Source specific planned improvements

During the review of the NIR 2006 by the ERT (in 2007) it was recommended to investigate the composition of soils in order to verify the fraction of organic carbon present and to include this fraction in the estimation of CH_4 emissions. In 2008 a project started studying, among others things, contaminated soils at landfill sites. As soon as the results are available these will be incorporated in the estimation method.

8.3 Wastewater handling [6B]

8.3.1 Source category description

General description of the source category

This source category covers emissions released from Wastewater handling and includes emissions from industrial, commercial and domestic wastewater and septic tanks.

The treatment of urban wastewaters and the resulting wastewater sludge is accomplished using aerobic and/or anaerobic processes. During the treatment, the biological breakdown of Degradable Organic Compounds (DOC) and nitrogen compounds can result in CH_4 and N_2O emissions, respectively. The discharge of effluents subsequently results in indirect N_2O emissions from surface waters due to the natural breakdown of residual nitrogen compounds. The source category also includes the CH_4 emissions from anaerobic industrial wastewater treatment plants (WWTP) and from septic tanks, but these are small compared to urban WWTP.

In this submission the N_2O emissions from the biological breakdown of nitrogen compounds in urban WWTP has been recalculated compared to the previous submission (see Section 8.1.5). N_2O emissions from waste water treatment (see Table 8.1) contributed about 3% to total N_2O emissions in 2007 (as well as in 1990) and 0.2% in total CO_2 eq N_2O emissions from waste water handling decreased by 2% during the period 1990–2007. This small decrease is the result of two counteracting trends. Improved biological breakdown of nitrogen compounds at urban WWTPs (see Table 8.4) leads to a gradual increase of N_2O emissions. However, this improved nitrogen removal results in lower effluent loads (see Table 8.4) and a subsequent decrease in the (indirect) N_2O emissions from human sewage.

The contribution of wastewater handling to the national total of CH_4 emissions in 2007 was 1%. Since 1994, CH_4 emissions from wastewater treatment plants have decreased due to the introduction in 1990 of a new sludge stabilization system in one of the largest wastewater treatment plants. As the operation of the plant took a few years to optimize, venting

Wastewater handling emissions of CH_4 and N_2O (Units: Gg/year) **Table 8.3**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CH_4 industrial wastewater	0.25	0.33	0.34	0.35	0.36	0.34	0.34	0.36	0.33	0.32
CH_4 domestic & commercial wastewater	9.07	7.90	7.96	8.15	8.55	7.99	8.50	8.20	8.12	8.37
CH_4 septic tanks	4.47	3.25	2.20	1.98	1.81	1.73	1.46	1.22	1.11	0.98
Net CH_4 emissions	13.79	11.48	10.50	10.47	10.72	10.06	10.31	9.78	9.56	9.68
CH_4 recovered and/or flared	33.0	39.2	40.4	39.6	43.3	43.2	44.0	41.9	43.8	43.7
Recovery/flared (% gross emission)	70.5	77.4	79.4	79.1	80.1	81.1	81.0	81.1	82.1	81.9
N_2O domestic & commercial wastewater	0.66	0.75	0.88	0.88	0.91	0.94	0.95	0.99	1.05	1.10
N_2O from human sewage	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Total N_2O emissions	1.50	1.40	1.41	1.42	1.42	1.39	1.40	1.43	1.43	1.47

Activity data of domestic and commercial wastewater handling (Gg/year), total volume of treated urban waste water (Mm^3/year) and percentage of population connected to septic tanks(%) **Table 8.4**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Wastewater DOC 1)	933	921	921	937	939	924	949	943	938	942
Sludge DOC	254	269	281	299	290	290	296	298	318	294
Nitrogen removed in urban WWTP	42.0	47.7	55.8	56.0	58.2	60.0	60.7	63.1	66.8	70.0
Nitrogen in effluents 2)	53.8	41.5	33.8	34.2	32.4	28.4	28.2	27.8	24.3	23.6
Treated volume	1,711	1,908	2,034	2,169	2,083	1,791	1,915	1,841	1,854	2,069
% Inhabitants with septic tanks	4.0	2.8	1.9	1.6	1.5	1.4	1.2	1.1	0.9	0.8

1) DOC, Degradable organic component.
2) Total of industrial, domestic and commercial effluents.

emissions were higher in the introductory period (1991–1994) than under normal operating conditions.

The amount of wastewater and sludge being treated does not change much over time. Therefore, the inter-annual changes in methane emissions can be explained by varying fractions of methane being flared instead of vented or used for energy purposes.

Table 8.3 shows the trend in greenhouse gas emissions from the different sources of wastewater handling.

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 9085 on the website www.greenhousegases.nl.

Most of the activity data on wastewater treatment are collected by Statistics Netherlands in yearly questionnaires which cover all urban WWTPs as well as all anaerobic industrial WWTPs; see also www.statline.cbs.nl for detailed statistics on wastewater treatment. Table 8.4 shows the development in the key activity data with respect to urban (= domestic and commercial) wastewater treatment. Due to the dry weather conditions in 2003 the volumes of treated wastewater and of the total load of DOC were significantly lower than those in surrounding years.

Table 8.3 shows that total N_2O emissions from wastewater handling decreased only 2% between 1990 and 2007. This small decrease is the overall result of an increase in N_2O emissions caused by improved nitrogen removal at urban WWTPs, and a decrease in the (indirect) N_2O emissions from human sewage as a result of lower effluent loads (see Table 8.4).

From Table 8.4 it can be concluded that the DOC of treated wastewater and sludge does not significantly change over time. Therefore, the interannual changes in CH_4 emissions can be explained by varying fractions of CH_4 being vented instead of flared or used for energy purposes.

The source Septic Tanks has steadily decreased from 1990 onwards. This can be explained by the increased number of households connected to the sewer system in the Netherlands (and therefore no longer using septic tanks; see Table 8.4).

8.3.2 Methodological issues

A full description of the methodology is provided in the monitoring protocol 9085 (see the website www.greenhousegases.nl) and in the background document (Oonk et al., 2004). In general, the emissions are calculated according to the IPCC guidelines, with country-specific parameters and emission factors being used for CH_4 emissions from wastewater handling (including sludge). The calculation methods are equivalent to the IPCC Tier 2 methods.

CH_4 emissions

For anaerobic industrial WWTPs, the CH_4 emission factor is expressed as 0.056 t/t DOC design capacity, assuming a utilization rate of 80%, a CH_4-producing potential (Bo) of 0.22 t/t DOC and a methane recovery (MR) of 99%.

For Urban wastewater treatment and anaerobic sludge handling, the combined emission factor is defined as 0.085 tons CH_4 per ton DOCinfluent. The emission factor takes into account that 37% of the influent DOC remains in the sludge and that CH_4 recovery from anaerobic sludge treatment is 94%.

Table 8.5: Removal efficiency for N in WWTP as fraction of influent N

1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
0.52	0.57	0.66	0.65	0.68	0.72	0.72	0.74	0.78	0.80

Source: Statistics Netherlands , Statline database

Incidental venting of biogas at urban WWTPs is recorded by the plant operators and subsequently reported to Statistics Netherlands.

For septic tanks, the emission factor for CH_4 is expressed as 0.0075 tons per year per person connected to a septic tank, assuming a methane correction factor (MCF) of 0.5 and a CH_4-producing potential (B_o) of 0.25.

N_2O emissions

N_2O emissions from the biological Nremoval processes in urban WWTP as well as indirect N_2O emission from effluents are calculated using the IPCC default emission factor of 0.01 tons N_2O-N per ton N removed or discharged. Since N_2O emissions from wastewater handling is identified in earlier NIR's as a key source, the present Tier 2 methodology complies with the IPCC Good Practice Guidance (IPCC, 2001).

Because of their insignificance compared to N_2O from domestic wastewater treatment, no N_2O emissions were estimated for industrial wastewater treatment and from septic tanks.

8.3.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis in Tables A7.1 and A7.2 in Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in annual CH_4 and N_2O emissions from wastewater handling are estimated to be 30% and 50%, respectively. The uncertainty in activity data is based on the judgments of experts and estimated to be 20%. The uncertainty in emission factors for CH_4 and N_2O are estimated to be 25% and 50% respectively.

Time-series consistency

The same methodology has been used to estimate emissions for all years, thereby providing a good time-series consistency. The time-series consistency of activity data is very good due to the continuity in the data provided by Statistics Netherlands.

8.3.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in Chapter 1.

8.3.5 Source-specific recalculations

Compared to the previous submission the calculation of N_2O emissions from urban WWTP has changed.

In the calculation of N_2O emissions from urban WWTP the default emissions factor of 0.01 kg N_2O per kg N removed is used. Up till now, the removed amount of N is calculated with a standard N-removal of 67% for the whole time series:

$$N_2O = 0.01 * N_{influent}$$
$$= 44/28 * EF * 0.67 * _{Ninfluent} \quad (1)$$

Where:

$N_{influent}$: amount of nitrogen in the influent (N-total or N-Kjeldahl) (in kg year⁻¹)
44/28 : conversion factor from N to N_2O
EF_{N_2O} : Emission factor =F 0.01 kg N_2O-N / kg N removed
0.67 : ηN =F removal efficiency of Nitrogen in the WWTP as fraction of influent.

It is recognized that the use of a standard removal rate is a simplification of the real situation. During the last 15 years Nitrogen removal in public WWTPs has increased rapidly due to the implementation of measures in order to comply with the requirements of the Urban Waste Water Treatment Directive. Emissions of N_2O are expected to increase simultaneously, because N_2O is a by-product of the nitrification and denitrification process. The old method did not reflect these increases. Therefore, in this submission a year-dependent removal efficiency is introduced in formula (1). Data on removal efficiencies are easy available from Statistics Netherlands. Table 8.5 gives the time series of the overall removal efficiency of N-total for all public WWTPs in the Netherlands.

As a result of introducing the yearly value of ηN, the formula for calculating laughing gas emissions will be as follows:

$$N_2O = 44/28 * 0.01 * \eta N * Ninfluent$$

The resulting data are presented in this submission. The consequences of the modification for the time series of emissions are given in Table 8.6. Compared to the old method, the new method will cause base year (1990) emissions to drop with 19%, while the emissions for 2006 will increase by 22%.

8.3.6 Source-specific planned improvements

8.3.7 There are no source specific planned improvements compared to the previous submission.

8.4 Waste incineration [6C]

8.4.1 Source category description

General description of the source category

The source category "Waste incineration" is included in category 1A1 (Energy industries) as part of the source 1A1a Public electricity and heat production, since all waste incineration facilities in the Netherlands also produce

Result of recalculation of N_2O emissions from Public WWTP **Table 8.6**

Year	N-influent [1]	Removal η	N_2O emissions (Gg/year)		Difference
	(Gg/year)	(-)	Current method	Proposed method	(%)
1990	81.3	0.517	0.813	0.660	-19%
1991	83.9	0.506	0.839	0.667	-21%
1992	84.5	0.524	0.845	0.696	-18%
1993	85.6	0.540	0.856	0.726	-15%
1994	86.6	0.537	0.866	0.730	-16%
1995	84.0	0.568	0.840	0.750	-11%
1996	82.9	0.578	0.829	0.753	-9%
1997	84.7	0.613	0.847	0.816	-4%
1998	85.6	0.598	0.856	0.804	-6%
1999	85.2	0.628	0.852	0.840	-1%
2000	84.7	0.658	0.847	0.876	3%
2001	85.7	0.653	0.857	0.879	3%
2002	86.0	0.677	0.860	0.915	6%
2003	83.7	0.718	0.837	0.944	13%
2004	84.2	0.721	0.842	0.955	13%
2005	84.8	0.744	0.848	0.991	17%
2006	85.8	0.778	0.858	1.049	22%

1) Source: Statline database of Statistics Netherlands

Composition of incinerated waste: carbon fraction and fossil fraction (%). **Table 8.7**

	Non household waste		Household Waste	
Waste type	Carbon fraction	Fossil fraction	Carbon fraction	Fossil Fraction
WIP[1]: paper/cardboard (%)	30	0	30	23
WIP: wood (%)	45	0	37	6
WIP: other organic (%)	20	0	22	6
WIP: plastics (%)	54	100	45	86
WIP: other combustible (%)	32	41	32	41
WIP: non-combustible (%)	1	100	1	100

1) WIP, Waste incineration plant; listed are the residential waste fractions; for waste fractions of other waste types (considered fixed in time), see Joosen and De Jager (2003).

electricity and/or heat used for energetic purposes. According to the IPCC Guidelines (IPCC, 2001), these are included in category 1A1a: Public electricity and heat production: other fuels (see Section 3.2.1).

Activity data and emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 9052 on the website www.greenhousegases.nl.

The activity data for the amount of waste incinerated are mainly based on the annual survey performed by the Working Group on Waste Registration at all 11 waste incinerators in the Netherlands. Data can be found on the website www.uitvoeringafvalbeheer.nl and in a background document (SenterNovem, 2007).

8.4.2 Methodological issues

A more detailed description of the method used and the emission factors can be found in the protocol 9052 on the website www.greenhousegases.nl, as indicated in Section 8.1.

Total CO_2 emissions – i.e. the sum of organic and fossil carbon – from waste incineration are reported per facility in the annual environmental reports and included in the ER-I data set. The fossil-based and organic CO_2 emissions from Waste incineration (e.g. plastics) are calculated from the total amount of waste incinerated. The composition of the waste (the six types listed in Table 8.5) is determined per waste stream (residential and several others). An assumption is made for each of these six types of waste with respect to the specific carbon and fossil carbon fractions, which will subsequently yield the CO_2 emissions. Table 8.7 shows the total amounts of waste incinerated, the fractions of the different waste components used for calculating the amounts of fossil and organic carbon in the waste (from their fossil and organic carbon fraction) and the corresponding amounts of fossil and organic carbon in total waste incinerated. The method is described in detail (Joosen and De Jager, 2003) and in the monitoring protocol, CH_4 emissions from these sources are not estimated (= neglected). Based on measurement data (Spoelstra, 1993), an emission factor of 20 g/ton waste is applied for N_2O from incineration with SCR. For Incineration with SNCR an emission of 100 g/ton is applied. The percentage SCR increased from 6% in 1990 to 36% in 2007.

In 2005 the carbon fraction of the household waste fraction and the percentage fossil of these fractions were determined.

Composition of incinerated waste **Table 8.8**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total waste incinerated (Gg)	2.8	2.9	4.9	4.7	5.0	5.0	5.2	5.5	5.5	5.5
of wich residential waste (Gg):	2.3	2.1	3.1	3.4	3.6	3.6	3.6	3.6	3.6	3.6
Of which:										
WIP[1]: paper/cardboard (%)	25	29	27	28	27	26	26	26	26	26
WIP: wood (%)	2	4	6	5	5	5	5	5	5	5
WIP: other organic (%)	46	33	32	32	32	32	32	32	32	32
WIP: plastics (%)	9	10	13	13	13	15	15	15	15	15
WIP: other combustible (%)	8	11	10	10	10	10	10	10	10	10
WIP: non-combustible (%)	11	12	12	12	13	13	13	13	13	13
Energy content (MJ/kg)	8.2	9.8	10.2	10.3	10.3	10.6	10.6	10.6	10.6	10.6
Fraction organic (%)	58	54	51	50	49	47	47	47	47	47
Amount of fossil carbon	162	221	405	408	435	477	477	477	477	477
Amount of organic carbon	530	563	929	897	932	924	924	924	924	924

1) WIP, Waste incineration plant (Not included incineration plant for specific waste streams as sewage sludge or hazardous waste.), listed are the residential waste fractions; for waste fractions of other waste types (considered fixed in time), see Joosen and De Jager (2003).

These values are still used for the calculation of the fossil and not fossil emissions from household waste. For the other fraction still the older values are used. (Bosselaar and Gerlagh, 2006).

8.4.3 Uncertainties and time-series consistency

Uncertainties
The Tier 1 uncertainty analysis in shown in Tables A7.1 and A7.2 in Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in annual CO_2 emissions from Waste incineration is estimated at 11%. The main factors influencing these emissions are the total amount being incinerated. The fractions of different waste components used for calculating the amounts of fossil and organic carbon in the waste (from their fossil and organic carbon fraction) and the corresponding amounts of fossil and organic carbon in the total waste incinerated. The uncertainty in the amounts of incinerated fossil waste and the uncertainty in the corresponding emission factor are estimated to be 10% and 5% respectively. These figures are based on expert judgment.

Time-series consistency
The time-series are based on consistent methodologies for this source category. The time-series consistency of the activity data is considered to be very good due to the continuity of the data provided by Statistics Netherlands.

8.4.4 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures that are discussed in Chapter 1.

8.4.5 Source-specific recalculations
There are no source-specific recalculations compared to the previous submission.

8.4.6 Source-specific planned improvements
There are no source-specific improvements planned for this category.

8.5 Other waste handling [6D]

8.5.1 Source category description

General description of the source category
This source category, which consists of the CH_4 and N_2O emissions from composting separately collected organic waste from households, is not considered to be a key source. Emissions from small-scale composting of garden waste and food waste by households are not estimated as these are assumed to be negligible. It should be noted that non-CO_2 emissions from the combustion of biogas at wastewater treatment facilities are allocated to category 1A4 "Fuel combustion – Other sectors" because this combustion is partly used for heat or power generation at the treatment plants.

The amount of composted organic waste from households increased from nearly 0 million tons up to 1.3 million tons in 2007. In 2007 there were 23 industrial composting sites in operation; these accounted for 1% of the emissions in the Waste sector in that year (see Table 8.1).

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 9086 on the website www.greenhousegases.nl.

The activity data for the amount of organic waste composted at industrial composting facilities are mainly based on the annual survey performed by the Working Group on Waste Registration at all industrial composting sites in the Netherlands. Data can be found on the website www.uitvoeringafvalbeheer.nl and in a background document (SenterNovem, 2007). This document also contains the amount of compost produced on a yearly basis.

The emission factors are based on the average emissions (per metric ton of composted organic waste) of a number of facilities that were measured in the late 1990s (during a large-scale monitoring program in the Netherlands). Recently the emission factors have been measured again (at three facilities, one measurement per facility) in the Netherlands. The average of these three measurements for methane was much lower than the applied emission factor, with a wide range. Because of the small number of measurements and the wide range of values these new insights have not been used.

8.5.2 Methodological issues
A more detailed description of the method used and the emission factors can be found in protocol 9086 on the website www.greenhousegases.nl as indicated in Section 8.1.

A country-specific methodology is used for estimating the industrial composting of organic food and garden waste from households. Since this source is not considered to be a key source, the present methodology level complies with the general IPCC Good Practice Guidance (IPCC, 2001). No mention is made of a method for estimating the industrial composting of organic waste in the Good Practice Guidance.

8.5.3 Uncertainties and time-series consistency

Uncertainty
The emissions of this source category are calculated using an average emission factor that has been obtained from the literature. Given the large scatter in reported emission factors the uncertainty is estimated to be more than 100%.

Time-series consistency
The time-series consistency of the activity data is very good due to the continuity in the data provided.

8.5.4 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures that are discussed in Chapter 1.

8.5.5 Source-specific recalculations
There are no source-specific recalculations compared to the previous submission.

8.5.6 Source-specific planned improvements
In 2007 the NIR 2006 was reviewed by an ERT. As a result of the review, the ERT recommended to investigate the application of compost to land and report the emissions from this application. In 2008 a study began to collect this information. After finalizing this study the emissions from the application of compost to land will be reported.

9 Other [CRF Sector 7]

The Netherlands allocates all emissions in Sectors 1 to 6; there are no sources of greenhouse gas emissions included in Sector 7

10 Recalculations and improvements

- **Major changes compared to the National Inventory Report 2008**
This chapter addresses the changes in emissions compared to the previous submission reported by van der Maas et al. (2008).
For the submission of this NIR 2009, the data for the most recent year (2007) were added to the corresponding Common Reporting Format (CRF). This submission also includes recalculated data for Land Use Change and Forestry (LULUCF), for CH_4 emissions from smaller CHP, for CH_4 and N_2O from agriculture and for N_2O from waste water treatment for the total period 1990-2007.
For more details on the effect and justification of the recalculations, the reader is referred to Chapters 3–8.

10.1 Explanation and justification for the recalculations

For this submission (NIR 2009), the Netherlands uses the CRF reporter software 3.2.2. The present CRF tables are based on improved methodologies after the UNFCCC review in 2007. These improved methodologies are also described in the (updated) monitoring protocols 2009 (see Annex 6).

This chapter summarizes the relevant changes in emission figures compared to the NIR 2008 (and CRF version 1.3). A distinction is made between:

- methodological changes: new emission data are reported resulting from revised or new estimation methods; improved emission factors or activity data are also captured in recalculations as a result of methodological changes
- allocation: changes in the allocation of emissions to different sectors (only affecting the totals per category or sector)
- error corrections: correction of incorrect data

10.1.1 Methodological changes

As part of the QA/QC activities in the Netherlands, the process of assessing and documenting methodological changes has been improved. This is now done using a brief check list for timely discussion with involved experts and users of information on likely changes. This process should improve peer review of and timely documentation on the background and justification of changes.

Since the submission of May 2008 different methodological changes are implemented in this submission:

- recalculation of LULUCF as an result of the in country review of 2007 Effect: -70.2 Gg CO_2 eq in the base year 1990 and -174.0 Gg CO_2 eq in the year 2006
- emission of methane from the smaller cogeneration facilities. Recent research shows that CH_4 emission from natural gas powered internal combustion engines is higher than formerly estimated. The emissions have increased for this source with 61 Gg CO_2 eq in 1990 and with 445 Gg CO_2 eq in the year 2006 compared to the last NIR. More details can be found in the monitoring protocol 9052: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.
- the new LULUCF data include now the use of limestone and associated CO_2 emissions in agriculture. To eliminate double counting, the emission from limestone use (as reported in 2.A.3) is now corrected. This reduced the CO_2 emission in 1990 with 44 Gg CO_2 eq and 29.7 Gg CO_2 eq in 2006.

Some significant improvements are made to the current methods:

- in the agriculture category the data for the total time series changed due to;
  - use of improved feed-data in the emission calculations for agriculture
  - inclusion of horses and ponies in the emission calculations for agriculture
  - inclusion of information of different husbandry systems and manure storage systems in the emission calculations for agriculture

  These improvements changed the base year emissions for CH_4 and N_2O with + 45 Gg CO_2 eq and +329 Gg CO_2 eq compared to the latest NIR. In 2006 the changes amounted to + 76 Gg CO_2 eq and +138 Gg CO_2 eq

Differences between NIR 2008 and NIR 2009 for the period 1990–2006 due to recalculations (unit: Tg CO_2 eq; for F-gases: Gg CO_2 eq) **Table 10.1**

Gas	Source	1990	1995	2000	2001	2002	2003	2004	2005	2006
CO_2 Incl. LUCF	NIR08	162.0	173.1	172.3	177.9	178.4	182.3	183.7	178.5	174.8
	NIR09	161.9	172.9	172.1	177.6	178.1	182.0	183.3	178.2	174.9
	Diff.	-0.1	-0.2	-0.2	-0.2	-0.3	-0.4	-0.4	-0.3	0.1
CO_2 Excl. LUCF	NIR08	159.4	170.6	169.6	175.2	175.8	179.7	181.1	175.9	172.2
	NIR09	159.3	170.6	169.6	175.2	175.7	179.6	181.0	175.8	172.5
	Diff.	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.3
CH_4	NIR08	25.4	23.8	19.2	18.8	18.0	17.5	17.3	16.8	16.3
	NIR09	25.5	24.2	19.8	19.3	18.4	17.9	17.6	17.2	16.8
	Diff.	0.1	0.4	0.6	0.5	0.5	0.3	0.3	0.4	0.6
N_2O	NIR08	19.9	21.3	19.0	17.9	17.1	16.8	17.3	17.1	16.9
	NIR09	20.2	21.5	19.3	18.1	17.3	16.9	17.4	17.3	17.1
	Diff.	0.3	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.2
PFCs Gg	NIR08	2,264	1,938	1,582	1,489	2,187	621	286	266	257
	NIR09	2,264	1,938	1,582	1,489	2,187	621	286	266	257
	Diff.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HFCs Gg	NIR08	4,432	6,020	3,824	1,469	1,541	1,379	1,511	1,353	1,559
	NIR09	4,432	6,020	3,829	1,469	1,541	1,377	1,507	1,358	1,566
	Diff.	0.0	0.0	5.4	-0.1	0.0	-1.6	-3.9	5.0	7.0
SF_6 Gg	NIR08	217	301	320	325	286	248	251	250	215
	NIR09	217	301	319	323	283	243	246	238	202
	Diff.	0.0	0.0	-1.1	-2.1	-3.1	-4.1	-5.1	-11.9	-12.9
Total Excl. LUCF	NIR08	211.7	224.0	213.6	215.3	214.9	216.3	217.7	211.8	207.5
	NIR09	212.0	224.6	214.4	215.9	215.5	216.7	218.0	212.2	208.5
	Diff.	0.3	0.6	0.8	0.6	0.6	0.4	0.3	0.4	1.0
Total Incl. LUCF	NIR08	214.3	226.4	216.3	217.9	217.5	218.9	220.3	214.3	210.1
	NIR09	214.6	226.9	216.9	218.3	217.8	219.0	220.4	214.6	210.9
	Diff.	0.3	0.4	0.6	0.4	0.3	0.1	0.1	0.2	0.9

Note: base year values as applied for the calculation of the Assigned Amount are indicated in bold.

- in the waste sector more detailed data on purification efficiencies in wastewater treatment plants are used in this submission. These improvements changed the base year emissions for CH_4 with – 47.7 Gg CO_2 eq compared to the latest NIR. In 2006 the changes amounted to + 62.9 Gg CO_2 eq
- increase in the use of company-specific emission factors, which does not effect the emissions in former years

The total effect of the above mentioned methodical changes and improvements on the emission level for the base year (1990) is -0.27Tg CO_2 eq and in 2006 +0.52 Tg CO_2 eq.

In 2006 the emissions of CO_2 changed compared to the previous submission due to improved fuel data for Fisheries and the removal of an error in the solid fuel emission from solids in 1.AA.1.A Public Electricity and Heat Production (see error correction below). These corrections amounted to an increase of the CO_2 emission with 0.29 Tg CO_2 eq in 2006.

The changes are elaborated in more detail in the sector chapters. Detailed breakdown of the changes and the explanations are documented in the CRF files.

10.1.2 Source allocation

In this submission an improved allocation of the fuels used for off road mobile machinery to different economic sources let also to a shift of emissions from category 1.AA.2.F Other Machinery to 1.AA.4.C Agriculture/Forestry/Fisheries. Total emissions did not change compared to previous submission. For 2006 an erroneous allocation of gaseous fuels and corresponding emissions was removed from 1.AA.4.C Agriculture/Forestry/Fisheries to 1.AA.4.A Commercial/Institutional.

10.1.3 Error correction

This year The Netherlands used a new automated system to transfer the data from the National Inventory Database to the CRFReporter. All the emissions of the greenhouse gasses and the F- gasses in this submission (for the total time series) were loaded in the CRFReporter using this system. In doing so, minor errors in the emission data of these gasses in the CRF were eliminated. These errors originated from the manual transfer of data between the databases in the past. The automated transfer of activity data and the emissions of the precursor gasses will be introduced in the next submission.

Besides the above mentioned smaller error corrections, one major error was removed in the solid fuel emission from solids in 1.AA.1.A Public Electricity and Heat Production for the year 2006.

All above changes in previous data (methodological, allocation and error correction) and others (which are of minor importance) are explained in the CRF.

Differences between NIR 2008 and NIR 2009 with respect to emission trends during the period 1990–2006 (Units: Gg CO_2 eq, rounded). **Table 10.2**

Gas	Trend (absolute)			Trend (percentage)		
CO_2 eq [Gg] [1]	NIR 2008	NIR 2009	*Difference*	NIR 2008	NIR 2009	*Difference*
CO_2	12,863	13,217	*354*	8.1%	8.3%	*0.2%*
CH_4	-9,155	-8,714	*441*	-36.0%	-34.1%	*1.9%*
N_2O	-3,000	-3,083	*-83*	-15.0%	-15.2%	*-0.2%*
HFCs	-2,873	-2,866	*7*	-64.8%	-64.7%	*0.2%*
PFCs	-2,008	-2,008	*0*	-88.7%	-88.7%	*0.0%*
SF_6	-2	-15	*-13*	-1.0%	-7.0%	*-5.9%*
Total	-4,174	-3,469	*705*	-2.0%	-1.6%	*0.3%*

1) Excluding LULUCF

10.2 Implications for emission levels

This chapter outlines and summarizes the implications of the changes as described in Section 10.1, for the emission levels over time. Table 10.1 elaborates the differences between the submissions from last year and the current NIR with respect to the level of the different greenhouse gases. More detailed explanations are elaborated in the relevant Chapters 3-8.

10.2.1 Effect of recalculations on base year and 2006 emission levels

Table 10.1 gives the changes due to the recalculations for the base year 1990, 1995 and 2000 to 2007 (compared to the NIR2008).

10.3 Implications for emission trends, including time-series consistency

In general, the recalculations improve both the accuracy and the time-series consistency of the estimated emissions. Table 10.2 presents the changed trends in the greenhouse gas emissions during this period due to the recalculations that were carried out.

10.4 Recalculations, response to the review process and planned improvements

10.4.1 Recalculations

No recalculations are anticipated in the next submission of the CRF.

10.4.2 Response to the review process

Public and peer review

Drafts of the NIR are subject to an annual process of general public review and a peer review. No remarks were received from the public on the draft NIR 2008 of January 2008. The peer review includes a general check on all chapters. In addition, a special focus is given to a specific sector or topic each year: this year a separate study (Neelis et al, 2009) focused on the industrial sector (CO_2 emissions from combustion and processes).

In general, the conclusion of the peer review is that "the quality of the Dutch NIR and related documents (CRF Tables, protocols) can be considered as good. Methodologies applied are generally described in sufficient detail and the information provided is in most cases clear, up-to-date and sufficient. Without any doubts, there are possibilities for further improvement, but these improvements can be regarded as improvements to an in principle very mature and high quality document."

The main recommendations from the peer review are concerned with transparency, readability and correction of small inconsistencies and inaccuracies in the text. In a few cases the peer review refers to the conclusions in the peer review of 2006 (Neelis, 2006). Many of these recommendations are implemented in the present NIR 2009.

UNFCCC reviews

The NIR 2007 and NIR 2008 were reviewed in the fall of 2008 and the report was published on 5th February 2009. The review report holds seven key recommendations and several sector specific recommendations and cross cutting issues.

To improve the consistency of information the documentation in the NIR and the protocols is being improved (rather than referring only to background reports). A first set of protocols is being updated; the full set is planned to be ready before the NIR 2010. The protocols for transport were targeted for this update among others to increase the transparency. The improved documentation of the export and import of manure and how this is treated in the calculations is under preparation, but this document could not be finalized in time for the 2009 submission and so not be incorporated in the protocols 2009.

The completeness of the inventory is a topic that already got attention for a long period, but the completeness is related to the allocation of resources and the relative importance of a source. This submission holds for the first time information on litter (as part of the Dead Organic Matter) in the LULUCF sector. To improve the transparency Annex 5 (Assessment of completeness) now holds information on actions undertaken to estimate AD and EFs and explanations why those did not result in reported data.

Information is also being further improved on sector-specific QC; the results are also expected in the NIR 2010.

For the key category analysis Annex 1 of the NIR holds now two tables (in stead of one) and so a clear differentiation of the key category analysis is presented.

For the LULUCF sector this year's submission holds major improvements. A new land use matrix is generated while the allocation of different land use categories is improved and made more consistent between 1990 and 2004. Among other forest land now holds only two subcategories and open water is reported no longer under other land (but under wetlands). Also deforestation got special attention and the emission factor for re- and afforestation was changed. For more detailed information, see Chapter 7

The time period was to short to take into account most of the sector specific recommendations for this submission and will be handled in the preparation of the 2010 submission.

10.4.3 Completeness of sources

The Netherlands' greenhouse gas emission inventory includes all sources identified by the Revised Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 1996) – with the exception of the following, very minor, sources:

- oil transport (1B2a3), due to missing activity data
- charcoal production (1B2) and use (1A4), due to missing activity data
- CO_2 from lime production (2A2), due to missing activity data
- CO_2 from asphalt roofing (2A5), due to missing activity data
- CO_2 from road paving (2A6), due to missing activity data
- CH_4 from enteric fermentation of poultry (4A9), due to missing emission factors
- N_2O from industrial waste water (6B1), due to negligible amounts
- Precursor emissions (i.e. carbon monoxide (CO), nitrogen oxide (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (2)) from Memo item "International bunkers" (international transport) have not been included.

For more extended information on this issue, see annex 5.

10.4.4 Completeness of the CRF files

For the years 1991–1994 the energy data is less detailed for all industrial source categories than in both the preceding and following years, but they adequately cover all sectors and source categories. All emissions are specified per fuel type (solid, liquid and gaseous fossil fuels). Coal-derived gases (coke oven gas, blast furnace gas etc.) are included in Solid fuels and refinery gases and residual chemical gases are included in Liquid fuels (also LPG, except for Transport). The fuel category Other fuels is used to report emissions from fossil waste in waste incineration (included in 1A1a).

Since the Industrial processes source categories in the Netherlands often comprise only a few companies, it is generally not possible to report detailed and disaggregated data. Activity data are confidential and not reported when a source category comprises three (or fewer) companies.

Potential emissions (= total consumption data) for PFCs and SF_6 are not reported due to the confidentiality of the consumption data. A limited number of companies report emissions or consumption data, and actual estimates are made on the basis of these figures. Data to estimate potential emissions, however, are confidential (Confidential Business Information).

10.4.5 Planned improvements

The Netherlands National System was established by the end of 2005, in line with the requirements under the Kyoto Protocol and under the EU Monitoring Mechanism. The establishment of the National System was a result of the implementation of a monitoring improvement programme (see Section 1.6). In 2007 the system was reviewed during the initial review. The review team concluded that the Netherlands' National System has been established in accordance with the guidelines for national systems under Article 5, Section 1, of the Kyoto Protocol (decision 19/CMP.1) and that it meets the requirements for implementation of the general functions of the National System as well the specific functions of inventory planning, inventory preparation and inventory management.

Monitoring improvement

The National System includes an annual evaluation and improvement process. The evaluation is based on experiences in previous years, results of UN reviews, peer reviews, audits, and so on. Where needed, improvements are included in the annual update of the QA/QC program (SenterNovem, 2008).

One of the recent improvement actions relates to the emission factor (EF) for natural gas. This EF has been calculated on a yearly basis for a number of years, using detailed data from the gas supply companies. The annual EF was established in this way for the NIR 2006, for 2004 and the base year 1990. For both years the emission factor proved to be 56.8. Given the time constraints, the EF for intermediate years was assumed to be constant. In 2008 a study analyzed this further using two further sample years; the conclusion was that annual fluctuations in intermediate years were very minor. It was therefore decided not to carry out any more detailed assessment for further intermediate years and to maintain the EF for these intermediate years at 56.8, especially since these years are neither base years nor commitment period years. Since 2007, the EF has been assessed annually. The value in 2007 was 58.7 [Zijlema, 2008], see Annex 2.

As a result of the initial review it was decided to re-assess the basic data on deforestation. Results are included in this NIR.

Monitoring protocol and QAQC program

The Netherlands uses monitoring protocols that describe the methodology, data sources (and the rationale for their selection). These protocols are available on the website www.greenhousegases.nl. The protocols were given a legal basis in December 2005. The monitoring protocols are assessed annually and –when needed– updated. The initial review recommended that some of the protocols should include more details (i.e. inclusion of some additional information that is now only included in background documents). For 2008 the Netherlands has included this recommendation in its QAQC program and improved the 'balance' between NIR, protocols and background reports. Some results are used in the NIR2009, but the finalization of this update will only take effect in the NIR 2010.

The QA/QC program for this year (SenterNovem, 2008) also continues the assessment of improvement options in the longer term, partly based on the consequences of the new 2006 IPCC guidelines. This will provide a basis for a possible improvement program for the longer term.

The review team recommended the further centralization of the archiving of intermediate calculations. Most documentation and archiving is already centralized, with the exception of some intermediate/supporting data calculations archived at task force level. This recommendation will also be considered during the data process in the coming years.

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Annex 1 Key sources

A1.1 Introduction

As explained in the Good Practice Guidance (IPCC, 2001), a key source category is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both.

For the identification of key sources in the Netherlands inventory, we allocated the national emissions according to the Intergovernmental Panel on Climate Change (IPCC) potential key source list, as presented in Table 7.1 in Chapter 7 of the Good Practice Guidance. As suggested in this table, the carbon dioxide (CO_2) emissions from stationary combustion (1A1, 1A2 and 1A4) are aggregated by fuel type. CO_2, methane (CH_4) and nitrous oxide (N_2O) emissions from "Mobile combustion: road vehicles" (1A3) are assessed separately. The CH_4 and N_2O emissions from aircrafts and ships are relatively small (about 1–2 GgCO_2 equivalents). Other mobile sources are not assessed separately by gas. "Fugitive emissions from oil and gas operations" (1B) is an important source of greenhouse gas emissions in the Netherlands. The most important gas/source combinations in this category are separately assessed. Emissions in other IPCC sectors are disaggregated, as suggested by IPCC.

The IPCC Tier 1 method consists of ranking the list of source category/gas combinations according to their contribution to the national total annual emissions and to the national total trend. The darker green areas at the top of the tables in this Annex are the largest sources, of which the total adds up to 95% of the national total: 32 sources for annual level assessment (emissions in 2007) and 30 sources for the trend assessment out of a total of 70 sources. Both lists can be combined to obtain an overview of sources that meet any of these two criteria.

The IPCC Tier 2 method for identification of key sources requires the incorporation of the uncertainty in each of these sources before ordering the list of shares. This has been carried out using the uncertainty estimates presented in Annex 7 (for details on the Tier 1 uncertainty analysis see Olivier et al.,2009). The results of the Tier 1 and Tier 2 level and trend assessments are summarized in Table A1.1 and show a total of 43 key sources. As expected, the Tier 2 level and trend assessment increases the importance of very uncertain sources. It can be concluded that in using the results of a Tier 2 key source assessment, 4 more sources are added to the list of 32 Tier 1 level and trend key sources:

- CH_4 emissions from "Manure management, poultry" (Tier 2 trend)
- Direct N_2O emissions from agricultural soils (Tier 2 trend)
- CO_2 emissions from Land converted to grassland (Tier 2 trend)
- N_2O emissions from wastewater handling (Tier 2 Level)

The share of these sources in the national annual total becomes more important when taking their uncertainty (50%–100%) into account (Table A1.4). We then include the most important Land Use, Land Use Change and Forestry (LULUCF) emission sinks and sources in the Tier 1 and Tier 2 key source calculations to identify the key sources in IPCC Sector 5. This results in 4 additional key sources, giving an overall total of 43 key sources; see also Table A1.2. In this report, the key source assessment is based on emission figures from Common Reporting Format (CRF) 2009 version 1.1, submitted to the European Union (EU) in January 2009.

Key source list identified by the Tier 1 and 2 level and trend assessments (based on CRF tables 2009 version 1.1. Level assessment for 2007 emissions including LULUCF sources)

Table A1.1

Category	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
ENERGY							
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: liquids	Key(L1,T1)	1	1	0	0
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: solids	Key(L,T1)	1	1	1	0
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: gases	Key(L,T)	1	1	1	1
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: waste incineration	Key(L1,T)	1	1	0	1
1A1b	CO_2	Stationary combustion: Petroleum Refining: liquids	Key(L,T1)	1	1	1	1
1A1b	CO_2	Stationary combustion: Petroleum Refining: gases	Key(L1,T1)	1	1	0	0
1A1c	CO_2	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	Non key	0	0	0	0
1A1c	CO_2	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	Key(L,T)	1	1	1	0
1A2	CO_2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	Key(L,T1)	1	1	1	0
1A2	CO_2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	Key(L,T1)	1	0	1	0
1A2	CO_2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	Key(L,T1)	1	1	1	1
1A3b	CO_2	Mobile combustion: road vehicles: gasoline	Key(L,T1)	1	1	1	0
1A3b	CO_2	Mobile combustion: road vehicles: diesel oil	Key(L,T)	1	1	1	1
1A3b	CO_2	Mobile combustion: road vehicles: LPG	Key(L1,T)	1	1	0	1
1A3	CO_2	Mobile combustion: water-borne navigation	Key(L1)	1	1	0	0
1A3	CO_2	Mobile combustion: aircraft	Non key	0	0	0	0
1A3	CO_2	Mobile combustion: other	Non key	0	0	0	0
1A3	CH_4	Mobile combustion: other	Non key	0	0	0	0
1A3	N_2O	Mobile combustion: other	Non key	0	0	0	0
1A3	CH_4	Mobile combustion: road vehicles	Non key	0	0	0	0
1A3	N_2O	Mobile combustion: road vehicles	Non key	0	0	0	0
1A4	CO_2	Stationary combustion: Other Sectors, solids	Non key	0	0	0	0
1A4a	CO_2	Stationary combustion: Other Sectors: Commercial/Institutional, gases	Key(L,T)	1	1	1	1
1A4b	CO_2	Stationary combustion: Other Sectors, Residential, gases	Key(L,T)	1	1	1	1
1A4c	CO_2	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	Key(L,T)	1	1	1	1
1A4c	CO_2	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	Key(L,T)	1	0	1	0
1A4	CO_2	Stationary combustion: Other Sectors, liquids excl. from 1A4c	Key(T)	1	1	0	1
1A5	CO_2	Military use of fuels (1A5 Other)	Non key	0	1	0	0
1A	CH_4	Emissions from stationary combustion: non-CO2	Key(L,T)	1	0	1	0
1A	N_2O	Emissions from stationary combustion: non-CO2	Non key	0	0	0	0
1B1	CH_4	Coal mining					
1B1b	CO_2	Coke production	Non key	0	0	0	0
1B2	CO_2	Fugitive emissions from venting/flaring: CO2	Key(,T)	0	1	0	1
1B2	CH_4	Fugitive emissions venting/flaring	Key(T)	0	1	0	1
1B2	CH_4	Fugitive emissions from oil and gas: gas distribution	Non key	0	0	0	0
1B2	CH_4	Fugitive emissions from oil and gas operations: other	Non key	0	0	0	0
INDUSTRIAL PROCESSES							
2A1	CO_2	Cement production	Non key	0	0	0	0
2A3	CO_2	Limestone and dolomite use	Non key	0	0	0	0
2A7	CO_2	Other minerals	Non key	0	0	0	0
2B1	CO_2	Ammonia production	Key(L1)	1	1	0	0
2B2	N_2O	Nitric acid production	Key(L,T)	1	1	1	1
2B5	N_2O	Caprolactam production	Non key	0	0	0	1
2B5	CO_2	Other chemical product manufacture	Key(L)	1	1	0	0
2C1	CO_2	Iron and steel production (carbon inputs)	Key(L1,T1)	1	1	1	1
2C3	CO_2	CO_2 from aluminum production	Non key	0	0	0	0
2C3	PFC	PFC from aluminum production	Key(T)	0	0	1	1
2F	SF_6	SF_6 emissions from SF6 use	Non key	0	0	0	0
2F	HFC	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	Key(L,T)	1	1	1	1
2E	HFC	HFC-23 emissions from HCFC-22 manufacture	Key(T)	0	0	1	1
2E	HFC	HFC byproduct emissions from HFC manufacture	Non key	0	0	0	0
2F	PFC	PFC emissions from PFC use	Non key	0	0	0	0
2G	CO_2	Other industrial: CO_2	Non key	0	0	0	0
2G	CH_4	Other industrial: CH_4	Non key	0	0	0	0
2G	N_2O	Other industrial: N_2O	Non key	0	0	0	0

Category	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
SOLVENTS AND OTHER PRODUCT USE							
3	CO_2	Indirect CO_2 from solvents/product use	Non key	0	0	0	0
3	CH_4	Solvents and other product use	IE in 2G				
AGRICULTURAL SECTOR							
4A1	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: cattle	Key(L,T)	1	1	1	1
4A8	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: swine	Non key	0	0	0	0
4A	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: other	Non key	0	0	0	0
4B	N_2O	Emissions from manure management	Key(L)	1	1	0	0
4B1	CH_4	Emissions from manure management: cattle	Key(L)	1	1	0	0
4B8	CH_4	Emissions from manure management: swine	Key(L)	1	1	0	0
4B9	CH_4	Emissions from manure management: poultry	Key(T2)	0	0	0	0
4B	CH_4	Emissions from manure management: other	Non key	0	0	0	0
4C	CH_4	Rice cultivation					
4D1	N_2O	Direct N_2O emissions from agricultural soils	Key(L,T2)	1	1	0	1
4D3	N_2O	Indirect N_2O emissions from nitrogen used in agriculture	Key(L,T)	1	1	1	1
4D2	N_2O	Animal production on agricultural soils	Key(L,T)	1	1	1	1
LAND USE, LAND USE CHANGE AND FORESTRY							
5A1	CO_2	5A1. Forest Land remaining Forest Land	Key(L,T)		1		1
5A2	CO_2	5A2. Land converted to Forest Land	Key(L,T)		1		1
5B2	CO_2	5B2. Land converted to Cropland	Non key		0		0
5C1	CO_2	5C1. Grassland remaining Grassland	Key(L)		1		0
5C2	CO_2	5C2. Land converted to Grassland	Key(L,T2)		1		0
5D2	CO_2	5D2. Land converted to Wetlands	Non key		0		0
5E2	CO_2	5E2. Land converted to Settlements	Non key		0		0
5F2	CO_2	5F2. Land converted to Other Land	Non key		0		0
5G	CO_2	5G. Other (liming of soils)	Non key		0		0
WASTE							
6A1	CH_4	CH_4 emissions from solid waste disposal sites	Key(L,T)	1	1	1	1
6B	CH_4	Emissions from waste water handling	Non key	0	0	0	0
6B	N_2O	Emissions from waste water handling	Key(L2)	0	0	0	0
6C	all	Emissions from waste incineration					
6D	CH_4	Misc. CH_4	Non key	0	0	0	0
3, 6D	N_2O	Misc. N_2O	Non key	0	0	0	0
TOTAL KEY SOURCE CATEGORIES (INCL. LULUCF)			43	36	34	29	27

Key source list identified by the Tier 1 and 2 level and trend assessments (based on CRF tables 2009 version 1.1. Level assessment for 2007 emissions excluding LULUCF sources.)

Table A1.2

Category	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
ENERGY							
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: liquids	Key(L1,T1)	1	1	0	0
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: solids	Key(L,T1)	1	1	1	0
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: gases	Key(L,T)	1	1	1	1
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: waste incineration	Key(L1,T)	1	1	0	1
1A1b	CO_2	Stationary combustion: Petroleum Refining: liquids	Key(L,T1)	1	1	1	1
1A1b	CO_2	Stationary combustion: Petroleum Refining: gases	Key(L1,T1)	1	1	0	0
1A1c	CO_2	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	Non key	0	0	0	0
1A1c	CO_2	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	Key(L,T)	1	1	1	0
1A2	CO_2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	Key(L,T1)	1	1	1	0
1A2	CO_2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	Key(L,T1)	1	0	1	0
1A2	CO_2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	Key(L,T1)	1	1	1	1
1A3	CO_2	Mobile combustion: road vehicles: gasoline	Key(L,T1)	1	1	1	0
1A3	CO_2	Mobile combustion: road vehicles: diesel oil	Key(L,T)	1	1	1	1
1A3	CO_2	Mobile combustion: road vehicles: LPG	Key(L1,T)	1	1	0	1
1A3	CO_2	Mobile combustion: water-borne navigation	Key(L1)	1	1	0	0
1A3	CO_2	Mobile combustion: aircraft	Non key	0	0	0	0
1A3	CO_2	Mobile combustion: other	Non key	0	0	0	0
1A3	CH_4	Mobile combustion: other	Non key	0	0	0	0
1A3	N_2O	Mobile combustion: other	Non key	0	0	0	0
1A3	CH_4	Mobile combustion: road vehicles	Non key	0	0	0	0
1A3	N_2O	Mobile combustion: road vehicles	Non key	0	0	0	0
1A4	CO_2	Stationary combustion: Other Sectors, solids	Non key	0	0	0	0
1A4a	CO_2	Stationary combustion: Other Sectors: Commercial/Institutional, gases	Key(L,T)	1	1	1	1
1A4b	CO_2	Stationary combustion: Other Sectors, Residential, gases	Key(L,T)	1	1	1	1
1A4c	CO_2	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	Key(L,T)	1	1	1	1
1A4c	CO_2	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	Key(L,T)	1	0	1	0
1A4	CO_2	Stationary combustion: Other Sectors, liquids excl. from 1A4c	Key(T)	1	1	0	1
1A5	CO_2	Military use of fuels (1A5 Other)	Non key	0	1	0	0
1A	CH_4	Emissions from stationary combustion: non-CO_2	Key(L,T)	1	0	1	0
1A	N_2O	Emissions from stationary combustion: non-CO_2	Non key	0	0	0	0
1B1	CH_4	Coal mining					
1B1b	CO_2	Coke production	Non key	0	0	0	0
1B2	CO_2	Fugitive emissions from venting/flaring: CO_2	Key(,T)	0	1	0	1
1B2	CH_4	Fugitive emissions venting/flaring	Key(T)	0	1	0	1
1B2	CH_4	Fugitive emissions from oil and gas: gas distribution	Non key	0	0	0	0
1B2	CH_4	Fugitive emissions from oil and gas operations: other	Non key	0	0	0	0
INDUSTRIAL PROCESSES							
2A1	CO_2	Cement production	Non key	0	0	0	0
2A3	CO_2	Limestone and dolomite use	Non key	0	0	0	0
2A7	CO_2	Other minerals	Key(L1)	1	1	0	0
2B1	CO_2	Ammonia production	Key(L,T)	1	1	1	1
2B2	N_2O	Nitric acid production	Non key	0	0	0	1
2B5	N_2O	Caprolactam production	Key(L)	1	1	0	0
2B5	CO_2	Other chemical product manufacture	Key(L1,T1)	1	1	1	1
2C1	CO_2	Iron and steel production (carbon inputs)	Non key	0	0	0	0
2C3	CO_2	CO_2 from aluminum production	Key(T)	0	0	1	1
2C3	PFC	PFC from aluminum production	Non key	0	0	0	0
2F	SF_6	SF_6 emissions from SF_6 use	Key(L,T)	1	1	1	1
2F	HFC	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	Key(T)	0	0	1	1
2E	HFC	HFC-23 emissions from HCFC-22 manufacture	Non key	0	0	0	0
2E	HFC	HFC byproduct emissions from HFC manufacture	Non key	0	0	0	0
2F	PFC	PFC emissions from PFC use	Non key	0	0	0	0
2G	CO_2	Other industrial: CO_2	Non key	0	0	0	0
2G	CH_4	Other industrial: CH_4	Non key	0	0	0	0
2G	N_2O	Other industrial: N_2O	Non key	0	0	0	0

SOLVENTS AND OTHER PRODUCT USE							
3	CO_2	Indirect CO_2 from solvents/product use	Non key	0	0	0	0
3	CH_4	Solvents and other product use	IE in 2G				
AGRICULTURAL SECTOR							
4A1	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: cattle	Key(L,T)	1	1	1	1
4A8	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: swine	Non key	0	0	0	0
4A	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: other	Non key	0	0	0	0
4B	N_2O	Emissions from manure management	Key(L)	1	1	0	0
4B1	CH_4	Emissions from manure management: cattle	Key(L)	1	1	0	0
4B8	CH_4	Emissions from manure management: swine	Key(L)	1	1	0	0
4B9	CH_4	Emissions from manure management: poultry	Key(T2)	0	0	0	0
4B	CH_4	Emissions from manure management: other	Non key	0	0	0	0
4C	CH_4	Rice cultivation					
4D1	N_2O	Direct N_2O emissions from agricultural soils	Key(L,T2)	1	1	0	1
4D3	N_2O	Indirect N_2O emissions from nitrogen used in agriculture	Key(L,T)	1	1	1	1
4D2	N_2O	Animal production on agricultural soils	Key(L,T)	1	1	1	1
WASTE							
6A1	CH_4	CH_4 emissions from solid waste disposal sites	Key(L,T)	1	1	1	1
6B	CH_4	Emissions from waste water handling	Non key	0	0	0	0
6B	N_2O	Emissions from waste water handling	Non key	0	0	0	0
6C	all	Emissions from waste incineration					
6D	CH_4	Misc. CH_4	Non key	0	0	0	0
3, 6D	N_2O	Misc. N_2O	Non key	0	0	0	0
KEY SOURCE CATEGORIES (EXCL. LULUCF)			39	32	30	26	23

A1.2 Changes in key sources compared to previous submission

Due to the use of emission data for 2007 in the key source analysis, the following changes have taken place compared to the previous NIR:

- N_2O emissions from 1A3 Mobile combustion: road vehicles: now non key;
- CO_2 emissions from 2A7 Other minerals: now non-key;
- N_2O emissions from 2B5 Caprolactam production now non-key;
- CO_2 emissions from 5C2 Land converted to Grassland now key;
- CO_2 emissions from 5F2 Land converted to other land now non-key;
- N_2O emissions from 6B waste water handling now key

A1.3 Tier 1 key source and uncertainty assessment

In Tables A1.3 and A1.4 the source ranking is done according to the contribution to the 2007 annual emissions total and to the base year to 2007 trend respectively. This resulted in 32 level key sources and 30 trend key sources (excluding LULUCF).

Source ranking using IPCC Tier 1 level assessment 2007 (amounts in GgCO_2 eq) — Table A1.3

IPCC	Category	Gas	CO_2 eq last year	Share	Cum. Share
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	26068	13%	13%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	23675	11%	24%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20496	10%	34%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	15747	8%	41%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	14148	7%	48%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13000	6%	55%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	9970	5%	59%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9060	4%	64%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	9051	4%	68%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	6585	3%	71%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	5636	3%	74%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	5260	3%	76%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4868	2%	79%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4550	2%	81%
2B2	Nitric acid production	N_2O	4305	2%	83%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3124	2%	85%
2B1	Ammonia production	CO_2	3016	1%	86%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	2596	1%	87%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2208	1%	88%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2184	1%	89%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2153	1%	90%
2C1	Iron and steel production (carbon inputs)	CO_2	1647	1%	91%
4B1	Emissions from manure management : cattle	CH_4	1471	1%	92%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1471	1%	93%
1A	Emissions from stationary combustion: non-CO_2	CH_4	1226	1%	93%
4B8	Emissions from manure management : swine	CH_4	1082	1%	94%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	962	0%	94%
4B	Emissions from manure management	N_2O	872	0%	95%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	741	0%	95%
2B5	Other chemical product manufacture	CO_2	606	0%	95%
1A3	Mobile combustion: water-borne navigation	CO_2	606	0%	96%
4D2	Animal production on agricultural soils	N_2O	603	0%	96%
2B5	Caprolactam production	N_2O	497	0%	96%
2A7	Other minerals	CO_2	485	0%	96%
1B2	Fugitive emissions venting/flaring	CH_4	479	0%	97%
6B	Emissions from wastewater handling	N_2O	456	0%	97%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	446	0%	97%
1B1b	CO_2 from coke production	CO_2	444	0%	97%
1A3	Mobile combustion: road vehicles	N_2O	438	0%	97%
2C3	CO_2 from aluminium production	CO_2	431	0%	98%
2A1	Cement production	CO_2	403	0%	98%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	367	0%	98%
1A5	Military use of fuels (1A5 Other)	CO_2	317	0%	98%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	315	0%	98%
1A	Emissions from stationary combustion: non-CO_2	N_2O	313	0%	98%
2G	Other industrial: CO_2	CO_2	307	0%	99%
2G	Other industrial: CH_4	CH_4	302	0%	99%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	272	0%	99%
2A3	Limestone and dolomite use	CO_2	261	0%	99%
2E	HFC-23 emissions from HCFC-22 manufacture	HF_C	243	0%	99%
2F	PFC emissions from PFC use	PFC	226	0%	99%
2F	SF_6 emissions from SF_6 use	SF_6	214	0%	99%
6B	Emissions from wastewater handling	CH_4	203	0%	99%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	158	0%	100%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	140	0%	100%
3	Indirect CO_2 from solvents/product use	CO_2	128	0%	100%
3, 6D	OTHER N_2O	N_2O	121	0%	100%
2C3	PFC from aluminium production	PFC	101	0%	100%
1A3	Mobile combustion: other (railways)	CO_2	97	0%	100%
1A4	Stationary combustion : Other Sectors, solids	CO_2	86	0%	100%

IPCC	Category	Gas	CO_2 eq last year	Share	Cum. Share
6D	OTHER CH_4	CH_4	67	0%	100%
4B9	Emissions from manure management : poultry	CH_4	66	0%	100%
1A3	Mobile combustion: road vehicles	CH_4	45	0%	100%
1A3	Mobile combustion: aircraft	CO_2	41	0%	100%
2E	HFC by-product emissions from HFC manufacture	HFC	24	0%	100%
4B	Emissions from manure management : other	CH_4	15	0%	100%
2G	Other industrial: N_2O	N_2O	6	0%	100%
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%

A1.4 Tier 2 key source assessment

Using the uncertainty estimate for each key source as a weighting factor (see Annex 7), the key source assessment was performed again. This is called the Tier 2 key source assessment. The results of this assessment are presented in Tables A1.5 and A1.6 for the contribution to the 2007 annual emissions total and to the trend respectively. Comparison with the Tier 1 assessment presented in Tables A1.3 and A1.4 shows less level and trend key sources (26 and 23 respectively instead of 32 and 30).

With respect to Tier 2 level key sources, and perhaps surprisingly, the energy industries, with the highest share (30%) in the national total are not number one when including the uncertainty estimates. As Table A1.5 shows, two large but quite uncertain N_2O sources are now in the top five list of level key sources:

- indirect N_2O emissions from nitrogen used in agriculture
- direct N_2O emissions from agricultural soils

The uncertainty in these emissions is estimated at 50% to 200%, with indirect N_2O emissions having an uncertainty of a factor of two; one or two orders of magnitude higher than the 4% uncertainty estimated for CO_2 from the energy industries.

Source ranking using IPCC Tier 1 trend assessment 2007 (amounts in GgCO_2 eq) — Table A1.4

IPCC	Category	Gas	CO_2 eq last year	Share	Cum. Share
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	23675	15%	15%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20496	13%	28%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	5260	9%	37%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	243	8%	45%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	14148	6%	51%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	9970	5%	56%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	15747	3%	59%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13000	3%	63%
2B2	Nitric acid production	N_2O	4305	3%	65%
2C3	PFC from aluminium production	PFC	101	2%	68%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3124	2%	70%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	962	2%	73%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2184	2%	75%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	2596	2%	77%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	6585	2%	79%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1471	2%	81%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	26068	1%	83%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	446	1%	84%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH4	5636	1%	85%
4D2	Animal production on agricultural soils	N2O	603	1%	87%
2C1	Iron and steel production (carbon inputs)	CO_2	1647	1%	88%
1B2	Fugitive emissions venting/flaring	CH_4	479	1%	89%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2208	1%	90%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9060	1%	91%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2153	1%	92%
1A	Emissions from stationary combustion: non-CO_2	CH_4	1226	1%	93%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	9051	1%	94%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	140	1%	94%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	741	1%	95%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4550	0%	96%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4868	0%	96%
2B5	Caprolactam production	N_2O	497	0%	96%
1A5	Military use of fuels (1A5 Other)	CO_2	317	0%	97%
2A7	Other minerals	CO_2	485	0%	97%
1A3	Mobile combustion: water-borne navigation	CO_2	606	0%	97%
4B9	Emissions from manure management : poultry	CH_4	66	0%	98%
2F	PFC emissions from PFC use	PFC	226	0%	98%
3	Indirect CO_2 from solvents/product use	CO_2	128	0%	98%
1A3	Mobile combustion: road vehicles	N_2O	438	0%	98%
3, 6D	OTHER N_2O	N_2O	121	0%	99%
1A3	Mobile combustion: road vehicles	CH_4	45	0%	99%
1A4	Stationary combustion : Other Sectors, solids	CO_2	86	0%	99%
1A	Emissions from stationary combustion: non-CO_2	N_2O	313	0%	99%
4B	Emissions from manure management	N_2O	872	0%	99%
2F	SF_6 emissions from SF_6 use	SF_6	214	0%	99%
6B	Emissions from wastewater handling	CH_4	203	0%	99%
6D	OTHER CH_4	CH_4	67	0%	99%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	367	0%	100%
4B1	Emissions from manure management : cattle	CH_4	1471	0%	100%
1B1b	CO_2 from coke production	CO_2	444	0%	100%
2C3	CO_2 from aluminium production	CO_2	431	0%	100%
2A3	Limestone and dolomite use	CO_2	261	0%	100%
4B8	Emissions from manure management : swine	CH_4	1082	0%	100%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	272	0%	100%
2B5	Other chemical product manufacture	CO_2	606	0%	100%
2G	Other industrial: CH_4	CH_4	302	0%	100%
2E	HFC by-product emissions from HFC manufacture	HFC	24	0%	100%
2G	Other industrial: CO_2	CO_2	307	0%	100%
1A3	Mobile combustion: other (railways)	CO_2	97	0%	100%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	315	0%	100%

IPCC	Category	Gas	CO_2 eq last year	Share	Cum. Share
2B1	Ammonia production	CO_2	3016	0%	100%
4B	Emissions from manure management : other	CH_4	15	0%	100%
2G	Other industrial: N_2O	N_2O	6	0%	100%
6B	Emissions from wastewater handling	N_2O	456	0%	100%
2A1	Cement production	CO_2	403	0%	100%
1A3	Mobile combustion: aircraft	CO_2	41	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	158	0%	100%

Source ranking using IPCC Tier 2 level assessment 2007 (in GgCO_2 eq). Table A1.5

IPCC	Category	Gas	CO_2 eq last year	Share	Uncer-tainty estimate	Level * Uncer-tainty	Share L*U	Cum. Share L*U
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3124	2%	206%	3%	20%	20%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4868	2%	61%	1%	9%	30%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	9970	5%	20%	1%	6%	36%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	5260	3%	34%	1%	6%	42%
4B1	Emissions from manure management : cattle	CH_4	1471	1%	100%	1%	5%	46%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9060	4%	14%	1%	4%	50%
4B8	Emissions from manure management : swine	CH_4	1082	1%	100%	1%	3%	54%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20496	10%	5%	0%	3%	57%
2B2	Nitric acid production	N_2O	4305	2%	22%	0%	3%	60%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	5636	3%	16%	0%	3%	63%
4B	Emissions from manure management	N_2O	872	0%	100%	0%	3%	66%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	26068	13%	3%	0%	3%	68%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	15747	8%	5%	0%	3%	71%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1471	1%	51%	0%	2%	73%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	6585	3%	10%	0%	2%	75%
1A	Emissions from stationary combustion: non-CO_2	CH_4	1226	1%	50%	0%	2%	77%
4D2	Animal production on agricultural soils	N_2O	603	0%	100%	0%	2%	79%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4550	2%	10%	0%	1%	80%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	9051	4%	5%	0%	1%	82%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2208	1%	21%	0%	1%	83%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2153	1%	20%	0%	1%	85%
2B5	Other chemical product manufacture	CO_2	606	0%	71%	0%	1%	86%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	14148	7%	2%	0%	1%	87%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13000	6%	2%	0%	1%	88%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	23675	11%	1%	0%	1%	89%
6B	Emissions from wastewater handling	N_2O	456	0%	54%	0%	1%	89%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2184	1%	11%	0%	1%	90%
1B1b	CO_2 from coke production	CO_2	444	0%	50%	0%	1%	91%
1A3	Mobile combustion: road vehicles	N_2O	438	0%	50%	0%	1%	92%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	367	0%	50%	0%	1%	92%
1A	Emissions from stationary combustion: non-CO_2	N_2O	313	0%	50%	0%	0%	93%
2G	Other industrial: CH4	CH_4	302	0%	51%	0%	0%	93%
2B5	Caprolactam production	N_2O	497	0%	28%	0%	0%	94%
2A7	Other minerals	CO_2	485	0%	25%	0%	0%	94%
1A3	Mobile combustion: water-borne navigation	CO_2	606	0%	20%	0%	0%	94%
1B2	Fugitive emissions venting/flaring	CH_4	479	0%	25%	0%	0%	95%
2F	SF_6 emissions from SF_6 use	SF_6	214	0%	56%	0%	0%	95%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	962	0%	10%	0%	0%	95%
2C1	Iron and steel production (carbon inputs)	CO_2	1647	1%	6%	0%	0%	96%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	315	0%	30%	0%	0%	96%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	446	0%	20%	0%	0%	96%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	158	0%	54%	0%	0%	97%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	741	0%	10%	0%	0%	97%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	140	0%	50%	0%	0%	97%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	272	0%	25%	0%	0%	97%
2B1	Ammonia production	CO_2	3016	1%	2%	0%	0%	98%

IPCC	Category	Gas	CO_2 eq last year	Share	Uncer-tainty estimate	Level * Uncer-tainty	Share L*U	Cum. Share L*U
2A3	Limestone and dolomite use	CO_2	261	0%	25%	0%	0%	98%
4B9	Emissions from manure management : poultry	CH_4	66	0%	100%	0%	0%	98%
3, 6D	OTHER N_2O	N_2O	121	0%	54%	0%	0%	98%
6B	Emissions from wastewater handling	CH_4	203	0%	32%	0%	0%	98%
1A5	Military use of fuels (1A5 Other)	CO_2	317	0%	20%	0%	0%	99%
2G	Other industrial: CO_2	CO_2	307	0%	21%	0%	0%	99%
2F	PFC emissions from PFC use	PFC	226	0%	25%	0%	0%	99%
2A1	Cement production	CO_2	403	0%	11%	0%	0%	99%
1A4	Stationary combustion : Other Sectors, solids	CO_2	86	0%	50%	0%	0%	99%
3	Indirect CO_2 from solvents/product use	CO_2	128	0%	27%	0%	0%	99%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	243	0%	14%	0%	0%	99%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	2596	1%	1%	0%	0%	100%
1A3	Mobile combustion: road vehicles	CH_4	45	0%	60%	0%	0%	100%
2C3	CO_2 from aluminium production	CO_2	431	0%	5%	0%	0%	100%
6D	OTHER CH_4	CH_4	67	0%	32%	0%	0%	100%
1A3	Mobile combustion: aircraft	CO_2	41	0%	50%	0%	0%	100%
2C3	PFC from aluminium production	PFC	101	0%	20%	0%	0%	100%
4B	Emissions from manure management : other	CH_4	15	0%	100%	0%	0%	100%
2E	HFC by-product emissions from HFC manufacture	HFC	24	0%	22%	0%	0%	100%
1A3	Mobile combustion: other (railways)	CO_2	97	0%	5%	0%	0%	100%
2G	Other industrial: N_2O	N_2O	6	0%	71%	0%	0%	100%
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	112%	0%	0%	100%
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	112%	0%	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0%	0%	100%

Source ranking using IPCC Tier 2 trend assessment (in $GgCO_2$ eq).

Table A1.6

IPCC	Category	Gas	CO_2 eq base year	CO_2 eq last year	Level assessment last year	Trend assess-ment	Uncer-tainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumu-lative
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	4975	3124	2%	1%	206%	2%	26%	26%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	5260	3%	3%	34%	1%	16%	41%
4D2	Animal production on agricultural soils	N_2O	1449	603	0%	0%	100%	0%	6%	47%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	243	0%	3%	14%	0%	5%	52%
1A4a	Stationary combustion : Other Sectors: Commercial/ Institutional, gases	CO_2	6634	9970	5%	2%	20%	0%	5%	58%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1471	1%	1%	51%	0%	5%	62%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11832	20496	10%	4%	5%	0%	3%	65%
2B2	Nitric acid production	N_2O	6330	4305	2%	1%	22%	0%	3%	68%
2C3	PFC from aluminium production	PFC	1901	101	0%	1%	20%	0%	3%	71%
1A	Emissions from stationary combustion: non-CO_2	CH_4	586	1226	1%	0%	50%	0%	2%	73%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	140	0%	0%	50%	0%	2%	75%
4B9	Emissions from manure management : poultry	CH_4	273	66	0%	0%	100%	0%	1%	77%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1476	446	0%	0%	20%	0%	1%	78%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4674	4868	2%	0%	61%	0%	1%	80%
1B2	Fugitive emissions venting/flaring	CH_4	1252	479	0%	0%	25%	0%	1%	81%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	592	2184	1%	1%	11%	0%	1%	82%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2738	962	0%	1%	10%	0%	1%	84%
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	8328	6585	3%	1%	10%	0%	1%	85%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	6783	5636	3%	0%	16%	0%	1%	86%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2208	1%	0%	21%	0%	1%	87%
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2893	2153	1%	0%	20%	0%	1%	88%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	15747	8%	1%	5%	0%	1%	89%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	23675	11%	5%	1%	0%	1%	90%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19020	14148	7%	2%	2%	0%	1%	90%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	9060	4%	0%	14%	0%	1%	91%
1A3	Mobile combustion: road vehicles	N_2O	271	438	0%	0%	50%	0%	1%	92%
4B	Emissions from manure management	N_2O	814	872	0%	0%	100%	0%	1%	92%
2B5	Caprolactam production	N_2O	766	497	0%	0%	28%	0%	1%	93%
3, 6D	OTHER N_2O	N_2O	250	121	0%	0%	54%	0%	0%	93%
1A3	Mobile combustion: road vehicles	CH_4	157	45	0%	0%	60%	0%	0%	94%
4B1	Emissions from manure management : cattle	CH_4	1571	1471	1%	0%	100%	0%	0%	94%
2A7	Other minerals	CO_2	275	485	0%	0%	25%	0%	0%	94%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	741	0%	0%	10%	0%	0%	95%

IPCC	Category	Gas	CO_2 eq base year	CO_2 eq last year	Level assessment last year	Trend assess-ment	Uncer-tainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumu-lative
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	86	0%	0%	50%	0%	0%	95%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10902	13000	6%	1%	2%	0%	0%	96%
2F	PFC emissions from PFC use	PFC	37	226	0%	0%	25%	0%	0%	96%
3	Indirect CO_2 from solvents/product use	CO_2	316	128	0%	0%	27%	0%	0%	96%
1A5	Military use of fuels (1A5 Other)	CO_2	566	317	0%	0%	20%	0%	0%	97%
2C1	Iron and steel production (carbon inputs)	CO_2	2514	1647	1%	0%	6%	0%	0%	97%
1A	Emissions from stationary combustion: non-CO_2	N2O	226	313	0%	0%	50%	0%	0%	97%
2F	SF_6 emissions from SF_6 use	SF_6	301	214	0%	0%	56%	0%	0%	98%
1A3	Mobile combustion: water-borne navigation	CO_2	405	606	0%	0%	20%	0%	0%	98%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5014	4550	2%	0%	10%	0%	0%	98%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8644	9051	4%	0%	5%	0%	0%	98%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	26068	13%	0%	3%	0%	0%	99%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	367	0%	0%	50%	0%	0%	99%
4B8	Emissions from manure management : swine	CH_4	1140	1082	1%	0%	100%	0%	0%	99%
1B1b	CO_2 from coke production	CO_2	403	444	0%	0%	50%	0%	0%	99%
6B	Emissions from wastewater handling	CH_4	290	203	0%	0%	32%	0%	0%	99%
6D	OTHER CH_4	CH_4	1	67	0%	0%	32%	0%	0%	99%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	2596	1%	1%	1%	0%	0%	100%
2B5	Other chemical product manufacture	CO_2	606	606	0%	0%	71%	0%	0%	100%
2A3	Limestone and dolomite use	CO_2	232	261	0%	0%	25%	0%	0%	100%
2G	Other industrial: CH_4	CH_4	297	302	0%	0%	51%	0%	0%	100%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	272	0%	0%	25%	0%	0%	100%
4B	Emissions from manure management : other	CH_4	12	15	0%	0%	100%	0%	0%	100%
2E	HFC by-product emissions from HFC manufacture	HFC	12	24	0%	0%	22%	0%	0%	100%
2G	Other industrial: N2O	N_2O	3	6	0%	0%	71%	0%	0%	100%
2C3	CO_2 from aluminium production	CO_2	395	431	0%	0%	5%	0%	0%	100%
2G	Other industrial: CO_2	CO_2	305	307	0%	0%	21%	0%	0%	100%
6B	Emissions from wastewater handling	N_2O	466	456	0%	0%	54%	0%	0%	100%
4A	CH4 emissions from enteric fermentation in domestic livestock: other	CH_4	319	315	0%	0%	30%	0%	0%	100%
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	112%	0%	0%	100%
1A3	Mobile combustion: aircraft	CO_2	41	41	0%	0%	50%	0%	0%	100%
1A3	Mobile combustion: other (railways)	CO_2	91	97	0%	0%	5%	0%	0%	100%
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	112%	0%	0%	100%
2A1	Cement production	CO_2	416	403	0%	0%	11%	0%	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	20%	0%	0%	100%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	162	158	0%	0%	54%	0%	0%	100%
2B1	Ammonia production	CO_2	3096	3016	1%	0%	2%	0%	0%	100%

Annex 2 Detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion

The Netherlands' list of fuels and standard CO_2 emission factors, version March 2009 (Vreuls et al, 2009) is included in this Annex. This list was first published in 2004 and updated with some editorial changes in November 2005. In August 2006 the CO_2 emission factor for natural gas has been changed for the period 1990-2006. Not included are Annex 2 and 3 of this publication as these hold a copy of page 1.13 of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) and of page 1.6 of the IPCC Good Practice Guidance for National Greenhouse Gas Inventories Workbook. In addition, Section A2.2.5 describes in which source categories of the national emission inventory the Netherlands' standard emission factors and source-specific carbon dioxide (CO_2) emission factors are applied. For a description of the methodology and activity data used for the calculation of CO_2 emissions from fossil fuel combustion we refer to the monitoring protocols (see Annex 6, protocols 9052 for stationary sources and protocols 9054-9061 for mobile sources).

A2.1 Introduction

For national monitoring of greenhouse gas emissions under the framework of the United Nations Climate Change Agreement (UNFCCC) and monitoring at corporate level for the European CO_2 emissions trade, international agreements state that each country must draw up a national list of defined fuels and standard CO_2 emission factors. This is based on the Intergovernmental Panel on Climate Change (IPCC) list (with default CO_2 emission factors), but should include national values that reflect the specific national situation. This list will also be used by the Netherlands in the e-MJV (electronic annual environmental report), because these are used for national monitoring, and because the data concerning the CO_2 emissions trade also needs to be entered into the e-MJV.

The Netherlands' list of energy carriers and standard CO_2 emission factors (further referred to as "the Netherlands' list") is now available in the form of:

1. a table containing the names (in Dutch and English) of the energy carrier and the accompanying standard energy content and CO_2 emissions factor
2. a fact sheet per energy carrier, substantiating the values given, presenting similar names and possible specifications, and providing an overview of the codes that organizations use for the individual energy carriers

This Annex is meant for people using the Netherlands' list. It contains the starting points for this list and indicates how it should be used for various objectives, e.g. national monitoring of greenhouse gas emissions, the European CO_2 emissions trade and the e-MJV. It also includes background zinformation. The list, plus this document and the background documents for substantiating the specific Netherlands' values can be found on the website: www.greenhousegases.nl / www.broeikasgassen.nl.

Based on new scientific knowledge in 2006 the CO_2 emission factor for natural gas has been changed for the period 1990-2006.

From 2007 onwards, the CO_2 emission factor for natural gas will be assessed annually. In this document the CO_2 emission factor for natural gas for 2007 has been determined.

A2.2 Starting points for the Netherlands' list

The following starting points were used to draw up the Netherlands' list:

1. the list contains all the fuels, as included in the IPCC guidelines (Revised 1996 Intergovernmental Panel on Climate Change (IPCC) for national greenhouse gas inventories,

further known as the "1996 IPCC guidelines"), Table 1-1 (in Chapter 1 of the Reference Manual, Volume 3 of the 1996 IPCC guidelines) and the differentiation thereof in the Workbook Table 1.2 (Module 1 of the Workbook, Volume 2 of the 1996 IPCC guidelines). The 1996 IPCC guidelines are applicable to the national monitoring of greenhouse gas emissions under the UNFCCC framework
2. the list contains all fuels, as included in European Commission (EC) Directive 2004/156/EG on reporting CO_2 emissions trading ("... defining guidelines for monitoring and reporting greenhouse gas emissions..."), Appendix 1, Chapter 8
3. the definition of fuels is based on the definition used by the CBS (Statistics Netherlands) when collating energy statistics
4. as a result of the 1996 IPCC guidelines and the EC's Directive 2004/156/EG mentioned in 1 and 2 above, the CO_2 emission factors are accurate to one digit after the decimal point
5. the list assumes the standard CO_2 emission factors as used in the 1996 IPCC guidelines and the EC directive 2004/156/EG but, where the Netherlands' situation deviates from this norm, specific standard values for the Netherlands are used, which are documented and substantiated

A2.3 The Netherlands' list

A study was carried out in 2002 with respect to specific Netherlands' CO_2 emission factors (TNO, 2002). This study showed that, for a limited number of Dutch fuels, their situations deviated such that national values needed to be determined. For a number of fuels the previously defined data was available to update national values (Spakman et al., 2003) but, for others, new values were required.

In 2006 a study was commissioned to research methods to determine the CO_2 emission factor for natural gas (Heslinga and van Harmelen, 2006). This resulted in the advice to use a country-specific factor for natural gas for 1990 onwards (Vreuls, 2006). At its meeting on 25 April 2006 the Steering Group for Emissions Registration agreed with this advice and approved an update of the national list.

A specific Netherlands standard CO_2 emissions factor has been determined for the following fuels, which does not appear in the 1996 IPCC guidelines or in the EC's Directive 2004/156/EG, but has been added as a specification for one of the following fuels:
1. petrol/gasoline
2. gas and diesel oil
3. LPG
4. coke coals (coke ovens and blast furnaces)
5. other bituminous coal
6. coke ovens/gas cokes
7. coke oven gas
8. blast furnace gas
9. oxygen furnace gas
10. phosphorus furnace gas
11. natural gas

For industrial gases, chemical waste gas is also differentiated from refinery gas. For the IPCC main group "other fuels", only non-biogenic waste is differentiated.

The list also includes biomass as a fuel, with accompanying specific Netherlands' CO_2 emission factors. Biomass emissions are reported separately in the national monitoring of greenhouse gas emissions under the UNFCCC framework (as a memo element) and are not included in the national emissions figures. For the European CO_2 emissions trading the emissions are not included because an emissions factor of zero is used for biomass.

The CO_2 emissions factor for wood is used for solid biomass, and that of palm oil is used for liquid biomass. A weighted average of three specified biogases is used as the standard factor for gaseous biomass. These are:
1. sewage treatment facility (WWTP) biogas
2. landfill gas
3. industrial organic waste gas

For coke coals the standard CO_2 emissions factor is also a weighted average, of coke coals used in coke ovens and in blast furnaces.

The heating values are the same as those used by the CBS for observed fuels in its surveys for collating energy statistics.

A2.4 Fact sheets

A fact sheet (consisting of at least two Sections) has been drawn up for each energy carrier:
1. General information:
    a. name of the energy carrier, in Dutch and English
    b. other names used (Dutch and English)
    c. description
    d. codes (in Dutch) used to specify the energy carrier
    e. unit
2. Specific values and substantiation:
    a. heating value
    b. carbon content
    c. CO_2 emissions factor
    d. density (if relevant), converting from weight to volume or converting from gases to m3 standard natural gas equivalents
    e. substantiating the choices, plus accurate referral to references and/or specific text Sections within the reference
    f. year and/or period for which the specific values apply

If a standard Dutch value for an energy carrier already exists, then this has been added to the fact sheet (as a third Section containing the same information as that described under 1) and 2) above).

Netherlands' fuels and standard CO_2 emission factors — Table A2.1

Main group (Dutch language)	Main group (English) IPCC (supplemented)	Unit	Heating value (MJ/unit)	CO_2 EF (kg/GJ)
	A. Liquid Fossil, Primary Fuels			
Ruwe aardolie	Crude oil	kg	42.7	73.3
Orimulsion	Orimulsion	kg	27.5	80.7
Aardgascondensaat	Natural Gas Liquids	kg	44.0	63.1
	Liquid Fossil, Secondary Fuels/ Products			
Motorbenzine	Petrol/gasoline	kg	44.0	72.0
Kerosine luchtvaart	Jet Kerosene	kg	43.5	71.5
Petroleum	Other Kerosene	kg	43.1	71.9
Leisteenolie	Shale oil	kg	36.0	73.3
Gas-/dieselolie	Gas/ Diesel oil	kg	42.7	74.3
Zware stookolie	Residual Fuel oil	kg	41.0	77.4
LPG	LPG	kg	45.2	66.7
Ethaan	Ethane	kg	45.2	61.6
Nafta's	Naphtha	kg	44.0	73.3
Bitumen	Bitumen	kg	41.9	80.7
Smeeroliën	Lubricants	kg	41.4	73.3
Petroleumcokes	Petroleum Coke	kg	35.2	100.8
Raffinaderijgrondstoffen	Refinery Feedstocks	kg	44.8	73.3
Raffinaderijgas	Refinery Gas	kg	45.2	66.7
Chemisch restgas	Chemical Waste Gas	kg	45.2	66.7
Overige oliën	Other Oil *	kg	40.2	73.3
	B. Solid Fossil, Primary Fuels			
Antraciet	Anthracite	kg	26.6	98.3
Cokeskolen	Coking Coal	kg	28.7	94.0
Cokeskolen (cokeovens)	Coking Coal (used in coke oven)	kg	28.7	95.4
Cokeskolen (basismetaal)	Coking Coal (used in blast furnaces)	kg	28.7	89.8
(Overige bitumineuze) steenkool	Other Bituminous Coal	kg	24.5	94.7
Sub-bitumineuze kool	Sub-bituminous Coal	kg	20.7	96.1
Bruinkool	Lignite	kg	20.0	101.2
Bitumineuze leisteen	Oil Shale	kg	9.4	106.7
Turf	Peat	kg	10.8	106.0
	Solid Fossil, Secondary Fuels			
Steenkool- en bruinkoolbriketten	BKB & Patent Fuel	kg	23.5	94.6
Cokesoven/ gascokes	Coke Oven/Gas Coke	kg	28.5	111.9
Cokesovengas	Coke Oven gas	MJ	1.0	41.2
Hoogovengas	Blast Furnace Gas	MJ	1.0	247.4
Oxystaalovengas	Oxygen Furnace Gas	MJ	1.0	191.9
Fosforovengas	Phosphorus Furnace Gas	Nm3	11.6	149.5
	C. Gaseous Fossil Fuels			
Aardgas	Natural Gas (dry)	Nm3	31.65	56.7 [1)]
Koolmonoxide	Carbon Monoxide	Nm3	12.6	155.2
Methaan	Methane	Nm3	35.9	54.9
Waterstof	Hydrogen	Nm3	10.8	0.0
	Biomass [2)]			
Biomassa vast	Solid Biomass	kg	15.1	109.6
Biomassa vloeibaar	Liquid Biomass	kg	39.4	71.2
Biomassa gasvormig	Gas Biomass	Nm3	21.8	90.8
RWZI biogas	Waste water biogas	Nm3	23.3	84.2
Stortgas	Landfill gas	Nm3	19.5	100.7
Industrieel fermentatiegas	Industrial organic waste gas	Nm3	23.3	84.2
	D. Other fuels			
Afval (niet biogeen)	Waste (not biogenic)	kg	34.4	73.6

1) The emission factor for natural gas in this table (56.7 kg CO_2/GJ) is applicable for the calculation of the emissions in 2007 (Zijlema, 2008). For the period 1990–2006 the emission factor remains unchanged (56.8 kg CO_2/GJ). In the future the emission factor for natural gas will be updated annually.
2) Biomass: the value of the CO_2 emission factor is shown as a memo item in reports for the climate agreement; the value is zero for emissions trading and for the Kyoto Protocol.

Comparison of emission factors in the allocation of CO_2 emission rights with the national list **Table A2.2**

Energy carrier	Unit	Allocation		National list	
		Heating value (GJ/unit)	CO_2 emission factor (kg/GJ)	Heating value (GJ/unit)	CO_2 emission factor (kg/GJ)
LPG	ton	46.00	63.00	45.2	66.7 1)
Heavy oil	ton	41.00	77.30	41.0	77.4 2)
Light oil	ton	42.50	73.00	42.7	74.3 1)
Coal	ton	29.30	94.50	24.5	94.7 3)

1) Country-specific factor (Olivier, 2004).
2) IPCC default value.
3) Country-specific factor (TNO, 2002).

A2.5 The Netherlands' list in national monitoring, European CO_2 emissions trade and in e-MJV

National monitoring
The 1996 IPCC guidelines are among those valid for national monitoring under the UNFCCC framework, which is reported annually in the NIR (National Inventory Report). This includes the default CO_2 emission factors shown in Table 1-1 (Chapter 1 of the Reference Manual, Volume 3 of the 1996 IPCC guidelines) and Table 1-2 (Module 1 of the Workbook, Volume 2 of the 1996 IPCC guidelines). With respect to the specification at national level: "...default assumptions and data should be used only when national assumptions and data are not available" (overview of the Reporting Instructions, Volume 1 of the 1996 IPCC guidelines) and "...because fuel qualities and emission factors may differ markedly between countries, sometimes by as much as 10% for nominally similar fuels, national inventories should be prepared using local emission factors and energy data where possible" (Chapter 1, Section 1.1 of the Reference Manual, Volume 3 of the 1996 IPCC guidelines).

With respect to documentation, "When countries use local values for the carbon emission factors they should note the differences from the default values and provide documentation supporting the values used in the national inventory calculations" (Chapter 1, Section 1.4.1.1 of the Reference Manual, Volume 3 of the 1996 IPCC guidelines). Exactly when and how the Netherlands' list should be used in the national monitoring process is further described in the 1996 IPCC guidelines. The Netherlands' list is included in the country's national report to the UNFCCC on greenhouse gas emissions.

Monitoring European CO_2 emissions trade
The EC Directive 2004/156/EG covers the monitoring under the framework of the European CO_2 emissions trade. This directive serves as a starting point for the Netherlands' monitoring system for trading in emission rights. With respect to the CO_2 emission factors and the calculations of CO_2 emissions at level 2a, the directive states, "The operator should use the relevant fuel caloric values that apply in that country, e.g. as indicated in the relevant Member State's latest national inventory, which has been submitted to the secretariat of the UNFCCC (EC Directive 2004/156/EG, Appendix II, Section 2.1.1.1)."

With respect to the reports, this states that, "Fuels, and the resulting emissions must be reported in accordance with the IPCC standard format for fuels.... this is based on the definitions set out by the IEA (International Energy Agency). If the Member State (relevant to the operator) has already published a list of fuel categories, including definitions and emission factors, which is consistent with the latest national inventory such as submitted to the UNFCCC secretariat, these categories and the accompanying emission factors should be used, if these have been approved within the framework of the relevant monitoring methodology" (EC Directive 2004/156/EG, Appendix I, Section 5).

Exactly when and how the Netherlands' list should be used in the monitoring process under the framework of the EU CO_2 emissions trading is further explained in EC Directive 2004/156/EG and the Netherlands' system for monitoring the trade in emission rights.

It has been decided to ignore these differences for the first trading period, so that the allocation to companies need not be modified. How these exceptions should be treated is further defined under the framework of the EU CO_2 emissions trading in the Netherlands.

e-MJV
Within the UNFCCC framework, the national monitoring of greenhouse gases is partly based on the information provided in the MJVs (annual environmental reports). Information on CO_2 emissions trading is also reported in the MJV, which is why the Netherlands' list is also used in the e-MJV. Since the monitoring of the energy covenant known as the MJA (long-term energy agreement) can be carried out via the e-MJV, the Netherlands' list is also used to compile these reports. Exactly how the Netherlands' list should be used in the e-MJV is further described in the e-MJV itself.

Use of the Netherlands' list by other stakeholders in the Netherlands
The Netherlands' list can also be used for other purposes, such as monitoring energy covenants, predicting future CO_2 emissions, and so on. Selections can be taken from the list, depending on the application. This usage is not defined in the legislation, but offers the advantage of harmonizing the national monitoring under the UNFCCC framework. Whenever CO_2 emissions are defined for the government, the Netherlands' list will be used wherever possible.

A2.6 Defining and maintaining the Netherlands' list

The Ministry of VROM (Spatial Planning, Housing and the Environment) initiated the compilation of the Netherlands' list, as it is responsible for the national monitoring of greenhouse gas emissions under the UNFCCC framework. This list has been prepared in consultation with those national institutes that are involved in the national monitoring activities. These are the Netherlands Environmental Assessment Agency (PBL), CBS, SenterNovem, plus other relevant organizations, such as the e-MJV, CO_2 emissions trade and the Energy Research Centre of the Netherlands (ECN). The EMSG (Emissions Registration Steering Group, the collaborative agencies implementing the national monitoring) compiled the list during its meeting held in October 2004.

The list will be maintained within the National System, the organizational structure that coordinates national greenhouse gas monitoring under the UNFCCC framework. The Netherlands list, this document and the background documents are all publicly accessible from the Dutch website (www.broeikasgassen.nl or the English version, www.greenhousegases.nl). As part of the quality monitoring system for the national monitoring of greenhouse gases, this list will be evaluated every three years. The values currently included are valid for the period from 1990 to 2007, at a minimum. This Annex was updated in November 2005 with some editorial changes. Both this Annex and the Netherlands' list were updated in 2006 based on research for methods to determine the CO_2 emission factor for natural gas in the Netherlands for the period 1990-2006.

From 2007 onwards, the CO_2 emission factor for natural gas will be assessed annually. In this document the CO_2 emission factor for natural gas for 2007 has been determined.

A2.7 Application of the Netherlands' standard and source-specific CO_2 emission factors in the national emission inventory

For the most common fuels (natural gas, coal, coal products, diesel and petrol), country-specific standard CO_2 emission factors are used; otherwise default IPCC emission factors are used (see Table A2.1). However, for some of the derived fuels the chemical composition and thus the CO_2 emission factor is highly variable between source categories and over time.

Thus, for blast furnace gas and oxygen furnace gas, refinery gas, chemical waste gas (liquids and solids treated separately) and solid waste (the biogenic and fossil carbon part treated separately), mostly source-specific (or plant-specific) emission factors have been used, that may also change over time. In addition, for raw natural gas combustion by the oil and gas production industry a source-specific (or company-specific) CO_2 emission factor is used. This refers to the so-called "own use" of unprocessed natural gas used by the gas and oil production industry, of which the composition may differ significantly from that of treated standard natural gas supplied to end-users. These emission factors are based on data submitted by industries in their Annual Environmental Reports (MJVs). These fuels are used in the subcategories "Public electricity and heat production" (1A1a), "Refineries" (1A1b) and "Other energy industries" included in 1A1c.

Fossil-based CO_2 emissions from waste incineration are calculated from the total amount of waste that is incinerated, split into six waste types per waste stream, each with a specific carbon content and fraction of fossil carbon in total carbon (see Section 8.4.2 for more details).

More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see Annex 6).

A2.8 Fact sheet for petrol as a transport fuel

Version: 4

Date: 17 October 2005

General information

Name of energy carrier	**Nederlands: Motorbenzine** **English: Petrol/gasoline (US)**	
Energy source-ID:		
Fuels understood to be included under this energy carrier	Unleaded petrol (30900) Petrol standard Euro, unleaded Superplus, unleaded Super with lead replacement (Petrol) Other Leaded petrol (30900) Petrol standard, leaded Euro, leaded (Petrol) Other, leaded Aviation fuel (30600)	
Description (using GN standards)	Unleaded petrol (30900): Petrol, standard 27101141 Petrol (Motor spirit) with a lead content of <= 0.013 g/l and a research-octane level "RON" of <= 95 Euro, unleaded: 27101145 Petrol (Motor spirit) with a lead content of <= 0.013 g/l and a research-octane level "RON" of > 95 or < 98 Superplus, unleaded: 27101149 Petrol (Motor spirit) with a lead content of <= 0.013 g/l and a research-octane level "RON" of >= 98 Super, with lead replacement: 27101149 Petrol (Motor spirit) with a lead content of <= 0.013 g/l and a research-octane level "RON" of >= 98 (Petrol) Other: 27101145 Petrol (Motor spirit) with a lead content of <=F 0.013 g/l and a research-octane level "RON" of > 95 or < 98 Leaded petrol (30900) Petrol standard, leaded: 27101151 Petrol (Motor spirit) with a lead content of > 0.013 g/l and a research-octane level "RON" of < 98 (except aviation fuel) Euro, leaded: 27101159 Petrol (Motor spirit) with a lead content of > 0.013 g/l and a research-octane level "RON" of >= 98 (except aviation fuel) (Petrol) Other, leaded: 27101145 Petrol (Motor spirit) with a lead content of <= 0.013 g/l and a research-octane level "RON" of > 95 or < 98 Aviation fuel (30600) 27101131 Aviation spirit	
Names currently in use	Netherlands Statistics (CBS):	Fuels in questionnaire form for crude oil statistics: 10+11+14 Fuels in NEH under table numbers 4.3.6 4.3.9
	MJA	
	CO_2 trade	
	EMJV	Petrol/motorbenzine
Names used in previous lists	ER/TNO	Petrol
	MJA	Petrol
	Benchmark	
	Kg	
Unit		

Specific values and substantiation

Heating value (MJ/[unit])	44.0	
Substantiation of heating value	NEH	
Carbon content (ton C/TJ)	19.6	
Substantiation of carbon content	Calculated based on the C-content% mass and energy conversion factor	
CO_2 emissions factor (ton CO_2/TJ)	72.0	
CEF IPCC default	69.3	
Substantiation of CO_2 emissions factor	The Netherlands deviates here from the IPCC default. The basis for this is the report "Netherlands' CO_2 emission factors for petrol, diesel and LPG" MNP Memorandum on the Netherlands' CO_2 emission factors, Olivier (2004).	
	At the request of the Ministry of VROM, in 2004 ITS Caleb Brett analyzed a number of petrol and diesel samples (winter and summer qualities) for both carbon and energy contents. This resulted in the following values:	
	C-content (% mass)	86.4
	Conversion factor (GJ/1000kg; LHV)	44.0
	Emissions factor (kg CO_2/GJ)	72.0
	This emissions factor can be used for all years from 1990 onwards	
Validity of CO_2 emissions factor	From 1990 onwards	
Density (kg/l)	Gasoline 0.745 kg/l	
Substantiation of density	NEH (Netherlands Energy Statistics) 1996	

Annex 3 Other detailed methodological descriptions for individual source or sink categories

A detailed description of methodologies per source/ sink category can be found in protocols on the website www.greenhousegases.nl, including country-specific emission factors

Annex 6 provides an overview of the available monitoring protocols at this site

Annex 4 CO_2 Reference Approach and comparison with Sectoral Approach

A4.1 Comparison of CO_2 emissions

The IPCC Reference Approach (RA) for CO_2 from energy use uses apparent consumption data per fuel type to estimate CO_2 emissions from fossil fuel use. This has been used as a means of verifying the sectoral total CO_2 emissions from fuel combustion (IPCC, 2001). For the Reference Approach energy statistics (production, imports, export, stock changes) were provided by Statistics Netherlands (CBS); national default, partly country-specific, CO_2 emission factors (see Annex 2.1, Tables A2.1 and A2.2) and constant carbon storage fractions based on the average of annual carbon storage fractions calculated per fossil fuel type for 1995-2002 from reported CO_2 emissions in the sectoral approach. Also, bunker fuels were corrected for the modification made to include fisheries, internal navigation, military aviation and shipping in domestic consumption instead of included in the bunker total in the original national energy statistics (see Annex 2.1, Tables A2.1 A2.3).

Table A4.1 presents the results of the Reference Approach calculation for 1990-2007 and compared with the official national total emissions reported as fuel combustion (source category 1A). The annual difference calculated from the direct comparison varies between 4.5% for 1991 and 1992; and 0.4% for 2006. The largest differences are seen for the early 1990's.

The Reference Approach (RA) and National Approach (NA) data show a 17% RA vs. 13% NA increase in emissions from liquid fuels (1990-2007) and a 7% RA vs. 9% NA increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period by 2% in the RA vs. an decrease of 1% in the NA. The emissions from others (i.e. fossil carbon in waste), which is only included in the NA increased from 0.6 Tg in 1990 to 2.2

Comparison of CO_2 emissions: Reference Approach (RA) 1) versus National Approach (NA) (in Tg) **Table A4.1**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Reference Approach										
Liquid fuels [1]	49.7	51.4	53.8	54.6	53.8	56.5	54.9	55.2	54.6	58.2
Solid fuels [1]	34.0	34.7	30.5	32.2	32.8	34.1	33.4	32.2	30.2	33.2
Gaseous fuels	71.9	79.9	81.0	83.4	83.1	83.5	85.3	81.8	79.6	77.2
Others	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total RA	155.6	166.0	165.3	170.2	169.7	174.1	173.7	169.2	164.4	168.6
National Approach										
Liquid fuels	49.8	52.3	54.4	55.6	55.1	57.3	56.8	56.5	56.2	56.0
Solid fuels	31.0	32.4	28.8	30.8	31.0	31.9	31.6	30.1	28.6	30.7
Gaseous fuels	68.6	76.0	76.7	79.7	79.6	80.2	82.0	78.5	77.0	74.9
Others [2]	0.6	0.8	1.5	1.5	1.6	1.7	2.0	2.1	2.1	2.2
Total NA	149.9	161.5	161.4	167.6	167.3	171.1	172.4	167.2	163.8	163.8
Difference [3] *(%)*										
Liquid fuels	-0.1%	-1.7%	-1.1%	-1.7%	-2.4%	-1.5%	-3.3%	-2.3%	-2.8%	4.0%
Solid fuels	9.9%	7.2%	6.1%	4.5%	5.8%	7.1%	5.9%	6.9%	5.8%	8.2%
Gaseous fuels	4.8%	5.2%	5.5%	4.6%	4.4%	4.1%	4.0%	4.2%	3.4%	3.1%
Other	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Total	3.8%	2.8%	2.4%	1.6%	1.4%	1.7%	0.8%	1.2%	0.4%	3.0%

1) Specification of national fuel types used in the IPCC fuel type categories: gasoline: jetfuel, gasoline basis; aviation gasoline; motor gasoline; Other Kerosene: petroleum; Other Oil: oil aromates; other light oils; other oil products; Other Bituminous Coal: all hard coal; lignite/brown coal; BKB and Patent Fuel: coal derivatives.
2) Fossil-fuel component of waste combustion in waste incineration that also produce heat and electricity for energy purposes. Last year accidentally the figures included the CO_2 from the organic carbon in the waste.
3) Defined as: (RA-NA)/NA.

Corrections of Reference Approach and National Approach for a proper comparison (in Tg) **Table A4.2**

RA,NA, correction term	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Difference RA-NA	5.7	4.6	5.0	4.9	3.2	3.0	3.9	2.6	2.4	3.0	1.3	2.0	0.6	4.8
Reference Approach:	155.6	166.0	174.2	167.1	167.9	162.3	165.3	170.2	169.7	174.1	173.7	169.2	164.4	168.6
Other: fossil waste cf. NA	0.6	0.8	1.1	1.3	1.4	1.5	1.5	1.5	1.6	1.7	2.0	2.1	2.1	2.2
RA incl. fossil waste:	156.2	166.9	175.3	168.4	169.3	163.8	166.8	171.7	171.2	175.9	175.7	171.3	166.6	170.8
Diff. RAincl.Waste-NA:	5.1	3.7	3.9	3.6	1.9	1.5	2.4	1.1	0.8	1.2	-0.7	0.0	-1.5	2.7
National Approach:	149.9	161.5	169.2	162.2	164.7	159.3	161.4	167.6	167.3	171.1	172.4	167.2	163.8	163.8
CO2 fossil in Sector 1B:														
1B1b. Solid Fuel Transf.	0.4	0.5	0.7	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.4	0.4
1B2c Flaring	0.4	0.3	0.2	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1B2a-iv Oil refining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	1.0
CO2 fossil in Sector 2:	5.8	5.4	5.1	5.7	5.3	5.2	5.0	4.3	4.3	4.5	4.4	4.4	4.6	4.5
A. Mineral Products														
Soda Ash Production	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
B. Chemical industry														
1. Ammonia production	3.1	3.6	3.4	3.6	3.6	3.6	3.6	3.0	2.9	2.9	3.1	3.1	3.1	3.0
5. Other, excl. act. carbon	0.4	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.3
5. Carbon electrodes and activ. carbon	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C. Metal industry														
1. Inputs in blast furnace	2.2	1.5	1.5	1.8	1.4	1.3	1.0	1.0	1.1	1.2	0.9	0.8	1.1	1.1
D. Other Production														
2. Food and Drink	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. Other (please specify)														
Other economic sectors[1]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Not in NA-1A:	6.7	6.1	6.0	6.5	6.0	5.7	5.5	4.8	4.9	5.0	5.0	4.9	5.2	5.1
NA+1B+Ind. Proc.	156.6	167.6	175.2	168.7	170.6	165.0	167.0	172.5	172.1	176.1	177.4	172.1	169.0	168.8
RA+Fossil waste:	156.2	166.9	175.3	168.4	169.3	163.8	166.8	171.7	171.2	175.9	175.7	171.3	166.6	170.8
New difference (abs)	-0.4	-0.8	0.1	-0.3	-1.3	-1.2	-0.1	-0.7	-0.9	-0.3	-1.7	-0.9	-2.4	2.0
New difference (%)	-0.2%	-0.5%	0.1%	-0.2%	-0.8%	-0.7%	-0.1%	-0.4%	-0.5%	-0.2%	-1.0%	-0.5%	-1.4%	1.2%

1) Comprises lubricants and waxes.

Tg CO_2 in 2007. However, as will be discussed below, these numbers cannot be compared well since the RA includes sources not in included in the NA and vice versa. Therefore, a corrected comparison will be made below.

A4.2 Causes of differences between the two approaches

There are five main reasons for differences in the two approaches, of which two are inherent to the comparison method itself (see Table A4.2):

1. The CO_2 from incineration of waste that contains fossil carbon (reported under 6C or 1A1a) is not included in the Reference Approach;
2. The fossil-fuel related emissions reported as process emissions (sector 2) and fugitive emissions (Sector 1B), which are not included in the Sectoral Approach total of Sector 1A. The most significant are gas used as feedstock in ammonia production (2B1) and losses from coke/coal inputs in blast furnaces (2C1);

and others are country-specific:

3. In addition, the country-specific carbon storage factors used in the Reference Approach are multi-annual averages, so the RA calculation for a specific year will deviate somewhat from the factors that could be calculated from the specific mix of feedstock/non-energy uses of different fuels;
4. The use of plant-specific emission factors in the NA vs. national defaults in the RA;
5. Other differences could – in principle – be due to the presence of statistical differences between apparent consumption and total sectoral fuel use and/or to differences between total sectoral fuel use as used in the emission inventory and as included in the national energy statistics in cases where plant-specific fuel use data have been used.

However, the latter is not applicable to the Netherlands: the national statistics are compiled in such a way that no statistical difference occurs (initial differences are removed by shifting to the most uncertain fuel entry). Moreover, the calculations are all based on the official sectoral energy statistics from Statistics Netherlands (CBS), which guarantees that the activity data in the inventory are identical to the national energy statistics.

Correction of inherent differences

The correction terms for the RA/NA total are for the Netherlands:

- waste incineration (in the Netherlands included in 1A1a, as 'other fuels');

Comparison of CO_2 emissions: differences between corrected Reference Approach (RA) versus corrected National Approach [(RA-NA)/NA)] (in %) **Table A4.3**

Fuel type [1]	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Liquids	-0.2%	-1.8%	-1.3%	-1.9%	-4.1%	-3.1%	-4.9%	-4.0%	-4.5%	-1.9%
Solids	0.9%	0.5%	0.5%	-0.4%	0.6%	1.4%	0.9%	2.2%	0.1%	2.8%
Gas	-0.8%	-0.1%	0.3%	0.4%	0.3%	0.1%	-0.2%	-0.3%	-1.1%	-1.5%
Total (incl. waste)	-0.2%	-0.5%	-0.1%	-0.4%	-0.5%	-0.2%	-1.0%	-0.5%	-1.4%	1.2%

1) Liquids incl. 2G; Solids incl. 1B1,2A,2B5,2C1,2D; Gaseous incl. 1B2, 2B1; Total incl. fossil waste.

- selected CRF Sector 2 components listed in Table A4.2 and selected fugitive CO_2 emissions included in CRF Sector 1B.

If the RA is corrected by including the fossil waste and the NA by including selected Sector 1B and Sector 2 emissions that should be added to the 1A total before the comparison is made (see Table A4.2), then a much smaller difference remains between the approaches. Remaining differences are generally below ±1%: between +1.2% in 2007 and -1.4% in 2006, with a direct average of (-0.2±0.3)% vs. (-0.2±2.1)% in the uncorrected comparison.

The corrected RA and NA comparison per fuel type is presented in Table A4.3. This shows that the largest differences do not concentrate in a particular corner of the period. The corrected 1990-2007 trends also differ only slightly: 8.3% for the corrected National Approach (NA) (= sum of sectoral emissions in source category 1A plus selected 1B and 2 minus fossil waste) and 8.3% for the corrected Reference Approach. We conclude that in total annual emissions the remaining differences are now all between about -1.5% and +0.5%, except for 2006 which shows a -2.1% difference.

The corrected approaches show differences in emissions from liquid fuels up to -5% for a single year vs. -3% for uncorrected comparisons; for solid fuels differences are up to 2% vs. 11% and for gaseous fuels -1% vs. +5%, respectively, if corrections are made for 2G (non energy uses of lubricants and waxes) in NA-liquids, 1B (coke production), 2A ('Soda Ash'), 2B5, 2C1 (blast furnaces) and 2D in NA-solids; and 1B2 (gas flaring, refineries) and 2B1 (ammonia) in NA-gases (Table A4.2). Remaining differences must be due to the use of one multi-annual average carbon storage factor per fuel type for all years (see Section A4.3) and plant-specific emission factors in some cases as discussed in Section A4.4 (for more details see Annex 2, Table A2.2).

A4.3 Other country-specific data used in the Reference Approach

Apart from different storage fractions of non-energy use of fuels as presented in Table A4.5 other country-specific information used in the RA is found in:

Carbon contents (i.e. CO_2 emission factors) used

For the fuels used in the Reference Approach the factors used are listed in Table A.2.1. These are the national defaults. For 'other bituminous coal' and "BKB & Patent fuel" the values are used of bituminous coal and coal bitumen respectively;

Fuel consumption in international marine and aviation bunkers

Some changes were made in the national energy statistics of total apparent consumption, mainly for diesel, jet kerosene and residual fuel oil, due the reallocation for the emissions inventory of part of the bunker fuels to domestic consumption (e.g fisheries and inland naviation). This explains the difference between the original bunker statistics in the national energy statistics (and as reported to international agencies such as the IEA) and the bunker fuel data used in the Reference Approach calculation.

A4.4 Feedstock component in the CO_2 Reference Approach

Feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for CO_2 from fossil fuel use. The fraction of carbon not oxidised during the use of these fuels during product manufacture or other uses is subtracted from total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidised have been calculated as three average values, one for gas, liquid and solid fossil fuels:
77.7±2% for liquid fuels;
55.5±13% for solid fuels;
38.8±4% for natural gas.

These were calculated from all processes for which emissions are calculated in the NA, either by assuming a fraction oxidised, e.g. ammonia, or by accounting for by-product gases (excluding emissions from blast furnaces and coke ovens). (In Table A.4.4 of the NIR 2005 the calculation of annual oxidation fractions for 1995-2002 are presented and the average values derived from them.) It shows indeed that the factors show significant interannual variation, in particular for solid fuels.

The use of one average oxidation factor per fuel type for all years, whereas in the derivation of the annual oxidation figures differences up to a few per cent points can be observed, are one reason for differences between the RA and the corrected NA.

In Table A.4.4 the total CO_2 calculated as emitted from the oxidation of the non-energy uses in the Reference Approach are presented per fuel type. According to the Reference Approach dataset, the CO_2 emissions of this group of sources

Trends in CO_2 emitted by feedstock use of energy carriers (production and direct uses) according to the correction term in the IPCC Reference Approach for CO_2 from fossil fuel use (in Tg CO_2)

Table A4.4

Fuel type	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Trend
Liquids [1) 2)]	5.0	5.2	4.9	5.1	5.0	5.6	6.1	6.6	6.8	7.8	7.9	8.8	8.1	3.1
Solids [3)]	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	-0.1
Gaseous	3.5	3.8	3.7	3.9	3.7	3.7	3.9	3.5	3.4	3.2	3.4	3.5	3.0	-0.5
Total	8.9	9.4	9.0	9.5	9.2	9.8	10.4	10.5	10.6	11.4	11.7	12.7	11.4	2.5
As% of RA	5.7%	5.7%	5.1%	5.7%	5.5%	6.0%	6.3%	6.2%	6.3%	6.6%	6.8%	6.9%	6.9%	

1) Using country-specific carbon Oxidation Factors (multi-year average, fuel type averaged).
2) Excluding refineries.
3) Coal oils and tars (from coking coal), coke and other bituminous coal only; excluding emissions from blast furnaces and coke ovens.

Carbon storage in the IPCC Reference Approach for CO_2 from fossil fuel use (in Tg CO_2)

Table A4.5

Fuel type	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Trend
Liquids	20.5	22.4	21.1	22.0	24.8	29.4	35.3	38.3	40.7	42.9	44.1	52.1	49.4	28.9
Solids	0.6	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.4	-0.2
Gaseous	2.2	2.4	2.3	2.5	2.4	2.4	2.5	2.2	2.1	2.0	2.1	2.2	1.9	-0.3
Total	23.3	25.3	24.0	25.1	27.9	32.4	38.3	41.1	43.4	45.5	46.8	54.9	51.8	28.5
% gross RA1)	15%	15%	14%	15%	17%	20%	23%	24%	26%	26%	27%	31%		

Expressed as part of total carbon in apparent consumption of fossil fuels (without subtracting the stored part).

increased by about 28% or 2.5 Tg CO_2 (from 8.9 to 11.4 Tg CO_2), of which most are due to changes in emissions from liquid fuels (Table 3.34). In Table A.4.6 and A4.5 the carbon storage in the RA calculation is shown. Its shows, that in the Netherlands about 25 to 55 Tg CO_2 or about 15 to 30% of all carbon in the apparent consumption of fossil fuels is stored.

Annex 5 Assessment of completeness and (potential) sources and sinks

The Netherlands emissions inventory focuses on completeness and improving accuracy in the most relevant sources. This means that for all 'NE' sources it is investigated what information is available and whether it could be assumed that a source is a really (very) small/negligible. For those sources that were not small, during the improvement programme, methods for estimating the emissions were developed.

As a result of this process, only for very few sources it was decided to keep these as 'NE', since data for estimating emissions are not available and the source is very small. Of course on regular basis it is being checked/re-assessed whether there are developments in NE sources that indicate (major) increase in emissions or new data sources for estimating emissions. For all except the biofuels this is the case for the 'NE' sources the ERT is referring to. For biofuels we are planning to incorporate activity data and emissions.

The Netherlands greenhouse gas emission inventory includes all sources identified by the Revised IPCC Guidelines (IPCC, 1996) – with the exception of the following (very) minor sources:

- Oil transport (1B2a3), due to missing activity data;
  The pipeline network in The Netherlands is dominated by the transport of natural gas (about 11,600 km in 2007). It is estimated that there is about 400 km pipelines for the transport of crude oil and about 1,000 km pipelines for the transport of oil products, chemical products and industrial gasses. Almost all pipelines are in the ground. Most of the pipelines for other transport then natural gas are short distance connections within industrial companies, companies close to each other and plant sites. E.g. some pipelines in the Rotterdam area within the refinery sector; the emissions of those pipelines are included in the emission estimates as reported in 1A.
  There is no information available on the annual transport of the different types of fluids and also not on the material used for the pipelines.
  So it estimated that the emissions from oil transport by pipelines are a very minor source. Due to missing activity data as well as missing information on the material of the pipeline system, it is not possible to estimate this very minor source.
- Charcoal production (1B2), due to missing activity data;
  As indicated in the NIR 2008 there is information indicating that there might be one company which produces charcoal. The production started after 1990. At this moment the production capacity is about 11,000 ton/year. Production levels are not known. The company is using the so called "Twin-retort" carbonization process to produce charcoal. Compared to traditional charcoal production processes, the CH4 emissions of the Twin-retort system are far lower (Reumerman and Frederiks, 2002). CH4 emissions from charcoal production are not estimated since these emissions are negligible.
- Charcoal use (1A4) , due to missing activity data;
  Emissions from charcoal are only expected from barbequing in the residential en services sector during the summer period. As indicated in the NIR 2008 there is no information on activity data on the actual charcoal use in 1A4 (other sectors), but it is assumed that these emissions are neglect able. For these reasons the very low emissions are not estimated.
- CO_2 from lime production (2A2), due to missing activity data;
  There are only four small companies in the Netherlands producing calcium from limestone, either as a primary or secondary activity. Most of the limestone and lime processed in the Netherlands is imported from Germany and Belgium (Van de Bank and Venderbosch, 1997). So emissions are assumed to be very small. As presented in Protocol 'Other process emissions and product consumption emissions of CO_2, N_2O (direct and indirect) and CH_4', this source category is currently not calculated due to the lack of both activity data and emissions.
- CO_2 from asphalt roofing (2A5) and CO_2 from road paving (2A6), due to missing activity data;
  Information on the use of bitumen is only available for two groups: the chemical industry and all others. There is no

information on the amount of asphalt roofing production and also no information on road paving with asphalt. The statistical information on sales (value) of asphalt roofing and asphalt for road paving was finalised by 2002. Based on this information is was assumed that emissions related to this two categories are very low/unelectable and that effort in generating activity data would therefore not be cost effective. So not only the missing activity data but also the very limited amount of emissions was the rationale of the decision to not estimate these emissions.

- CH_4 from Enteric fermentation poultry (4A9), due to missing emission factors;
- For this source category no IPCC default emission factor is available
- N_2O from Industrial wastewater (6B1), due to negligible amounts.
  As presented in the NIR 2008, page 194 the annual source for activity data are yearly questionnaires which cover all urban WWTPs and all anaerobic industrial WWTPs. For these industrial WWTPs CH_4 emissions are estimated based on the design capacity of the installations (47 plants) and reported. CH_4 emissions reported for 2006 were 0.33 Gg CH_4. From this anaerobic pre-treatment there is no N_2O emission
  In 2000 The Netherlands investigated at that moment not yet estimated sources for non-CO_2 emissions. One of these sources was the wastewater handling (DHV 2000). As a result of this study emissions were estimated (Oonk 2004) and the methods are presented in the protocols CH_4, N_2O from waste water treatment (6B).

  We are not able to estimate N2O emissions from aerobic industrial WWTPs, as there is no information available on these installations. In the priority setting for allocation of budgets for improvements in emission estimates, we did consider this as a source for which it could not be argued that a new data collection process or a new statistic was a priority. The argumentations for this decision includes following:The majority of the small and medium enterprises are linked to the municipal wastewater treatment plants (for which we made emission estimates) and do not have an own wastewater treatment;
  - The anaerobic pre-treatment reduce the N load to the aerobic final treatment;
  - The aerobic (post) treatment is done for several of the industrial companies in the municipal WWTP's;
  - The composition of the industrial waste water is mainly process water and although we have no specific information on the N-content of the influent, it is assumed that it is low N content.

Additional there are indications that the number of industrial wastewater treatment plants will reduce in the near future and this will also further minimize the minor effect of not estimating this source.

- Precursor emissions (i.e. CO, NOx, NMVOC and $_2$) from Memo item international bunkers (international transport) have not been included.

Annex 6 Additional information to be considered as part of the NIR submission

The following information should be considered as part of this NIR submission:

A6.1 List of protocols

See table 6.1

A6.2 Documentation of uncertainties used in IPCC Tier 1 uncertainty assessments and Tier 2 key source identification

- Olivier, J.G.J., L.J. Brandes, R.A.B. te Molder, 2009 (in print): Estimate of annual and trend uncertainty for Dutch sources of greenhouse gas emissions using the ipcc Tier 1 approach. PBL Report 500080013, PBL, Bilthoven
- Olsthoorn, X. and A. Pielaat, 2003: Tier-2 uncertainty analysis of the Dutch greenhouse gas emissions 1999. Institute for Environmental Studies (IVM), Free University, Amsterdam. IVM Report no. R03-06.
- Ramírez-Ramírez, A., C. de Keizer and J.P. van der Sluijs, 2006: Monte Carlo Analysis of Uncertainties in the Netherlands Greenhouse Gas Emission Inventory for 1990–2004, report NWS-E-2006-58, Department of Science, Technology and Society, Copernicus Institute for Sustainable Development and Innovation, Utrecht University, Utrecht, the Netherlands.

A6.3 Background documents and uncertainty discussion papers

- Van Amstel, A.R., J.G.J. Olivier and P.G. Ruyssenaars (eds.), 2000a: Monitoring of Greenhouse Gases in the Netherlands: Uncertainty and Priorities for Improvement. Proceedings of a National Workshop held in Bilthoven, the Netherlands, 1 September 1999. WIMEK report/RIVM report no. 773201 003. Bilthoven, May 2000.
- Kuikman, P.J., J.J.H van den Akker and F. de Vries, 2005: Lachgasemissie uit organische landbouwbodems. Alterra, Wageningen. Alterra rapport 1035-II.
- Hoek, K. W. van der, 2002: Uitgangspunten voor de mest- en ammoniakberekeningen 1999 tot en met 2001 zoals gebruikt in de Milieubalans 2001 en 2002, inclusief dataset landbouwemissies 1980-2001. RIVM rapport 773004013. RIVM, Bilthoven.
- Hoek, K. W. van der and M. W. van Schijndel, 2006: Methane and nitrous oxide emissions from animal manure management, including an overview of emissions 1990-2003. Background document for the Dutch National Inventory Report. RIVM report 680.125.002, Bilthoven.
- Hoek, K.W. van der, M.W. van Schijndel, P.J. Kuikman, 2007. Direct and indirect nitrous oxide emissions from agricultural soils, 1990 - 2003. Background document on the calculation method for the Dutch National Inventory Report. RIVM Report No. 68012.003./2007 MNP Report No. 500080003/2007 Bilthoven, the Netherlands.
- Nabuurs, G.J., I.J. van den Wyngaert, W.D. Daamen, A.T.F. Helmink, W de Groot, W.C. Knol, H. Kramer, P Kuikman, 2005: National System of Greenhouse Gas Reporting for Forest and Nature Areas under UNFCCC in the Netherlands - version 1.0 for 1990–2002. Alterra, Wageningen. Alterra rapport 1035-I.
- Van den Wyngaert, I.J.J., Kramer, H., Kuikman, P., Nabuurs, G.J. (2009) Greenhouse gas reporting of the LULUCF sector, revisions and updates related to the Dutch NIR 2009. Alterra report1035.7, Alterra, Wageningen.

A6.4 Documentation of Quality Assurance and Quality Control for national greenhouse gas inventory compilation and reporting

- DHV, 2002: Quality Assurance and Quality Control for the Dutch National Inventory Report; report on phase 1, January 2002, report no. ML-BB-20010367. DHV, Amersfoort.
- PBL, 2008. Werkplan EmissieRegistratie ronde 2008 – 2009. PBL, Bilthoven, 2008.

Methodological description (monitoring protocols 2009, from 15 April 2009 available at the website). Table A6.1

Protocol	IPCC code	Description	Gases
9051	All	Reference approach	CO_2
9052	1A1 1A2 1A4	Stationary combustion (fossil) *	CO_2 N_2O CH_4
9053	1A1b 1B1b 1B2aiv 2A4i 2B1 2B4i 2B5i 2B5vii 2B5viii 2C1vi 2D2 2Giv	Process emissions (fossil)	CO_2 N_2O CH_4
9054	1A2f 1A4c	Mobile equipment	CO_2 N_2O CH_4
9055	1A3a	Inland aviation	CO_2 N_2O CH_4
9056	1A3b	Road transport	CO_2
9057	1A3b	Road transport	N_2O CH_4
9058	1A3c	Rail transport	CO_2 N_2O CH_4
9059	1A3d	Inland navigation	CO_2 N_2O CH_4
9060	1A4c	Fisheries	CO_2 N_2O CH_4
9061	1A5	Defense	CO_2 N_2O CH_4
9062	1B2	Oil & gas production	CO_2 CH_4
9063	1B2	Oil & gas distribution/transport	CO_2 CH_4
9064	2A1 2A2 2A3 2A4ii 2A7i 2B5ix 2C1i 2C1vii 2C3 2Gi 2Gii 2Giii 2Gv 3A 3B 3C 3D	Process emissions (non-fossil)	CO_2 N_2O CH_4
9065	2B2	Nitric acid	N_2O
9066	2B5	Caprolactam	N_2O
9067	2C3	Aluminum production	PFC
9068	2E1	HCFC-22 production	HFC
9069	2E3	HFC byproduct emissions	HFC
9070	2F1	Stationary refrigeration	HFC
9071	2F1	Mobile refrigeration	HFC
9072	2F2	Hard foams	HFC
9073	2F4	Aerosols	HFC
9074	2F8	Sound proof windows	SF_6
9075	2F8	Semi-conductors	SF_6 PFC
9076	2F8	Electrical equipment	SF_6
9077	4A	Enteric fermentation,	CH_4
9078	4B	Manure management	N_2O
9079	4B	Manure management	CH_4
9080	4D	Agricultural soils, indirect	N_2O
9081	4D	Agricultural soils, direct	N_2O
9082	5A	Forest	CO_2
9083	5D-5G	Soil	CO_2
9084	6A1	Waste disposal	CH_4
9085	6B	Waste water treatment	CH_4 N_2O
9086	6D	Large-scale composting	CH_4 N_2O
In addition to the emissions described in the protocols, two memo items are included in the National System			
9087	Memo item	International bunker emissions	CO_2 N_2O CH_4
9088	1A, (CO_2 memo item)	Biomass	CO_2 CH_4 N_2O

- Coenen, P.W.H.G., Memorandum on recalculations as presented in the CRF submission 2006. TNO, Apeldoorn.
- SenterNovem, the Netherlands National System:QA/QC programme 2008/2009 Version 4.0 Autumn 2008.

Annex 7 Tables 6.1 and 6.2 of the IPCC Good Practice guidance

As described in Section 1.7, a Tier 1 uncertainty assessment was made to estimate the uncertainty in total national greenhouse gas emissions and in their trend. Tier 1 here means that non-Gaussian uncertainty distributions and correlations between sources have been neglected[1]. The uncertainty estimates for activity data and emission factors as listed in Table A7.2 were also used for a Tier 1 trend uncertainty assessment, as shown in Table A7.1. Uncertainties for the activity data and emission factors are derived from a mixture of empirical data and expert judgment and presented here as half the 95% confidence interval. The reason for halving the 95% confidence interval is that the value then corresponds to the familiar plus or minus value when uncertainties are loosely quoted as "plus or minus x%".

Details on this calculation can be found in Table A7.2 and in Olivier et al.(2009). It should be stressed that most uncertainty estimates are ultimately based on collective expert judgment and therefore also rather uncertain (usually of the order of 50%). However, the reason to make these estimates is to identify the relatively most important uncertain sources. For this purpose, a reasonable order-of-magnitude estimate of the uncertainty in activity data and in emission factors is usually sufficient: uncertainty estimates are a means to identify and prioritize inventory improvement activities, rather than an objective in itself.

This result may be interpreted in two ways: part of the uncertainty is due to inherent lack of knowledge on the sources that cannot be improved; another part, however, can be attributed to elements of the inventory of which the uncertainty could be reduced in the course of time. The latter may be a result of either dedicated research initiated by the Inventory Agency or by other researchers. When this type of uncertainty is in sources that are expected to be relevant for emission reduction policies, the effectiveness of the policy package could be in jeopardy if the unreduced emissions turn out to be much less than originally estimated.

The results of this uncertainty assessment for the list of potential key sources can also be used to refine the Tier 1 key source assessment discussed above. This is the topic of the next Section.

Table A7.1. Uncertainty estimates for Tier 1 trend. **Table A7.1**

	Uncertainty in emission level	Uncertainty in emission trend
CO_2 eq	± 5%	± 3%-points of 3% decrease
CO_2	± 3%	± 2%-points of 8% increase
CH_4	± 25%	± 10%-points of 34% decrease
N_2O	± 50%	± 15%-points of 23% decrease
F-gases	± 50%	± 9%-points of 72% decrease

1 We note that a Tier 2 uncertainty assessment and a comparison with a Tier 1 uncertainty estimate based on similar data showed that in the Dutch circumstances the errors made in the simplified Tier 1 approach for estimating uncertainties are quite small (Olsthoorn and Pielaat, 2003 and Ramírez-Ramírez et al., 2006). This conclusion holds for both annual uncertainties and the trend uncertainty (see Section 1.7 for more details).

Tier 1 level and trend uncertainty assessment 1990–2007 (for F-gases with base year 1995) with the categories of the IPCC potential key source list (without adjustment for correlation sources).

Table A7.2

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	trend in national emissions introduced by emission factor	trend in national emissions introduced by activity data	Uncertainty introduced into the trend in total national emissions
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	107	741	2%	10%	10%	0,0%	0,3%	0%	0,0%	0,0%	0,0%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	26068	2%	3%	3%	0,4%	0,5%	12%	0,0%	0,3%	0,3%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	23675	2%	2%	2%	0,2%	5,0%	16%	0,1%	0,6%	0,6%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	591	2184	0,1	0,05	11%	0,1%	0,8%	1%	0,0%	0,2%	0,2%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	9060	10%	10%	14%	0,6%	-0,3%	4%	0,0%	0,6%	0,6%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1041	2596	0,005	0,01	1%	0,0%	0,7%	1%	0,0%	0,0%	0,0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	20%	3%	20%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2208	20%	5%	21%	0,2%	0,3%	1%	0,0%	0,3%	0,3%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8644	9051	2%	5%	5%	0,2%	0,3%	4%	0,0%	0,1%	0,1%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5014	4550	3%	10%	10%	0,2%	-0,3%	2%	0,0%	0,1%	0,1%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19010	14148	2%	1%	2%	0,2%	-1,0%	7%	0,0%	0,2%	0,2%
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	86	0,5	0,05	50%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	6634	9970	20%	2%	20%	1,0%	1,0%	5%	0,0%	1,3%	1,3%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	15747	5%	2%	5%	0,4%	-1,1%	7%	0,0%	0,5%	0,5%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	8318	6585	10%	2%	10%	0,3%	-0,7%	3%	0,0%	0,4%	0,4%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2893	2153	20%	3%	20%	0,2%	-0,3%	1%	0,0%	0,3%	0,3%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1476	446	20%	3%	20%	0,0%	-0,5%	0%	0,0%	0,1%	0,1%
1A5	Military use of fuels (1A5 Other)	CO_2	566	317	20%	3%	20%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
1A	Emissions from stationary combustion: non-CO_2	CH_4	586	1116	3%	50%	50%	0,3%	0,3%	1%	0,1%	0,0%	0,1%
1A	Emissions from stationary combustion: non-CO_2	N_2O	226	313	3%	50%	50%	0,1%	0,0%	0%	0,0%	0,0%	0,0%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10901	13000	0,01	0,004	1%	0,1%	1,1%	6%	0,0%	0,1%	0,1%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11832	20096	5%	2%	5%	0,5%	4,2%	10%	0,0%	0,7%	0,7%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	1738	962	10%	2%	10%	0,0%	-0,8%	0%	0,0%	0,1%	0,1%
1A3	Mobile combustion: water-borne navigation	CO_2	405	606	20%	2%	20%	0,1%	0,1%	0%	0,0%	0,1%	0,1%
1A3	Mobile combustion: aircraft	CO_2	41	41	50%	2%	50%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: other (railways)	CO_2	91	97	5%	2%	5%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: other (non-road)	CH_4	1	1	50%	100%	112%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: other (non-road)	N_2O	1	2	50%	100%	112%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: road vehicles	CH_4	157	45	3%	60%	60%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: road vehicles	N_2O	171	438	0,05	0,5	50%	0,1%	0,1%	0%	0,0%	0,0%	0,0%
1B2	Fugitive emissions venting/flaring	CH_4	1051	479	2%	25%	25%	0,1%	-0,3%	0%	-0,1%	0,0%	0,1%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	171	3%	25%	25%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	162	158	20%	50%	54%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1B1b	CO_2 from coke production	CO_2	403	444	50%	2%	50%	0,1%	0,0%	0%	0,0%	0,1%	0,1%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	140	50%	2%	50%	0,0%	-0,3%	0%	0,0%	0,0%	0,0%
2A1	Cement production	CO_2	416	403	0,05	0,1	11%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2A3	Limestone and dolomite use	CO_2	232	161	25%	5%	25%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2A7	Other minerals	CO_2	275	485	25%	5%	25%	0,1%	0,1%	0%	0,0%	0,1%	0,1%
2B1	Ammonia production	CO_2	3096	3016	2%	2%	2%	0,0%	0,0%	1%	0,0%	0,0%	0,0%
2B2	Nitric acid production	N_2O	6330	4305	10%	20%	22%	0,5%	-0,9%	2%	-0,2%	0,3%	0,3%
2B5	Caprolactam production	N_2O	766	497	20%	20%	28%	0,1%	-0,1%	0%	0,0%	0,1%	0,1%
2B5	Other chemical product manufacture	CO_2	606	606	50%	50%	71%	0,2%	0,0%	0%	0,0%	0,2%	0,2%
2C1	Iron and steel production (carbon inputs)	CO_2	1534	1647	3%	5%	6%	0,0%	-0,4%	1%	0,0%	0,0%	0,0%
2C3	CO_2 from aluminium production	CO_2	395	431	0,01	0,05	5%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2C3	PFC from aluminium production	PFC	1901	101	2%	20%	20%	0,0%	-0,8%	0%	-0,2%	0,0%	0,2%
2F	SF6 emissions from SF6 use	SF6	301	214	50%	25%	56%	0,1%	0,0%	0%	0,0%	0,1%	0,1%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1471	0,2	0,5	54%	0,4%	0,6%	1%	0,3%	0,1%	0,3%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	243	10%	10%	14%	0,0%	-2,5%	0%	-0,3%	0,0%	0,3%
2E	HFC by-product emissions from HFC manufacture	HFC	12	24	0,2	0,2	22%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2F	PFC emissions from PFC use	PFC	37	226	5%	25%	25%	0,0%	0,1%	0%	0,0%	0,0%	0,0%
2G	Other industrial: CO_2	CO_2	305	307	0,05	0,2	21%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2G	Other industrial: CH_4	CH_4	297	302	10%	50%	51%	0,1%	0,0%	0%	0,0%	0,0%	0,0%
2G	Other industrial: N_2O	N_2O	3	6	50%	50%	71%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
3001	Indirect CO_2 from solvents/product use	CO_2	316	128	25%	10%	27%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	6783	5696	5%	15%	16%	0,4%	-0,5%	3%	-0,1%	0,2%	0,2%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	367	5%	50%	50%	0,1%	0,0%	0%	0,0%	0,0%	0,0%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	316	315	5%	30%	30%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
4B	Emissions from manure management	N_2O	814	872	0,1	1	100%	0,4%	0,0%	0%	0,0%	0,1%	0,1%
4B1	Emissions from manure management : cattle	CH_4	1571	1471	10%	100%	100%	0,7%	0,0%	1%	0,0%	0,1%	0,1%
4B8	Emissions from manure management : swine	CH_4	1140	1081	10%	100%	100%	0,5%	0,0%	1%	0,0%	0,1%	0,1%
4B9	Emissions from manure management : poultry	CH_4	173	66	10%	100%	100%	0,0%	-0,1%	0%	-0,1%	0,0%	0,1%
4B	Emissions from manure management : other	CH_4	12	15	10%	100%	100%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4874	4868	10%	60%	61%	1,4%	0,2%	2%	0,1%	0,3%	0,3%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	4975	3014	50%	200%	206%	3,1%	-0,8%	1%	-1,6%	1,0%	1,9%
4D2	Animal production on agricultural soils	N_2O	1449	603	10%	100%	100%	0,3%	-0,4%	0%	-0,4%	0,0%	0,4%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	10011	5260	0,3	0,15	34%	0,9%	-3,0%	2%	-0,5%	1,0%	1,1%
6B	Emissions from wastewater handling	CH_4	290	203	20%	25%	32%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
6B	Emissions from wastewater handling	N_2O	466	456	20%	50%	54%	0,1%	0,0%	0%	0,0%	0,1%	0,1%
6D	OTHER CH_4	CH_4	1	67	20%	25%	32%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
3, 6D	OTHER N_2O	N_2O	256	121	20%	50%	54%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%

Emissions (Gg) and uncertainty estimates for the subcategories of Sector 5 LULUCF, as used in the Tier 1 uncertainty analysis.

Table A7.3

IPCC	Category	Gas	CO_2 eq 1990	CO_2 eq 2005	AD uncert.	EF uncert.	EM uncertainty estimate
5A1	5A1. Forest Land remaining Forest Land	CO_2	-2.529	-2.167	25,0%	61,8%	67%
5A2	5A2. Land converted to Forest Land	CO_2	-3	-575	25,0%	57,9%	63%
5B2	5B2. Land converted to Cropland	CO_2	35	48	25,0%	50,0%	56%
5C1	5C1. Grassland remaining Grassland	CO_2	4.246	4.246	25,0%	50,0%	56%
5C2	5C2. Land converted to Grassland	CO_2	394	542	25,0%	61,2%	66%
5D2	5D2. Land converted to Wetlands	CO_2	40	55	25,0%	50,0%	56%
5E2	5E2. Land converted to Settlements	CO_2	212	292	25,0%	50,0%	56%
5F2	5F2. Land converted to Other Land	CO_2	18	25	25,0%	50,0%	56%
5G	5G. Other (liming of soils)	CO_2	183	71	25,0%	1,0%	25%

Annex 8 CRF Summary tables

This annex shows a copy of selected sheets from the Common Reporting Format (CRF) data files (the digital annexes to this national inventory report), presenting unrounded figures. The number of digits shown does not represent the uncertainty for the emissions.

A8.1 IPCC Table 7A for base years 1990, 1995 and for 2007

Emissions of greenhouse gases in the Netherlands; IPCC — Table A8.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs(1) P	HFCs(1) A	PFCs(1) P	PFCs(1) A	SF6 P	SF6 A	NOx	CO	NMVOC	SOx
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	161,890.11	1,016.47	65.24	NA, NE, NO	6,432.03	C, NA, NE, NO	1,264.48	C, NA, NE, NO	0.01	344.66	1,066.83	435.35	190.00
1. Energy	151,598.85	114.87	1.80							328.74	935.78	240.10	178.76
A. Fuel Combustion — Reference Approach (2)	155,641.19												
Sectoral Approach (2)	149,961.25	35.59	1.61							328.61	934.10	194.79	171.23
1. Energy Industries	52,469.33	3.55	0.45							105.18	11.74	2.58	105.84
2. Manufacturing Industries and Construction	32,677.65	2.85	0.19							88.33	153.67	8.98	45.90
3. Transport	26,009.02	7.51	0.88							250.68	683.26	166.35	13.18
4. Other Sectors	38,216.83	21.43	0.14							76.48	85.46	16.87	6.32
5. Other	589.72	0.05	0.03							7.73	IE	IE	IE
B. Fugitive Emissions from Fuels	1,177.40	79.48	0.00							0.13	1.58	42.31	7.52
1. Solid Fuels	402.67	1.44	NA, NO							IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NO
2. Oil and Natural Gas	774.75	78.04	0.00							0.13	1.58	42.31	7.52
2. Industrial Processes	7,837.63	14.14	21.90	NA, NE, NO	6,432.03	C, NA, NE, NO	1,264.48	C, NA, NE, NO	0.01	11.00	129.26	82.79	7.06
A. Mineral Products	922.73	NO	NO							1.28	3.52	1.03	0.29
B. Chemical Industry	3,741.13	11.13	21.89	NA, NO	NA, NO	NA, NO	NA, NO	NA	NA	8.21	IE, NA, NO	33.11	IE, NA, NO
C. Metal Production	2,928.84	IE, NA, NO	NO				1,246.21		NO	IE, NO	118.75	3.53	IE, NO
D. Other Production (3)	77.54									NO	NO	10.77	NO
E. Production of Halocarbons and SF6					6,432.03		NO		NO				
F. Consumption of Halocarbons and SF6				NE, NO	NO	C, NE, NO	18.26	C, NE	0.01				
G. Other	170.69	2.01	0.01	NA, NO	NO	NA, NO	NO	NO	NO	1.50	6.81	34.77	6.77
3. Solvent and Other Product Use	316.42		0.73							NO	NO	118.93	NO
4. Agriculture		521.69	38.50							NA, NO	NA, NO	0.46	NO
A. Enteric Fermentation		359.04											
B. Manure Management		162.65	2.62									NE, NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils (4)		NE, NO	35.88									0.46	
E. Prescribed Burning of Savannas		NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues		NO	NO							NO	NO	NO	
G. Other		NO	NO							NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	(9) 2,597.10	NA, NE, NO	NA, NE, NO							IE, NE	IE, NE	NE	NE
A. Forest Land	(9) -1,531.75	NE, NO	NE, NO							IE, NE	IE, NE	NE	
B. Cropland	(9) 34.68	NA, NE	NA, NE							NE	NE	NE	
C. Grassland	(9) 4,640.47	NE	NE							NE	NE	NE	
D. Wetlands	(9) 60.29	NE	NE							NE	NE	NE	
E. Settlements	(9) 212.14	NE	NE							NE	NE	NE	
F. Other Land	(9) 18.13	NE	NE							NE	NE	NE	
G. Other	(9) 183.15	NE	NE							NE	NE	NE	NE
6. Waste	IE, NA, NO	385.78	1.40							3.91	1.93	1.96	4.17
A. Solid Waste Disposal on Land	(11) NA, NO	371.03								NA, NO	NA, NO	1.45	
B. Waste-water Handling		13.79	1.40							NO	NO	NO	
C. Waste Incineration	(11) IE	IE	IE							IE	IE	IE	IE
D. Other	NA	0.06	0.00							3.91	1.93	0.11	4.17
7. Other (please specify) (7)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items: (8)													
International Bunkers	38,897.84	1.06	0.31							NE	NE	NE	NE
Aviation	4,540.46	0.22	0.04							NE	NE	NE	NE
Marine	34,357.38	0.84	0.27							NE	NE	NE	NE
Multilateral Operations	IE	IE	IE							NE	NE	NE	NE
CO_2 Emissions from Biomass	3,877.95												

Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; Year: 1995. — Figure A8.2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs(1) P	HFCs(1) A	PFCs(1) P	PFCs(1) A	SF_6 P	SF_6 A	NO_x	CO	NMVOC	SO_2
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	175,194.18	807.86	58.34	NA, NE, NO	1,737.59	C, NA, NE, NO	327.07	C, NA, NE, NO	0.01	290.04	534.18	159.67	59.73
1. Energy	165,273.49	103.82	3.43							285.66	490.47	77.98	58.86
A. Fuel Combustion — Reference Approach (2)	168,811.30												
Sectoral Approach (2)	163,775.88	60.58	3.43							281.46	485.67	57.46	41.30
1. Energy Industries	65,378.10	8.62	0.79							39.98	11.11	1.69	22.19
2. Manufacturing Industries and Construction	37,749.41	3.83	2.08							46.70	123.46	4.70	15.81
3. Transport	35,201.26	3.21	1.42							132.16	281.16	37.87	1.39
4. Other Sectors	24,988.94	49.09	0.12							61.80	70.00	13.40	1.80
5. Other	977.23	0.05	0.02							4.10	IE	IE	IE
B. Fugitive Emissions from Fuels	1,597.61	43.27	IE, NA, NO							4.20	4.80	19.50	16.50
1. Solid Fuels	443.79	1.08	NA, NO							IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NO
2. Oil and Natural Gas	1,153.82	41.19	IE, NA, NO							4.20	4.80	19.50	16.50
2. Industrial Processes	7,195.07	14.39	15.51	NA, NE, NO	1,737.59	C, NA, NE, NO	327.07	C, NA, NE, NO	0.01	8.58	43.77	22.96	0.92
A. Mineral Products	1,148.37	NO	NO							0.50	1.70	0.10	0.90
B. Chemical Industry	3,612.23	12.83	15.49	NA, NO	NA, NO	NA, NO	NA, NO	NA	NA	IE, NA, NO	1.00	2.90	IE, NA, NO
C. Metal Production	2,077.86	IE, NA, NO	NO				101.43		NO	IE, NO	37.60	IE, NA	IE, NO
D. Other Production (3)	29.03									NO	NO	5.11	NO
E. Production of Halocarbons and SF_6					166.87		NO		NO				
F. Consumption of Halocarbons and SF_6				NE, NO	1,470.73	C, NE, NO	225.58	C, NE	0.01				
G. Other	327.78	1.36	0.02	NA, NO	NA, NO	NA, NO	NO	NO	NO	0.08	3.47	16.45	0.02
3. Solvent and Other Product Use	108.29		0.25							NO	NO	53.87	NO
4. Agriculture		426.28	38.53							NA, NO	NA, NO	0.46	NO
A. Enteric Fermentation		300.85											
B. Manure Management		125.43	2.81									NE, NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils(4)		NE, NO	27.74									0.46	
E. Prescribed Burning of Savannas		NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues		NO	NO							NO	NO	NO	
G. Other		NO	NO							NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	(9) 3,532.23	NA, NE, NO	NA, NE, NO							IE, NE	IE, NE	NE	NE
A. Forest Land	(9) -1,741.51	NE, NO	NE, NO							IE, NE	IE, NE	NE	
B. Cropland	(9) 47.69	NA, NE	NA, NE							NE	NE	NE	
C. Grassland	(9) 4,788.24	NE	NE							NE	NE	NE	
D. Wetlands	(9) 55.38	NE	NE							NE	NE	NE	
E. Settlements	(9) 290.85	NE	NE							NE	NE	NE	
F. Other Land	(9) 24.91	NE	NE							NE	NE	NE	
G. Other	(9) 71.08	NE	NE							NE	NE	NE	NE
6. Waste	IE, NA, NO	263.34	1.60							0.00	0.02	8.73	0.00
A. Solid Waste Disposal on Land	(11) NA, NO	250.40								NA, NO	NA, NO	8.62	
B. Waste-water Handling		9.68	1.47							NO	NO	NO	
C. Waste Incineration	(11) IE	IE	IE							IE	IE	IE	IE
D. Other	NA	3.26	0.13							0.00	0.02	0.10	0.00
7. Other (please specify)(7)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items: (8)													
International Bunkers	62,481.31	1.68	0.49							NE	NE	NE	NE
Aviation	11,096.62	0.53	0.09							NE	NE	NE	NE
Marine	51,384.89	1.15	0.40							NE	NE	NE	NE
Multilateral Operations	IE	IE	IE							NE	NE	NE	NE
CO_2 Emissions from Biomass	5,303.06												

Table A8.3 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; Year: 2007.

Figure A8.3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	151,138.95	156,114.40	154,780.47	159,415.44	158,630.23	162,480.50	170,300.61	163,200.49	165,452.49	159,981.62
A. Fuel Combustion (Sectoral Approach)	149,961.55	154,976.20	153,707.33	158,392.59	157,563.22	161,522.34	169,265.92	162,201.36	164,650.42	159,317.05
1. Energy Industries	52,492.33	53,103.44	53,076.55	55,243.94	58,024.91	61,615.14	62,477.51	63,497.35	65,813.08	61,863.50
2. Manufacturing Industries and Construction	32,677.65	32,432.61	33,096.07	32,303.48	30,871.55	28,581.76	29,039.63	27,687.06	27,762.26	27,541.17
3. Transport	26,009.02	26,291.35	27,571.59	28,185.26	28,659.31	29,176.36	29,917.91	30,314.34	31,054.15	32,047.80
4. Other Sectors	38,216.83	42,610.27	39,410.03	42,121.56	39,521.58	41,636.98	47,322.64	40,217.47	39,500.99	37,215.29
5. Other	565.72	538.55	553.10	538.36	485.87	512.10	508.24	485.14	519.94	649.50
B. Fugitive Emissions from Fuels	1,177.40	1,138.19	1,073.14	1,020.84	1,067.01	958.16	1,034.69	999.14	802.07	664.57
1. Solid Fuels	402.67	430.02	431.50	445.73	558.50	516.87	650.57	504.53	492.20	445.62
2. Oil and Natural Gas	774.73	708.17	641.64	575.12	508.51	441.29	384.12	494.60	309.87	218.94
2. Industrial Processes	7,837.63	7,947.13	7,387.41	7,153.89	7,873.39	7,881.66	7,293.75	7,754.05	7,608.21	7,583.60
A. Mineral Products	922.73	1,317.22	1,261.11	1,256.10	1,475.41	1,432.49	990.33	1,015.57	1,101.32	1,230.94
B. Chemical Industry	3,701.53	3,707.07	3,767.18	3,669.04	3,874.00	3,973.80	3,743.44	3,995.27	4,050.61	4,038.95
C. Metal Production	2,908.84	2,547.91	1,953.13	1,888.34	2,189.23	2,184.13	2,134.64	2,443.92	2,109.51	1,994.92
D. Other Production	72.54	49.24	53.98	50.19	29.36	22.37	49.31	48.27	41.25	51.35
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	231.99	325.69	352.02	290.22	305.39	268.87	276.03	251.43	265.52	267.44
3. Solvent and Other Product Use	316.43	238.61	215.31	207.58	214.37	242.28	193.97	174.30	189.14	196.86
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry(2)	2,597.10	2,201.15	2,454.20	2,235.63	2,191.00	2,329.63	2,150.88	2,415.42	2,317.96	2,351.37
A. Forest Land	-2,531.75	-2,906.21	-2,664.59	-2,892.62	-2,916.23	-2,797.75	-3,005.90	-2,759.19	-2,867.52	-2,832.04
B. Cropland	34.68	35.41	36.27	37.06	37.93	38.81	39.65	40.56	41.40	42.27
C. Grassland	4,640.47	4,648.90	4,658.71	4,667.74	4,677.62	4,687.64	4,697.27	4,707.65	4,717.19	4,727.10
D. Wetlands	40.23	41.16	42.16	43.08	44.09	45.11	46.10	47.16	48.13	49.15
E. Settlements	212.14	216.61	221.86	226.67	231.96	237.31	242.46	248.02	253.11	258.41
F. Other Land	18.13	18.52	18.97	19.38	19.84	20.30	20.74	21.22	21.66	22.12
G. Other	183.15	146.76	140.82	134.31	95.79	98.20	110.56	109.99	103.99	84.37
6. Waste	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
A. Solid Waste Disposal on Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Waste-water Handling										
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 emissions including net CO_2 from LULUCF	161,890.12	166,501.30	164,837.38	169,010.53	168,908.99	172,934.08	179,839.21	173,544.27	175,567.79	170,113.45
Total CO_2 emissions excluding net CO_2 from LULUCF	159,293.01	164,300.14	162,383.18	166,774.90	166,717.99	170,604.45	177,688.33	171,128.85	173,249.83	167,762.08
Memo Items:										
International Bunkers	38,897.84	40,171.14	41,240.19	43,084.42	41,493.06	42,982.73	44,254.29	47,150.51	48,404.77	49,990.82
Aviation	4,540.46	4,844.86	5,648.73	6,214.34	6,534.56	7,584.14	8,079.78	8,739.60	9,560.09	9,832.32
Marine	34,357.38	35,326.28	35,591.45	36,870.08	34,958.50	35,398.58	36,174.51	38,410.91	38,844.69	40,158.49
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	3,877.95	3,795.79	3,832.30	4,055.68	3,940.42	4,272.73	4,865.00	5,290.55	5,501.20	5,727.80

A8.2 Recalculation tables for base years 1990 and 2006

For this submission (NIR 2009), the Netherlands uses the CRF reporter software 3.2.3. The recalculation table is included in Chapter 10.

A8.3 CRF Trend Tables 10: greenhouse gas emissions and by source and sink categories

Emissions of greenhouse gases in the Netherlands; CRF Trend Table 10: CO_2 **Figure A8.4**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	1.61	1.75	1.90	2.10	2.22	2.34	2.44	2.44	2.46	2.40
A. Fuel Combustion (Sectoral Approach)	1.61	1.75	1.90	2.10	2.22	2.34	2.44	2.44	2.46	2.40
1. Energy Industries	0.45	0.42	0.41	0.47	0.51	0.53	0.59	0.60	0.63	0.59
2. Manufacturing Industries and Construction	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.07	0.08	0.08
3. Transport	0.88	1.05	1.22	1.35	1.46	1.56	1.59	1.61	1.59	1.57
4. Other Sectors	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.13	0.13	0.12
5. Other	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
B. Fugitive Emissions from Fuels	0.00	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
2. Oil and Natural Gas	0.00	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
2. Industrial Processes	22.90	22.91	23.08	24.71	24.13	22.86	22.87	22.67	22.71	21.57
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	22.89	22.90	23.07	24.70	24.12	22.85	22.85	22.65	22.69	21.54
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.03
3. Solvent and Other Product Use	0.725	0.72916	0.73333	0.69848	0.65946	0.637313	0.62399	0.55114	0.520364	0.495554
4. Agriculture	38.50	39.44	42.23	41.73	40.47	42.10	41.45	40.87	39.61	38.67
A. Enteric Fermentation										
B. Manure Management	2.63	2.83	2.99	2.96	2.81	2.88	2.83	2.80	2.91	3.03
C. Rice Cultivation										
D. Agricultural Soils	35.87832077	36.60692846	39.24135762	38.77342947	37.65585678	39.22524304	38.61228023	38.07603403	36.70172178	35.64186992
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO
A. Forest Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
B. Cropland	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	1.50	1.55	1.56	1.56	1.59	1.54	1.53	1.56	1.57	1.54
A. Solid Waste Disposal on Land										
B. Waste-water Handling	1.50	1.52	1.50	1.49	1.47	1.40	1.39	1.41	1.43	1.40
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	0.00	0.03	0.06	0.08	0.12	0.14	0.14	0.14	0.14	0.14
7. Other (as specified in Summary 1.A)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total N2O emissions including N2O from LULUCF	65.24	66.37	69.50	70.80	69.07	69.49	68.90	68.09	66.87	64.67
Total N2O emissions excluding N2O from LULUCF	65.24	66.37	69.50	70.80	69.07	69.49	68.90	68.09	66.87	64.67
Memo Items:										
International Bunkers	0.31	0.32	0.33	0.34	0.33	0.34	0.35	0.37	0.38	0.40
Aviation	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.08
Marine	0.27	0.28	0.28	0.29	0.27	0.28	0.28	0.30	0.30	0.31
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO2 Emissions from Biomass										

Emissions of greenhouse gases in the Netherlands; CRF Trend Table 10: CH_4 — Figure A8.5

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	1.61	1.75	1.90	2.10	2.22	2.34	2.44	2.44	2.46	2.40
A. Fuel Combustion (Sectoral Approach)	1.61	1.75	1.90	2.10	2.22	2.34	2.44	2.44	2.46	2.40
1. Energy Industries	0.45	0.42	0.41	0.47	0.51	0.53	0.59	0.60	0.63	0.59
2. Manufacturing Industries and Construction	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.07	0.08	0.08
3. Transport	0.88	1.05	1.22	1.35	1.46	1.56	1.59	1.61	1.59	1.57
4. Other Sectors	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.13	0.13	0.12
5. Other	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
B. Fugitive Emissions from Fuels	0.00	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
2. Oil and Natural Gas	0.00	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
2. Industrial Processes	22.90	22.91	23.08	24.71	24.13	22.86	22.87	22.67	22.71	21.57
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	22.89	22.90	23.07	24.70	24.12	22.85	22.85	22.65	22.69	21.54
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.03
3. Solvent and Other Product Use	0.725	0.72916	0.73333	0.69848	0.65946	0.637313	0.62299	0.55114	0.520364	0.495554
4. Agriculture	38.50	39.44	42.23	41.73	40.47	42.10	41.45	40.87	39.62	38.67
A. Enteric Fermentation										
B. Manure Management	2.63	2.83	2.99	2.96	2.81	2.88	2.83	2.80	2.91	3.03
C. Rice Cultivation										
D. Agricultural Soils	35.87832077	36.60692846	39.24135762	38.77242947	37.65585678	39.22524304	38.61228023	38.07603403	36.70172178	35.64186992
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO
A. Forest Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
B. Cropland	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	1.50	1.55	1.56	1.56	1.59	1.54	1.53	1.56	1.57	1.54
A. Solid Waste Disposal on Land										
B. Waste-water Handling	1.50	1.52	1.50	1.49	1.47	1.40	1.39	1.41	1.43	1.40
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	0.00	0.03	0.06	0.08	0.12	0.14	0.14	0.14	0.14	0.14
7. Other (as specified in Summary 1.A)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total N2O emissions including N2O from LULUCF	65.24	66.37	69.50	70.80	69.07	69.49	68.90	68.09	66.87	64.67
Total N2O emissions excluding N2O from LULUCF	65.24	66.37	69.50	70.80	69.07	69.49	68.90	68.09	66.87	64.67
Memo Items:										
International Bunkers	0.31	0.32	0.33	0.34	0.33	0.34	0.35	0.37	0.38	0.40
Aviation	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.08
Marine	0.27	0.28	0.28	0.29	0.27	0.28	0.28	0.30	0.30	0.31
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO2 Emissions from Biomass										

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	1.61	1.75	1.90	2.10	2.22	2.34	2.44	2.44	2.46	2.40
A. Fuel Combustion (Sectoral Approach)	1.61	1.75	1.90	2.10	2.22	2.34	2.44	2.44	2.46	2.40
1. Energy Industries	0.45	0.42	0.41	0.47	0.51	0.53	0.59	0.60	0.63	0.59
2. Manufacturing Industries and Construction	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.07	0.08	0.08
3. Transport	0.88	1.05	1.22	1.35	1.46	1.56	1.59	1.61	1.59	1.57
4. Other Sectors	0.14	0.15	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.12
5. Other	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
B. Fugitive Emissions from Fuels	0.00	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
2. Oil and Natural Gas	0.00	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
2. Industrial Processes	22.90	22.91	23.08	24.71	24.13	22.86	22.87	22.67	22.71	21.57
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	22.89	22.90	23.07	24.70	24.12	22.85	22.85	22.65	22.69	21.54
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.03	0.02	0.03
3. Solvent and Other Product Use	0.725	0.72916	0.73333	0.69848	0.65946	0.637313	0.62299	0.55114	0.520364	0.495554
4. Agriculture	38.50	39.44	42.23	41.73	40.47	42.10	41.45	40.87	39.62	38.67
A. Enteric Fermentation										
B. Manure Management	2.63	2.83	2.99	2.96	2.81	2.88	2.83	2.80	2.91	3.03
C. Rice Cultivation										
D. Agricultural Soils	35.87832077	36.60692846	39.24135762	38.77242947	37.65585678	39.22524304	38.54228023	38.07603403	36.70172178	35.64186992
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO
A. Forest Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
B. Cropland	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	1.50	1.55	1.56	1.56	1.59	1.54	1.53	1.56	1.57	1.54
A. Solid Waste Disposal on Land										
B. Waste-water Handling	1.50	1.52	1.50	1.49	1.47	1.40	1.39	1.41	1.43	1.40
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	0.00	0.03	0.06	0.08	0.12	0.14	0.14	0.14	0.14	0.14
7. Other (as specified in Summary 1.A)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total N2O emissions including N2O from LULUCF	65.24	66.37	69.50	70.80	69.07	69.49	68.90	68.09	66.87	64.67
Total N2O emissions excluding N2O from LULUCF	65.24	66.37	69.50	70.80	69.07	69.49	68.90	68.09	66.87	64.67
Memo Items:										
International Bunkers	0.31	0.32	0.33	0.34	0.33	0.34	0.35	0.37	0.38	0.40
Aviation	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.08
Marine	0.27	0.28	0.28	0.29	0.27	0.28	0.28	0.30	0.30	0.31
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO2 Emissions from Biomass										

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	2.40	2.41	2.45	2.42	2.43	2.44	2.45	2.43	51.03
A. Fuel Combustion (Sectoral Approach)	2.40	2.40	2.45	2.42	2.43	2.44	2.45	2.43	51.08
1. Energy Industries	0.63	0.66	0.70	0.70	0.73	0.78	0.77	0.79	76.06
2. Manufacturing Industries and Construction	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	-24.07
3. Transport	1.53	1.53	1.53	1.50	1.47	1.44	1.46	1.42	61.69
4. Other Sectors	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	-16.97
5. Other	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	-42.59
B. Fugitive Emissions from Fuels	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	100.00
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
2. Oil and Natural Gas	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	-100.00
2. Industrial Processes	22.06	20.03	19.15	19.42	21.12	20.55	20.21	15.51	-32.26
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	22.04	20.01	19.12	19.40	21.10	20.53	20.19	15.49	-32.33
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Other Production									
E. Production of Halocarbons and SF6									
F. Consumption of Halocarbons and SF6									
G. Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	120.82
3. Solvent and Other Product Use	**0.44**	**0.36**	**0.29**	**0.27**	**0.28**	**0.25**	**0.26**	**0.25**	**-65.86**
4. Agriculture	35.75	34.04	32.33	31.04	30.91	31.04	30.82	30.55	-20.63
A. Enteric Fermentation									
B. Manure Management	2.88	2.78	2.84	2.34	2.60	2.78	2.74	2.81	7.10
C. Rice Cultivation									
D. Agricultural Soils	32.87	31.25	29.48	28.70	28.32	28.26	26.08	27.74	22.68
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	0.00
A. Forest Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	0.00
B. Cropland	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	NA, NE	0.00
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	0.00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	0.00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	0.00
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	1.56	1.55	1.56	1.52	1.54	1.56	1.56	1.60	8.18
A. Solid Waste Disposal on Land									
B. Waste-water Handling	1.41	1.42	1.42	1.39	1.40	1.43	1.43	1.47	-2.13
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	0.15	0.13	0.14	0.13	0.14	0.13	0.12	0.13	5,520.99
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total N2O emissions including N2O from LULUCF	62.21	58.40	55.77	54.67	56.28	55.85	55.30	50.34	-22.84
Total N2O emissions excluding N2O from LULUCF	62.21	58.40	55.77	54.67	56.28	55.85	55.30	50.34	-22.84
Memo Items:									
International Bunkers	0.41	0.45	0.45	0.42	0.45	0.51	0.53	0.49	60.51
Aviation	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	144.39
Marine	0.33	0.37	0.36	0.34	0.37	0.42	0.44	0.40	48.62
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	0.00
CO2 Emissions from Biomass									

Emissions of greenhouse gases in the Netherlands; CRF Trend Table 10: HFCs, PFCs and SF_6 — Figure A8.7

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs(3) - (Gg CO2 equivalent)	4,432.03	3,451.56	4,447.33	4,998.04	6,480.37	6,019.54	7,677.81	8,300.13	9,341.37	4,859.17
HFC-23	0.38	0.30	0.38	0.42	0.54	0.49	0.59	0.57	0.67	0.29
HFC-32	NO	NO	NO	NO	NO	0.00	NO	0.00	0.00	NO
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	0.00	0.01	0.02	0.04	0.05
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	0.02	0.01	0.04	0.04	0.11	0.17	0.12	0.14
HFC-152a	NO	NO	0.01	0.03	0.02	0.02	0.03	NO	NO	NO
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	0.00	0.01	0.00	0.03	0.01	0.04	0.04
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed HFCs(4) - (Gg CO2 equivalent)	NO	NO	NO	21.41	117.36	187.62	489.42	1,272.05	1,157.38	974.28
Emissions of PFCs(3) - (Gg CO2 equivalent)	2,264.48	2,244.88	2,042.85	2,068.47	1,989.67	1,937.81	2,155.33	2,343.91	1,829.24	1,472.23
CF4	0.28	0.28	0.25	0.25	0.24	0.24	0.26	0.28	0.21	0.15
C2F6	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04
C 3F8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C4F10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C4F8	NA,NO	NA,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO
C5F12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C6F14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed PFCs(4) - (Gg CO2 equivalent)	18.26	21.00	24.15	27.77	31.94	37.03	51.10	101.26	113.87	147.11
Emissions of SF6(3) - (Gg CO2 equivalent)	217.32	133.91	143.09	149.90	191.20	301.26	312.40	344.85	328.84	317.03
SF6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO2 equivalent)	3,828.94	1,469.23	1,541.41	1,377.06	1,506.65	1,357.71	1,566.39	1,737.59	-60.79
HFC-23	0.21	0.04	0.06	0.04	0.03	0.02	0.02	0.02	-94.53
HFC-32	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	0.06	0.08	0.06	0.07	0.09	0.09	0.10	0.11	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.12	0.16	0.20	0.24	0.30	0.33	0.37	0.42	100.00
HFC-152a	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	100.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.08	0.05	0.05	0.06	0.07	0.08	0.09	0.12	100.00
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO2 equivalent)	774.76	408.12	216.39	216.05	237.14	173.03	170.88	185.48	100.00
Emissions of PFCs(3) - (Gg CO2 equivalent)	1,581.54	1,489.43	2,187.03	620.53	285.64	266.20	256.54	327.07	-85.56
CF4	0.16	0.15	0.24	0.05	0.01	0.01	0.01	0.01	-95.25
C2F6	0.04	0.04	0.06	0.01	0.00	0.00	0.00	0.00	-96.41
C 3F8	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C4F10	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C4F8	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C5F12	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C6F14	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO2 equivalent)	193.35	162.71	119.70	180.25	179.04	178.19	194.46	225.58	1,135.28
Emissions of SF6(3) - (Gg CO2 equivalent)	318.71	323.37	282.98	243.47	246.15	237.92	202.17	213.95	-1.55
SF6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-1.55

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	161,890.12	166,501.30	164,837.38	169,010.53	168,908.99	172,934.08	179,839.21	173,544.27	175,567.79	170,113.45
CO_2 emissions excluding net CO_2 from LULUCF	159,293.01	164,300.14	162,383.18	166,774.90	166,717.99	170,604.45	177,688.33	171,128.85	173,249.83	167,762.08
CH_4 emissions including CH_4 from LULUCF	25,545.87	25,907.21	25,457.52	25,187.89	24,441.67	24,153.23	23,487.02	22,640.58	21,733.73	20,708.60
CH_4 emissions excluding CH_4 from LULUCF	25,545.87	25,907.21	25,457.52	25,187.89	24,441.67	24,153.23	23,487.02	22,640.58	21,733.73	20,708.60
N_2O emissions including N_2O from LULUCF	20,225.11	20,573.68	21,546.29	21,948.17	21,410.82	21,540.89	21,359.43	21,107.48	20,729.07	20,047.71
N_2O emissions excluding N_2O from LULUCF	20,225.11	20,573.68	21,546.29	21,948.17	21,410.82	21,540.89	21,359.43	21,107.48	20,729.07	20,047.71
HFCs	4,432.03	3,451.56	4,447.33	4,998.04	6,480.37	6,019.54	7,677.81	8,300.13	9,341.37	4,859.17
PFCs	2,264.48	2,244.88	2,042.85	2,068.47	1,989.67	1,937.81	2,155.33	2,343.91	1,829.24	1,472.23
SF6	217.32	133.91	143.09	149.90	191.20	301.26	312.40	344.85	328.84	317.03
Total (including LULUCF)	**214,574.92**	**218,812.53**	**218,474.46**	**223,363.00**	**223,422.71**	**226,886.81**	**234,831.20**	**228,281.23**	**229,530.03**	**217,518.20**
Total (excluding LULUCF)	**211,977.82**	**216,611.37**	**216,020.26**	**221,127.37**	**221,231.71**	**224,557.18**	**232,680.32**	**225,865.81**	**227,212.07**	**215,166.83**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	154,049.99	159,099.38	157,804.74	162,554.66	161,839.52	165,797.98	173,697.41	166,056.87	168,236.82	162,582.49
2. Industrial Processes	22,147.35	21,175.90	21,472.64	22,325.82	24,312.63	23,534.79	24,725.00	26,066.46	26,440.96	21,214.84
3. Solvent and Other Product Use	541.18	464.65	442.64	424.10	418.80	439.85	387.10	345.15	350.45	350.48
4. Agriculture	22,471.64	22,971.18	23,632.12	23,479.08	22,763.14	23,502.56	22,938.75	22,784.64	21,990.21	21,629.06
5. Land Use, Land-Use Change and Forestry(5)	2,597.10	2,201.15	2,454.20	2,235.63	2,191.00	2,329.63	2,150.88	2,415.42	2,317.96	2,351.37
6. Waste	12,767.65	12,900.26	12,668.11	12,343.72	11,897.63	11,291.99	10,932.06	10,612.69	10,193.63	9,389.96
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**214,574.92**	**218,812.53**	**218,474.46**	**223,363.00**	**223,422.71**	**226,886.81**	**234,831.20**	**228,281.23**	**229,530.03**	**217,518.20**

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	172,130.76	177,616.81	178,066.33	181,955.10	183,308.13	178,159.78	174,910.42	175,194.16	8.22
CO_2 emissions excluding net CO_2 from LULUCF	169,619.23	175,190.37	175,730.17	179,636.12	180,965.97	175,779.99	172,510.04	172,656.94	8.39
CH_4 emissions including CH_4 from LULUCF	19,793.60	19,328.24	18,445.98	17,885.29	17,595.17	17,228.18	16,831.58	16,965.06	-33.59
CH_4 emissions excluding CH_4 from LULUCF	19,793.60	19,328.24	18,445.98	17,885.29	17,595.17	17,228.18	16,831.58	16,965.06	-33.59
N_2O emissions including N_2O from LULUCF	19,285.53	18,103.71	17,287.82	16,949.23	17,445.38	17,311.95	17,141.80	15,605.03	-22.84
N_2O emissions excluding N_2O from LULUCF	19,285.53	18,103.71	17,287.82	16,949.23	17,445.38	17,311.95	17,141.80	15,605.03	-22.84
HFCs	3,828.94	1,469.23	1,541.41	1,377.06	1,506.65	1,357.71	1,566.39	1,737.59	-60.79
PFCs	1,581.54	1,489.43	2,187.03	620.53	285.64	266.20	256.54	327.07	-85.56
SF_6	318.71	323.37	282.98	243.47	246.15	237.92	202.17	213.95	-1.55
Total (including LULUCF)	**216,939.06**	**218,330.79**	**217,811.56**	**219,030.67**	**220,387.11**	**214,561.74**	**210,908.90**	**210,042.87**	**-2.11**
Total (excluding LULUCF)	**214,427.54**	**215,904.35**	**215,475.39**	**216,711.69**	**218,044.95**	**212,181.96**	**208,508.52**	**207,505.64**	**-2.11**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	164,624.80	170,707.82	171,280.33	175,070.83	176,271.70	171,172.08	167,875.18	168,307.55	9.26
2. Industrial Processes	20,221.43	16,622.38	16,994.39	15,432.89	15,844.85	15,498.51	15,608.94	14,544.53	-34.33
3. Solvent and Other Product Use	306.89	268.54	248.57	227.00	220.91	213.41	216.09	205.12	-62.10
4. Agriculture	20,394.53	19,918.50	18,912.22	18,441.87	18,460.29	18,482.60	18,395.95	18,423.14	-18.02
5. Land Use, Land-Use Change and Forestry[5]	2,511.52	2,426.44	2,336.17	2,318.98	2,342.16	2,379.79	2,400.38	2,537.23	-2.31
6. Waste	8,879.89	8,387.12	8,039.88	7,539.10	7,247.20	6,815.35	6,412.35	6,025.31	-52.81
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)[5]	**216,939.06**	**218,330.79**	**217,811.56**	**219,030.67**	**220,387.11**	**214,561.74**	**210,908.90**	**210,042.87**	**-2.11**

A8.4 Trend tables for the precursor gases and SO_2

Emissions of precursor gases in the Netherlands; All gases and by sector (Gg) **Figure A8.9**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
National Total										
NO_x	544.7	448.9	386.4	375.9	369.3	365.7	345.8	329.9	316.5	290.4
CO	1066.8	803.7	647.2	625.4	602.6	582.5	582.5	551.5	543.5	534.3
NMVOC	455.6	316.2	217.6	198.2	188.4	174.9	167.9	168.1	163.1	155.7
SO_2	190.0	127.8	71.5	73.4	66.6	62.7	63.3	65.5	64.4	59.7
1. Energy										
NO_x	528.7	440.1	381.9	371.6	365.7	365.2	343.4	329.3	315.9	289.9
CO	935.7	736.7	541.3	522.8	532.7	538.9	520.9	501.1	500.8	490.5
NMVOC	242.1	161.7	108.7	99.8	92.7	87.4	81.4	80.3	78.9	78.0
SO_2	178.8	124.5	69.7	71.1	64.1	61.9	62.3	64.4	63.5	58.8
2. Industial processes										
NO_x	12.0	6.4	4.5	3.9	3.1	0.5	1.1	0.6	0.6	0.6
CO	129.2	66.5	105.9	102.5	69.6	43.5	61.2	50.3	42.7	43.8
NMVOC	82.8	53.0	39.7	32.9	31.9	28.0	26.7	25.0	24.1	23.0
SO_2	7.1	3.0	1.9	2.2	2.5	0.8	1.0	1.1	1.0	0.9
3. Solvents and Other product use										
NO_x	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NMVOC	128.9	99.7	68.0	64.3	62.7	58.5	58.8	61.9	59.2	53.9
SO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Agriculture										
NO_x	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
CO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
NMVOC	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
SO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste										
NO_x	3.9	2.4	0.0	0.4	0.5	0.0	1.2	0.0	0.0	0.0
CO	1.9	0.4	0.0	0.1	0.3	0.0	0.4	0.0	0.0	0.0
NMVOC	1.6	1.8	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.7
SO_2	4.2	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0

Annex 9 Chemical compounds, global warming potentials, units and conversion factors

A9.1 Chemical compounds

CF_4	Perfluoromethane (tetrafluoromethane)
C_2F_6	Perfluoroethane (hexafluoroethane)
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HNO_3	Nitric Acid
NH_3	Ammonia
NOx	Nitrogen oxide (NO and NO_2), expressed as NO_2
N_2O	Nitrous oxide
NMVOC	Non-Methane Volatile Organic Compounds
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride
SO_2	Sulphur dioxide
VOC	Volatile Organic Compounds (may include or exclude methane)

A9.2 Global Warming Potentials for selected greenhouse gases

Gas	Atmospheric lifetime	20-year GWP	100-year GWP 1)	500-year GWP
CO_2	Variable (50-200)	1	1	1
CH_4 2)	12±3	56	21	6.5
N_2O	120	280	310	170
HFCs 3):				
HFC-23	264	9100	11700	9800
HFC-32	5.6	2100	650	200
HFC-125	32.6	4600	2800	920
HFC-134a	10.6	3400	1300	420
HFC-143a	48.3	5000	3800	1400
HFC-152a	1.5	460	140	42
HFC-227ea	36.5	4300	2900	950
HFC-236fa	209	5100	6300	4700
HFC-245ca	6.6	1800	560	170
PFCs 3):				
CF_4	50000	4400	6500	10000
C_2F_6	10000	6200	9200	14000
C_3F_8	2600	4800	7000	10100
C_4F_{10}	2600	4800	7000	10100
C_6F_{14}	3200	5000	7400	10700
SF_6	3200	16300	23900	34900

Source: IPCC (1996)
1) GWP's calculated with a 100-year time horizon (indicated in the shaded column) and from the SAR are used in this report (thus not of the Third Assessment Report), in compliance with the UNFCCC Guidelines for reporting (UNFCCC, 1999). Gases indicated in italics are not emitted in the Netherlands.
2) The GWP of methane includes the direct effects and the indirect effects due to the production of tropospheric ozone and stratospheric water vapour; the indirect effect due to the production of CO_2 is not included.
3) The average GWP-100 of emissions reported as 'HFC unspecified' and 'PFC unspecified' is 3000 and 8400, respectively.

A9.3 Units

MJ	Mega Joule (10^6 Joule)
GJ	Giga Joule (10^9 Joule)
TJ	Tera Joule (10^{12} Joule)
PJ	Peta Joule (10^{15} Joule)
Mg	Mega gramme (10^6 gramme)
Gg	Giga gramme (10^9 gramme)
Tg	Tera gramme (10^{12} gramme)
Pg	Peta gramme (10^{15} gramme)
ton	metric ton (= 1 000 kilogramme = 1 Mg)
kton	kiloton (= 1 000 metric ton = 1 Gg)
Mton	Megaton (= 1 000 000 metric ton = 1 Tg)
ha	hectare (= 10^4 m^2)
kha	kilo hectare (= 1 000 hectare = 10^7 m^2 = 10 km^2)
mln	million (= 10^6)
mld	milliard (= 10^9)

A9.4 Other conversion factors for emissions

From element basis to full molecular mass		**From full molecular mass to element basis**	
$C \rightarrow CO_2$:	x 44/12 = 3.67	$CO_2 \rightarrow C$:	x 12/44 = 0.27
$C \rightarrow CH_4$:	x 16/12 = 1.33	$CH_4 \rightarrow C$:	x 12/16 = 0.75
$C \rightarrow CO$:	x 28/12 = 2.33	$CO \rightarrow C$:	x 12/28 = 0.43
$N \rightarrow N_2O$:	x 44/28 = 1.57	$N_2O \rightarrow N$:	x 28/44 = 0.64
$N \rightarrow NO$:	x 30/14 = 2.14	$NO \rightarrow N$:	x 14/30 = 0.47
$N \rightarrow NO_2$:	x 46/14 = 3.29	$NO_2 \rightarrow N$:	x 14/46 = 0.30
$N \rightarrow NH_3$:	x 17/14 = 1.21	$NH_3 \rightarrow N$:	x 14/17 = 0.82
$N \rightarrow HNO_3$:	x 63/14 = 4.50	$HNO_3 \rightarrow N$:	x 14/63 = 0.22
$S \rightarrow SO_2$:	x 64/32 = 2.00	$SO_2 \rightarrow S$:	x 32/64 = 0.50

Annex 10 List of abbreviations

AD	Activity Data
AE	Anode Effect
AWMS	Animal Waste Management Systems
BAK	Monitoring report of gas consumption of small users
BEES	Order governing combustion plant emissions requirements (1992) (in Dutch: "Besluit Emissie-Eisen Stookinstallaties")
BEK	Monitoring report of electricity consumption of small users
BF	Blast Furnace (gas)
BOD	Biological Oxygen Demand
C	Confidential (notation key in CRF)
CO	Coke Oven (gas)
CS	Country-Specific (notation key in CRF)
Cap	capita (person)
CBS	Statistics Netherlands
CDM	Clean Development Mechanism (one of three mechanisms of the Kyoto Protocol)
CHP	Combined Heat and Power
CLRTAP	Convention on Long-range Transboundary Air Pollution (UN-ECE)
CORINAIR	CORe INventory AIR emissions
CRF	Common Reporting Format (of emission data files, annexed to an NIR)
CRT	Continuous Regeneration Trap
DLO	Legal name of Wageningen University and Research Centre (Wageningen UR)
DM	Dry Matter
DOC	Degradable Organic Carbon
DOCF	Degradable Organic Carbon Fraction
EC-LNV	National Reference Centre for Agriculture
ECE	Economic Commission for Europe (UN)
ECN	Energy Research Centre of the Netherlands
EEA	European Environment Agency
EF	Emission Factor
EGR	Exhaust Gas Recirculation
EIT	Economies-In-Transition (countries from the former SU and Eastern Europe)
EMEP	European program for Monitoring and Evaluation of long-range transmission of air Pollutants
EMS	Emission Monitor Shipping
EMSG	Emissions Registration Steering Group
ENINA	Task Group Energy, Industry and Waste Handling
EPA	US Environmental Protection Agency
ER-I	Emission Registration-Individual firms
ERT	Expert Review Team
ET	Emissions Trading
ETC/ACC	European Topic Centre on Air and Climate Change
ETS	Emission Trading System
EU	European Union
EZ	Ministry of Economic Affairs
FAD	Forest According to Definition
FAO	Food and Agricultural Organization (UN)
F-gases	Group of fluorinated compounds comprising HFCs, PFCs and SF_6
FGD	Flue Gas Desulphurization
FO-I	Dutch Facilitating Organization for Industry
GE	Gross Energy
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GIS	Gas Insulated Switchgear
GWP	Global Warming Potential
HBO	Heating Oil
HDD	Heating-Degree Day
HFO	Heavy Fuel Oil
HOSP	Timber Production Statistics and Forecast (in Dutch: "Hout Oogst Statistiek en Prognose oogstbaar hout")
IE	Included Elsewhere (notation key in CRF)
IEA	International Energy Agency
IEF	Implied Emission Factor
INK	Dutch Institute for Quality Management
IPCC	Intergovernmental Panel on Climate Change
KNMI	Royal Netherlands Meteorological Institute
LEI	Agricultural Economics Institute
LHV	Lower Heating Value
LNV	Ministry of Agriculture, Nature and Food Quality
LPG	Liquefied Petroleum Gas
LTO	Landing and Take-Off
LUCF	Land Use Change and Forestry
LULUCF	Land Use, Land Use Change and Forestry
MCF	Methane Conversion Factor
MEP	TNO Environment, Energy and Process Innovation
MFV	Measuring Network Functions (in Dutch: "Meetnet Functievervulling")
MJV	Annual Environmental Report
MNP	Netherlands Environmental Assessment Agency (in Dutch: "Milieu- en Natuur Planbureau")
MR	Methane Recovery
MSW	Municipal Solid Waste
MW	Mega Watt
NA	Not Available; Not Applicable (notation key in CRF); also: National Approach
NACE	Statistical Classification of Economic Activities from the European Union: Nomenclature générale des Activités économiques dans les Communautés Européennes.

NAM	Nederlandse Aardolie Maatschappij
NAV	Dutch Association of Aerosol Producers
ND	No Data
NDF	Neutral Detergent Fiber
NE	Not Estimated (notation key in CRF)
NEAT	Non-Energy CO_2 emissions Accounting Tables (model of NEU-CO_2 Group)
NEC	National Emission Ceilings
NEH	Netherlands Energy Statistics
NGL	Natural Gas Liquids
NIE	National Inventory Entity
NIR	National Inventory Report (annual greenhouse gas inventory report to UNFCCC)
NLR	National Aerospace Laboratory
NOGEPA	Netherlands Oil and Gas Exploration and Production Association
NOP-MLK	National Research Program on Global Air Pollution and Climate Change
NS	Dutch Railways
ODS	Ozone Depleting Substances
ODU	Oxidized During Use (of direct non-energy use of fuels or of petrochemical product)
OECD	Organization for Economic Cooperation and Development
OM	Organic Matter
OX	Oxygen Furnace (gas)
PBL	Netherlands Environmental Assessment Agency
PER	Pollutant Emission Register
PRTR	Pollutant Release and Transfer Register
QA	Quality Assurance
QC	Quality Control
RA	Reference Approach (vs. Sectoral or National Approach)
RIVM	National Institute for Public Health and the Environment
RIZA	National Institute of Water Management and Waste Treatment
ROB	Reduction Program on Other Greenhouse Gases
SA	Sectoral Approach; also: National Approach (vs. Reference Approach)
SBI	Standaard bedrijven indeling (NACE)
SCR	Selective Catalytic Reduction
SBSTA	Subsidiary Body for Scientific and Technological Advice (of Parties to the UNFCCC)
SGHP	Shell Gasification and Hydrogen Production
SNCR	Selective Non-Catalytic Reduction
SW	Streefwaarde (Dutch for “target value”)
SWDS	Solid Waste Disposal Site
TNO	Netherlands Organization for Applied Scientific Research
TBFRA	Temperate and Boreal Forest Resources Assessment (ECE-FAO)
TOF	Trees outside Forests
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
UNFCCC	United Nation’s Framework Convention on Climate Change
VOC	Volatile Organic Compound
VROM	Ministry of Housing, Spatial Planning and the Environment
VS	Volatile Solids
V&W	Ministry of Transport, Public Works and Water Management
WBCSD	World Business Council for Sustainable Development
WEB	Working Group Emission Monitoring of Greenhouse Gases
WEM	Working Group Emission Monitoring
WIP	Waste Incineration Plant
WUR	Wageningen University and Research Centre (or: Wageningen UR)
WWTP	Waste Water Treatment Plant

Annex 11 to the National Inventory Report 2009 of the Netherlands:

[Submission under the Kyoto Protocol and the Climate Change Convention]

Supplementary information under article 7 of the Kyoto Protocol

Ministry of Environment (VROM), NEa (Netherlands Emission Authority), PBL

(Netherlands Environmental Assessment Agency), SenterNovem (National Inventory Entity)

A11.1 Introduction

Article 7.1 describes the supplementary information required under the Kyoto Protocol, to be submitted with the annual inventory. Where appropriate, reference is made to other Sections of this NIR where more information can be found.

In this annex , we refer to the Guidelines for the preparation of the information required under article 7 under the Kyoto protocol, laid down in the annex of decision 15/CMP.1 annex I.

Three separate files with information on registry and holdings under Art.7 of the Kyoto Protocol have been uploaded together with the NIR 2009:
1. SEF_NL_2009_1_16-25-14 25-3-2009.xls
2. SIAR Reports 2009-NL v1.0.pdf
3. SIAR Reports 2009-NL v1.0.xls

A11.2 Greenhouse gas inventory information (15/CMP.1 annex I.D)

Information according to 15/CMP.1 annex I.D paragraph 4
The actions taken and (expected) results are described in the Section on LULUCF (Section 7.9) and planned improvements (Section 10.4).The UN initial review team decided to apply an adjustment for the base year emissions of 'deforestation' (LULUCF sector). The Netherlands have accepted this adjustment. The Netherlands have carried out a study on whether and how changes in emission estimates in this sector and in the relevant background documentation should be implemented [Wyngaert et al, 2009]. The results are included in this NIR 2009.

Information according to 15/CMP.1 annex I.D paragraph 5
Information under articles 3.3. and 3.4 of the Kyoto Protocol is not applicable yet. In the NIR 2009 the Netherlands does not intend to make use of the possibility of earlier voluntary reporting under article 3.3. Furthermore, as indicated also in the Initial Report of the Netherlands, the Netherlands will not make use of Article 3.4 of the Kyoto Protocol under the first commitment period.

Information according to 15/CMP.1 annex I.D paragraph 6
Information under articles 3.3. and 3.4 of the Kyoto Protocol is not applicable yet. In the NIR 2009 the Netherlands does not intend to make use of the possibility of earlier voluntary reporting under article 3.3. Furthermore, as indicated also in the Initial Report of the Netherlands, the Netherlands will not make use of Article 3.4 of the Kyoto Protocol under the first commitment period.

Information according to 15/CMP.1 annex I.D paragraph 7
Information under articles 3.3. and 3.4 of the Kyoto Protocol is not applicable yet. In the NIR 2009 the Netherlands does not intend to make use of the possibility of earlier voluntary reporting under article 3.3. Furthermore, as indicated also in the Initial Report of the Netherlands, the Netherlands will not make use of Article 3.4 of the Kyoto Protocol under the first commitment period.

Information according to 15/CMP.1 annex I.D paragraph 8
Information under article 3.3. of the Kyoto Protocol is not applicable yet. In the NIR 2009 the Netherlands does not intend to make use of the possibility of earlier voluntary reporting under article 3.3.

Information according to 15/CMP.1 annex I.D paragraph 9
Information under article 3.4 of the Kyoto Protocol is not applicable yet. As indicated in the Initial Report of the Netherlands, the Netherlands will not make use of Article 3.4 of the Kyoto Protocol under the first commitment period.

A11.3 Information on emission reduction units, certified emission reductions, temporary certified emission reductions, long-term certified emission reductions, assigned amount units and removal units (15/CMP.1 annex I-E)

Information according to 15/CMP.1 annex I.D paragraph 11 (Standard electronic format)
The Standard Electronic Format report is included in this submission as an Excel file with the name "SEF_NL_2009_1_16-25-14 25-3-2009.xls".

Information according to 15/CMP.1 annex I.D paragraph 12 (List of discrepant transactions)
The list of discrepant transactions is listed in the table named "R2" in the Excel file included with this submission with the name "SIAR Reports 2009-NL v1.0.xls".

Information according to 15/CMP.1 annex I.D paragraph 13 (List of CDM notifications)
No CDM notifications where received by the Dutch National Registry during the reporting period (see the Word file included with this submission with the name "SIAR Reports 2009-NL v1.0.pdf" and the table named "R3" in the Excel file included with this submission with the name "SIAR Reports 2009-NL v1.0.xls").

Information according to 15/CMP.1 annex I.D paragraph 14 (List of CDM notifications)
No CDM notifications where received by the Dutch National Registry during the reporting period (see the Word file included with this submission with the name "SIAR Reports 2009-NL v1.0.pdf" and the table named "R3" in the Excel file included with this submission with the name "SIAR Reports 2009-NL v1.0.xls").

Information according to 15/CMP.1 annex I.D paragraph 15 (List of non-replacements)
No non-replacements occurred during the reporting period (see the Word file included with this submission with the name "SIAR Reports 2009-NL v1.0.pdf" and the table named "R4" in the Excel file included with this submission with the name "SIAR Reports 2009-NL v1.0.xls").

Information according to 15/CMP.1 annex I.D paragraph 16 (List of invalid units)
There are no invalid units to report this reporting period (see the Word file included with this submission with the name "SIAR Reports 2009-NL v1.0.pdf" and the table named "R5" in the Excel file included with this submission with the name "SIAR Reports 2009-NL v1.0.xls").

Information according to 15/CMP.1 annex I.D paragraph 17 (Actions and changes to address discrepancies)
This information is included in this submission as a Word file with the name "SIAR Reports 2009-NL v1.0.pdf"

Information according to 15/CMP.1 annex I.D paragraph 18 (CPR Calculation)
In April 2008 the Netherlands became eligible under the Kyoto Protocol. Its assigned amount was fixed at 1,001,262,141 tonnes CO_2 equivalent. The CPR was calculated at that point in time at 901,135,927 tonnes CO2 equivalent. The CPR has not been changed.

More extended information on this issue is included in this submission as a Word file with the name "SIAR Reports 2009-NL v1.0.pdf"

Information according to 15/CMP.1 annex I.D paragraph 20
Not applicable for this submission

A11.4 Changes in the National System (15/CMP.1 annex I.F)

Extensive information on the national inventory system is described in this National Inventory Report under the appropriate Sections as required by the UNFCCC guidelines. More extensive background information on the National System is also included in the Netherlands Initial Report. The Initial Review in 2007 concluded that the Netherlands National System has been established in accordance with the guidelines. There have been no changes in the National System since the last submission and since the initial report[1].

A11.5 Changes in the National Registry (15/CMP.1 annex I.G)

An extensive description and background information on the registry have been included in the Netherlands Initial Report, submitted to the UN. Additional information on the registry has been provided to the UN and the Initial Review team in the IAR report (independent assessment report). Since then, no changes have been applied to the registry system. Based on the results of the technical assessment, as reported in the IAR, the ERT concluded that the Netherlands' national registry is fully compliant with the registry requirements as defined by decisions 13/CMP.1 and 5/CMP.1, noting that registries do not have obligations regarding operational performance or public availability of information prior to the operational phase.

1 It should be noted, however:
- that up to and including 2008, PBL maintained an ISO 9001/2000 certification. After December 31st, 2008, PBL will no longer apply for prolongation of this certificate, but use its own quality management system, following the INK model (the Dutch variety of the European Foundation for Quality Management (EFQM) Business Model). As part of this system PBL will periodically contract consultants to assess the implementation of its quality system and the INK guidelines (see also Section 16.2 in the NIR). In practice this modification will not have any significant impact on the quality checks and -assurance within PBL, nor on the QA/QC activities under the National System
- as part of the national system and its annual evaluation cycle, each year some (reference) documents are updated, such as the monitoring protocols and the QAQC programme (if needed). This process and its results are described in chapter 1 of this NIR (notably Section 1.6) and Chapter 10 (reflecting the response on findings of the UNFCCC review process). These have not yet resulted in any significant changes (only editorial changes, some closely related protocols were merged, some updates of references, etc).

More extended information on this issue is included in this submission as a Word file with the name “SIAR Reports 2009-NL v1.0.pdf”

A11.6 Minimization of adverse impacts in accordance with article 3 paragraph 14 (15/CMP.1 annex I.H)

This issue will be reported from NIR 2010 onwards.

Annex 12 Emission Factors and Activity Data Agriculture

Animal numbers — **Table A12.1**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cattle for breeding											
Female young stock under 1 yr	752,658	760,636	720,342	687,326	687,442	696,063	703,237	651,019	615,834	596,635	562,563
Male young stock under 1 yr	53,229	59,044	53,905	49,753	47,841	44,163	57,182	46,785	41,830	37,653	37,440
Female young stock, 1-2 yrs	734,078	754,860	748,325	696,243	678,960	682,888	679,796	684,011	639,875	607,670	594,100
Male young stock, 1-2 yrs	34,635	37,628	39,297	31,957	33,034	33,118	37,203	31,632	27,586	25,331	26,328
Female young stock, 2 yrs and over	145,648	152,994	144,542	139,866	123,924	124,970	125,153	137,880	117,120	106,348	104,633
Cows in milk and in calf	1,877,684	1,852,165	1,775,259	1,746,733	1,697,868	1,707,875	1,664,648	1,590,571	1,610,630	1,588,489	1,504,097
Bulls for service 2 yrs and over	8,762	9,899	8,547	8,551	7,975	8,674	9,229	8,198	8,141	10,278	10,410
Cattle for fattening											
Meat calves, for rosé veal production	28,876	39,784	51,018	62,996	77,226	85,803	100,394	100,948	101,267	118,397	145,828
Meat calves, for white veal production	572,709	581,834	586,713	593,214	612,290	583,516	577,196	603,171	609,724	634,257	636,907
Female young stock < 1 yr	53,021	65,551	61,436	63,009	63,144	57,218	55,575	47,669	42,362	45,977	41,300
Male young stock (incl. young bullocks) < 1 yr	255,375	275,383	244,178	233,479	226,539	188,193	147,553	137,053	115,106	97,465	83,447
Female young stock, 1-2 yrs	56,934	70,367	76,980	78,906	70,340	66,653	60,061	54,137	50,169	46,462	44,807
Male young stock (incl. young bullocks), 1-2 yrs	178,257	198,533	199,261	186,821	179,714	169,546	139,452	142,050	130,080	112,198	88,669
Female young stock, 2 yrs and over	42,555	51,515	50,843	49,859	50,791	48,365	37,084	22,345	20,208	17,528	16,917
Male young stock (incl. young bullocks) ≥ 2 yrs	12,073	12,503	13,253	11,596	12,161	10,969	11,170	8,664	7,790	8,421	9,397
Suckling cows (incl. fattening/ grazing ≥ 2 yrs)	119,529	139,375	145,708	156,459	146,462	146,181	146,384	144,502	145,362	152,581	163,397

Animal numbers (continued) — **Table A12.1 (continued)**

	1990	2000	2001*	2002	2003*	2004	2005	2006	2007
Cattle for breeding									
Female young stock under 1 yr	752,658	562,563	552,595	529,127	503,703	508,943	499,937	488,356	509,863
Male young stock under 1 yr	53,229	37,440	88,001	44,692	31,213	32,155	33,778	31,736	32,470
Female young stock, 1-2 yrs	734,078	594,100	559,089	551,716	528,133	517,262	515,972	513,238	494,853
Male young stock, 1-2 yrs	34,635	26,328	26,819	31,543	19,650	16,879	18,149	17,206	13,627
Female young stock, 2 yrs and over	145,648	104,633	106,908	96,781	89,162	80,719	74,180	66,331	69,110
Cows in milk and in calf	1,877,684	1,504,097	1,539,180	1,485,531	1,477,766	1,470,589	1,433,202	1,419,716	1,413,166
Bulls for service 2 yrs and over	8,762	10,410	10,982	14,132	11,755	9,360	12,391	8,200	10,028
Cattle for fattening									
Meat calves, for rosé veal production	28,876	145,828	150,950	152,033	171,501	187,571	204,227	221,710	261,620
Meat calves, for white veal production	572,709	636,907	556,780	561,300	560,027	577,492	624,513	622,015	598,252
Female young stock < 1 yr	53,021	41,300	42,911	38,887	38,016	39,485	43,313	40,718	44,671
Male young stock (incl. young bullocks) < 1 yr	255,375	83,447	76,861	62,988	59,682	62,216	66,655	55,069	55,008
Female young stock, 1-2 yrs	56,934	44,807	42,950	42,337	44,081	40,800	43,452	43,381	41,102
Male young stock (incl. young bullocks), 1-2 yrs	178,257	88,669	82,234	68,759	53,705	52,688	52,788	52,392	49,280
Female young stock, 2 yrs and over	42,555	16,917	18,097	16,228	16,595	16,047	15,260	14,428	16,056
Male young stock (incl. young bullocks) ≥ 2 yrs	12,073	9,397	12,668	11,368	10,197	9,294	9,346	7,515	9,713
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	119,529	163,397	160,802	150,972	144,004	145,292	151,641	143,082	143,965

* statistical data from the agriculture survey, corrected for avian flu and swine disease

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Pigs											
Piglets	5,190,749	4,465,911	5,270,428	5,672,918	5,599,760	5,596,117	5,626,233	5,996,140	5,094,466	5,238,755	5,102,434
Fattening pigs	7,025,102	7,040,888	7,144,732	7,525,935	7,270,868	7,123,923	7,094,533	7,432,558	6,591,246	6,774,085	6,504,540
Gilts not yet in pig	385,502	396,132	398,868	392,432	367,675	357,520	375,251	393,745	421,101	343,620	339,570
Sows	1,272,215	1,272,559	1,307,710	1,334,880	1,293,910	1,287,224	1,292,402	1,318,003	1,293,619	1,171,016	1,129,174
Young boars 1	13,893	14,312	12,901	13,061	10,530	11,382	8,623	18,759	19,343	7,057	6,917
Boars for service	27,587	26,812	25,763	25,219	22,268	21,297	21,631	29,859	26,091	32,284	35,182
Poultry											
Broilers	41,172,110	41,639,370	46,524,971	45,780,901	43,055,802	43,827,286	44,142,119	44,986,833	48,537,027	53,246,552	50,936,625
Broilers parents under 18 weeks	2,882,250	3,088,160	3,007,100	3,003,660	3,166,090	3,065,170	2,688,180	3,090,370	3,482,870	3,254,710	3,644,120
Broilers parents 18 weeks and over	4,389,830	4,359,760	4,837,300	4,900,600	4,811,560	4,506,840	5,032,380	4,951,550	5,237,950	5,804,260	5,397,520
Laying hens < 18 weeks, liq. manure	7,339,708	7,230,010	7,821,924	6,635,699	6,258,132	4,889,555	5,381,525	5,713,747	2,646,390	2,760,770	2,865,850
Laying hens < 18 weeks, solid manure	3,781,062	3,724,550	4,029,476	3,418,391	4,172,088	4,000,545	4,403,066	4,674,884	7,939,170	8,282,310	8,597,550
Laying hens ≥ 18 weeks, liq. manure	19,919,466	20,132,292	19,882,788	19,307,928	15,218,915	12,294,122	12,513,392	12,469,090	6,786,734	6,911,947	7,166,060
Laying hens ≥ 18 weeks, solid manure	13,279,644	13,421,528	13,255,192	12,871,952	15,218,915	16,977,598	17,280,398	17,219,220	24,062,056	24,505,993	25,406,940
Ducks for slaughter	1,085,510	1,151,710	1,035,968	843,875	756,128	868,965	861,064	906,225	970,279	1,076,737	958,466
Turkeys for slaughter	1,003,350	1,184,920	1,310,348	1,257,402	1,252,965	1,175,527	1,205,705	1,218,055	1,461,973	1,386,608	1,543,830
Turkeys parents under 7 months	28,550	31,050	29,700	45,650	18,050	13,930	27,000	102,800	20,600	38,600	
Turkeys parents 7 months and over	20,460	20,160	24,110	19,610	23,890	17,290	17,150	36,220	17,650	13,200	
Rabbits (mother animals)	105,246	105,246	105,249	89,373	73,719	64,234	61,492	64,372	61,323	54,666	52,252
Minks (mother animals)	543,969	543,969	563,054	465,735	476,337	456,104	485,357	525,088	565,564	575,830	584,806
Foxes (mother animals)	10,029	10,029	7,933	7,320	7,079	7,102	6,748	6,744	7,644	5,290	3,816
Other grazing animals											
Sheep (ewes)	789,691	858,779	876,293	874,674	794,317	770,730	784,976	719,190	693,897	715,776	681,441
Goats (mothers)	37,472	43,706	38,123	34,607	37,554	43,231	55,251	61,448	71,152	85,764	98,077
Horses	49,931	55,438	62,231	65,089	68,333	70,101	73,397	75,468	76,639	76,619	78,892
Ponies	19,661	21,278	24,021	26,639	28,990	29,903	33,308	36,868	36,969	38,547	39,352

	1990	2000	2001*	2002	2003*	2004	2005	2006	2007
Pigs									
Piglets	5,190,749	5,102,434	5,418,427	4,744,505	4,541,673	4,523,643	4,562,991	4,646,509	4,837,355
Fattening pigs	7,025,102	6,504,540	6,216,252	5,591,044	5,367,450	5,382,515	5,504,295	5,475,689	5,558,828
Gilts not yet in pig	385,502	339,570	312,990	282,510	289,355	275,999	274,085	273,120	285,361
Sows	1,272,215	1,129,174	1,071,504	1,007,154	950,449	953,914	946,466	946,105	966,439
Young boars 1	13,893	6,917	7,405	6,625	5,487	5,997	6,486	5,516	4,192
Boars for service	27,587	35,182	15,072	15,839	14,681	10,432	17,235	9,028	10,479
Poultry									
Broilers	41,172,110	50,936,625	50,127,029	54,660,302	39,319,158	44,262,247	44,496,116	41,913,979	43,351,898
Broilers parents under 18 weeks	2,882,250	3,644,120	2,932,780	2,553,650	2,328,749	2,234,820	2,191,650	2,852,760	2,808,924
Broilers parents 18 weeks and over	4,389,830	5,397,520	4,548,120	4,949,320	3,723,907	3,650,730	3,596,700	3,992,590	4,260,360
Laying hens < 18 weeks, liq. manure	7,339,708	2,865,850	1,850,969	1,527,888	1,034,689	811,130	1,035,581	1,052,463	963,881
Laying hens < 18 weeks, solid manure	3,781,062	8,597,550	9,037,082	8,658,032	5,863,237	7,638,140	9,751,719	9,910,697	9,076,541
Laying hens ≥ 18 weeks, liq. manure	19,919,466	7,166,060	4,775,660	3,731,346	2,672,492	1,959,772	2,292,654	2,308,303	2,325,546
Laying hens ≥ 18 weeks, solid manure	13,279,644	25,406,940	27,062,071	24,971,314	17,885,137	25,259,278	29,549,756	29,751,467	29,973,709
Ducks for slaughter	1,085,510	958,466	866,945	852,420	655,259	722,704	1,030,867	1,043,349	1,134,146
Turkeys for slaughter	1,003,350	1,543,830	1,523,250	1,450,590	796,032	1,238,450	1,245,420	1,139,840	1,232,354
Turkeys parents under 7 months	28,550								
Turkeys parents 7 months and over	20,460								
Rabbits (mother animals)	105,246	52,252	49,386	50,391	44,634	49,358	48,034	40,517	49,413
Minks (mother animals)	543,969	584,806	611,368	617,472	613,296	631,769	691,862	694,017	802,853
Foxes (mother animals)	10,029	3,816	4,648	4,851	4,179	3,490	5,240	4,489	4,860
Other grazing animals									
Sheep (ewes)	789,691	681,441	647,668	589,315	592,806	613,118	648,235	647,691	644,799
Goats (mothers)	37,472	98,077	115,573	142,879	157,848	167,733	172,159	177,423	188,676
Horses	49,931	78,892	77,587	79,084	83,002	85,050	87,807	83,262	86,008
Ponies	19,661	39,352	42,899	42,383	43,290	43,530	45,514	44,478	47,516

* statistical data from the agriculture survey, corrected for avian flu and swine disease

Table A12.2 Gross energy intake (MJ/head.day) for cattle — Table A12.2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle for breeding																		
Female young stock under 1 yr	73.6	74.7	75.0	74.9	75.0	75.6	73.7	74.5	74.9	76.4	75.0	75.3	74.8	76.6	76.7	75.8	76.4	77.0
Male young stock under 1 yr	86.1	86.5	86.5	86.5	87.6	86.7	85.4	85.9	85.7	86.7	85.1	85.6	85.6	86.6	89.7	89.1	89.4	89.8
Female young stock, 1-2 yrs	139.5	141.2	141.9	141.7	141.2	142.5	138.4	140.7	141.0	141.6	139.5	140.2	139.2	147.9	147.0	144.6	145.6	149.1
Male young stock, 1-2 yrs	151.1	157.7	158.6	158.3	158.2	162.2	156.5	157.1	160.7	160.9	155.9	155.7	152.9	158.3	157.7	154.1	154.1	155.8
Female young stock, 2 yrs and over	139.4	141.2	141.9	141.7	141.1	142.5	138.3	140.6	141.0	141.5	139.5	140.1	139.2	147.9	147.0	144.6	145.6	149.1
Cows in milk and in calf	279.6	281.6	281.8	288.2	294.3	292.1	291.4	297.0	300.9	302.1	306.8	310.4	307.5	319.0	321.3	321.2	327.2	333.2
Bulls for service 2 yrs and over	151.1	157.7	158.6	158.3	158.2	162.2	156.5	157.1	160.7	160.9	155.9	155.7	152.9	158.3	157.7	154.1	154.1	155.8
Cattle for fattening																		
Meat calves, for rosé veal production	77.9	77.9	77.9	77.9	77.9	77.9	77.9	77.9	71.6	95.5	95.5	95.5	80.9	80.9	82.8	82.8	82.8	82.8
Meat calves, for white veal production	30.9	30.9	30.9	30.9	30.9	32.7	32.7	32.6	35.2	35.6	35.6	35.5	36.5	36.5	34.8	34.8	37.2	37.2
Female young stock < 1 yr	73.6	74.6	74.9	74.8	74.9	75.5	73.6	74.4	74.7	76.2	74.9	75.1	74.6	76.5	76.6	75.8	76.2	76.7
Male young stock (incl. young bullocks) < 1 yr	82.3	83.8	80.9	79.2	89.2	87.6	85.6	88.7	91.4	90.4	88.8	86.9	87.8	87.5	86.6	86.7	86.7	85.7
Female young stock, 1-2 yrs	139.5	141.2	141.8	141.7	141.1	142.4	138.3	140.6	140.8	141.4	139.3	139.9	139.1	147.8	146.8	144.4	145.4	148.9
Male young stock (incl. young bullocks), 1-2 yrs	167.3	179.7	182.3	196.2	161.5	164.1	154.7	158.7	157.1	156.5	154.1	154.9	156.2	155.9	157.4	157.5	157.4	156.0
Female young stock, 2 yrs and over	139.5	141.2	141.9	141.7	141.1	142.5	138.4	140.6	140.8	141.4	139.4	140.0	139.0	147.8	146.8	144.5	145.5	149.0
Male young stock (incl. young bullocks) ≥ 2 yrs	167.3	179.7	182.3	196.2	161.5	164.1	154.7	158.7	157.1	156.5	154.1	154.9	156.2	155.9	157.4	157.5	157.4	156.0
Suckling cows (incl. fattening/ grazing ≥ 2 yrs)	165.0	166.2	167.0	166.8	165.7	167.1	162.5	165.6	164.4	170.0	169.1	170.0	169.7	182.5	183.2	180.0	181.4	184.0

Table A12.3 Emission factors enteric fermentation for cattle kg/animal.year — Table A12.3

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle for breeding																		
Female young stock under 1 yr	29.0	29.4	29.5	29.5	29.5	29.8	29.0	29.3	29.5	30.1	29.5	29.7	29.4	30.2	30.2	29.8	30.1	30.3
Male young stock under 1 yr	33.9	34.0	34.1	34.0	34.5	34.1	33.6	33.8	33.7	34.1	33.5	33.7	33.7	34.1	35.3	35.0	35.2	35.3
Female young stock, 1-2 yrs	54.9	55.6	55.8	55.8	55.5	56.1	54.5	55.4	55.5	55.7	54.9	55.2	54.8	58.2	57.8	56.9	57.3	58.7
Male young stock, 1-2 yrs	59.5	62.1	62.4	62.3	62.3	63.8	61.6	61.8	63.2	63.3	61.3	61.3	60.2	62.3	62.1	60.7	60.7	61.3
Female young stock, 2 yrs and over	54.9	55.6	55.8	55.8	55.5	56.1	54.4	55.3	55.5	55.7	54.9	55.1	54.8	58.2	57.8	56.9	57.3	58.7
Cows in milk and in calf	110.5	111.2	111.9	113.9	115.6	115.8	113.5	117.0	116.9	119.1	120.0	122.1	120.2	123.3	124.8	126.3	127.8	129.4
Bulls for service 2 yrs and over	59.5	62.1	62.4	62.3	62.3	63.8	61.6	61.8	63.2	63.3	61.3	61.3	60.2	62.3	62.1	60.7	60.7	61.3
Cattle for fattening																		
Meat calves, for rosé veal production	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	28.2	37.6	37.6	37.6	31.8	31.8	32.6	32.6	32.6	32.6
Meat calves, for white veal production	8.1	8.1	8.1	8.1	8.1	8.6	8.6	8.6	9.2	9.3	9.3	9.3	9.6	9.6	9.1	9.1	9.8	9.8
Female young stock < 1 yr	29.0	29.4	29.5	29.5	29.5	29.7	29.0	29.3	29.4	30.0	29.5	29.6	29.4	30.1	30.1	29.8	30.0	30.2
Male young stock (incl. young bullocks) < 1 yr	32.4	33.0	31.8	31.2	35.1	34.5	33.7	34.9	36.0	35.6	34.9	34.2	34.5	34.4	34.1	34.1	34.1	33.7
Female young stock, 1-2 yrs	54.9	55.5	55.8	55.7	55.5	56.0	54.4	55.3	55.4	55.6	54.8	55.1	54.7	58.2	57.8	56.8	57.2	58.6
Male young stock (incl. young bullocks), 1-2 yrs	65.8	70.7	71.7	77.2	63.6	64.6	60.9	62.4	61.8	61.6	60.7	61.0	61.5	61.3	61.9	62.0	62.0	61.4
Female young stock, 2 yrs and over	54.9	55.6	55.8	55.8	55.5	56.1	54.5	55.3	55.4	55.6	54.9	55.1	54.7	58.2	57.8	56.9	57.2	58.6
Male young stock (incl. young bullocks) ≥ 2 yrs	65.8	70.7	71.7	77.2	63.6	64.6	60.9	62.4	61.8	61.6	60.7	61.0	61.5	61.3	61.9	62.0	62.0	61.4
Suckling cows (incl. fattening/ grazing ≥ 2 yrs)	64.9	65.4	65.7	65.6	65.2	65.8	63.9	65.2	64.7	66.9	66.6	66.9	66.8	71.8	72.1	70.8	71.4	72.4

Volatile Solids (= Organic Matter) per 1000 kg manure

Table A12.4

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle for breeding																			
Female young stock under 1 yr	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock under 1 yr	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Female young stock, 1-2 yrs	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock, 1-2 yrs	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Female young stock, 2 yrs and over	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Cows in milk and in calf	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Bulls for service 2 yrs and over	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Cattle for fattening																			
Meat calves, for rosé veal production	liquid manure	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Meat calves, for white veal production	liquid manure	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Female young stock < 1 yr	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock (incl. young bullocks) < 1 yr	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Female young stock, 1-2 yrs	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Female young stock, 2 yrs and over	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	140	140	140	140	140	153	153	153	153	153	150	150	150	150	150	150	150	150
Cattle for breeding																			
Female young stock under 1 yr	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock under 1 yr	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Female young stock, 1-2 yrs	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock, 1-2 yrs																			
Female young stock, 2 yrs and over	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Cows in milk and in calf	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Bulls for service 2 yrs and over																			
Cattle for fattening																			
Meat calves, for rosé veal production																			
Meat calves, for white veal production																			
Female young stock < 1 yr	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock (incl. young bullocks) < 1 yr																			
Female young stock, 1-2 yrs	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock (incl. young bullocks), 1-2 yrs																			
Female young stock, 2 yrs and over	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Male young stock (incl. young bullocks) ≥ 2 yrs																			
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Pigs																			
Piglets																			
Fattening pigs	liquid manure	50	50	50	50	50	60	60	60	60	60	60	60	60	60	60	60	60	60
Gilts not yet in pig	liquid manure	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Sows	liquid manure	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Young boars 1	liquid manure	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Boars for service	liquid manure	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Poultry																			
Broilers	solid manure	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
Broilers parents under 18 weeks	solid manure	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423
Broilers parents 18 weeks and over	solid manure	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423
Laying hens < 18 weeks, liq. manure	liquid manure	90	90	90	90	90	93	93	93	93	93	93	93	93	93	93	93	93	93
Laying hens < 18 weeks, solid manure	solid manure	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Laying hens ≥ 18 weeks, liq. manure	liquid manure	90	90	90	90	90	93	93	93	93	93	93	93	93	93	93	93	93	93
Laying hens ≥ 18 weeks, solid manure	solid manure	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Ducks for slaughter	solid manure	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Turkeys for slaughter	solid manure	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
Turkeys parents under 7 months	solid manure	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
Turkeys parents 7 months and over	solid manure	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464	464
Rabbits (mother animals)	solid manure	367	367	367	367	367	367	367	367	367	367	367	367	367	367	367	367	367	367
Minks (mother animals)	solid manure	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Foxes (mother animals)	solid manure	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Ruminants, not cattle																			
Sheep (ewes)	solid manure	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205
Goats (mothers)	solid manure	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182
Horses	solid manure	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Ponies	solid manure	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Ruminants, not cattle																			
Sheep (ewes)	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Goats (mothers)																			
Horses	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64
Ponies	pasture	60	60	60	60	60	66	66	66	66	66	64	64	64	64	64	64	64	64

Methane conversion factor for pigs and poultry

Table A12.5

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Pigs																			
Piglets																			
Fattening pigs	liquid manure	0.34	0.34	0.34	0.36	0.36	0.36	0.36	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Gilts not yet in pig	liquid manure	0.34	0.34	0.34	0.36	0.36	0.36	0.36	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Sows	liquid manure	0.34	0.34	0.34	0.36	0.36	0.36	0.36	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Young boars 1	liquid manure	0.34	0.34	0.34	0.36	0.36	0.36	0.36	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Boars for service	liquid manure	0.34	0.34	0.34	0.36	0.36	0.36	0.36	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Poultry																			
Broilers	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Broilers parents under 18 weeks	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Broilers parents 18 weeks and over	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Laying hens < 18 weeks, liq. manure	liquid manure	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Laying hens < 18 weeks, solid manure	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Laying hens ≥ 18 weeks, solid manure	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Ducks for slaughter	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkeys for slaughter	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkeys parents under 7 months	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkeys parents 7 months and over	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Rabbits (mother animals)	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Minks (mother animals)	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Foxes (mother animals)	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Methane conversion factor for cattle and ruminants and ultimate CH_4 production (B0 in m^3 CH_4/kg VS) — Table A12.6

		MCF	B0
Cattle for breeding			
Female young stock under 1 yr	liquid manure	0.17	0.25
Male young stock under 1 yr	liquid manure	0.17	0.25
Female young stock, 1-2 yrs	liquid manure	0.17	0.25
Male young stock, 1-2 yrs	liquid manure	0.17	0.25
Female young stock, 2 yrs and over	liquid manure	0.17	0.25
Cows in milk and in calf	liquid manure	0.17	0.25
Bulls for service 2 yrs and over	liquid manure	0.17	0.25
Cattle for fattening			
Meat calves, for rosé veal production	liquid manure	0.14	0.25
Meat calves, for white veal production	liquid manure	0.14	0.25
Female young stock < 1 yr	liquid manure	0.17	0.25
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.17	0.25
Female young stock, 1-2 yrs	liquid manure	0.17	0.25
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	0.17	0.25
Female young stock, 2 yrs and over	liquid manure	0.17	0.25
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.17	0.25
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	0.015	0.25
Cattle for breeding			
Female young stock under 1 yr	pasture	0.01	0.25
Male young stock under 1 yr	pasture	0.01	0.25
Female young stock, 1-2 yrs	pasture	0.01	0.25
Male young stock, 1-2 yrs			
Female young stock, 2 yrs and over	pasture	0.01	0.25
Cows in milk and in calf	pasture	0.01	0.25
Bulls for service 2 yrs and over			
Cattle for fattening			
Meat calves, for rosé veal production			
Meat calves, for white veal production			
Female young stock < 1 yr	pasture	0.01	0.25
Male young stock (incl. young bullocks) < 1 yr			
Female young stock, 1-2 yrs	pasture	0.01	0.25
Male young stock (incl. young bullocks), 1-2 yrs			
Female young stock, 2 yrs and over	pasture	0.01	0.25
Male young stock (incl. young bullocks) ≥ 2 yrs			
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	pasture	0.01	0.25

		MCF	B0
Pigs			
Piglets			
Fattening pigs	liquid manure		0.34
Gilts not yet in pig	liquid manure		0.34
Sows	liquid manure		0.34
Young boars 1	liquid manure		0.34
Boars for service	liquid manure		0.34
Poultry			
Broilers	solid manure		0.34
Broilers parents under 18 weeks	solid manure		0.34
Broilers parents 18 weeks and over	solid manure		0.34
Laying hens < 18 weeks, liq. manure	liquid manure		0.34
Laying hens < 18 weeks, solid manure	solid manure		0.34
Laying hens ≥ 18 weeks, liq. manure	liquid manure		0.34
Laying hens ≥ 18 weeks, solid manure	solid manure		0.34
Ducks for slaughter	solid manure		0.34
Turkeys for slaughter	solid manure		0.34
Turkeys parents under 7 months	solid manure		0.34
Turkeys parents 7 months and over	solid manure		0.34
Rabbits (mother animals)	solid manure		0.34
Minks (mother animals)	solid manure		0.34
Foxes (mother animals)	solid manure		0.34
Ruminants, not cattle			
Sheep (ewes)	solid manure	0.015	0.25
Goats (mothers)	solid manure	0.015	0.25
Horses	solid manure	0.015	0.25
Ponies	solid manure	0.015	0.25
Ruminants, not cattle			
Sheep (ewes)	pasture	0.01	0.25
Goats (mothers)			
Horses	pasture	0.01	0.25
Ponies	pasture	0.01	0.25

Emission factors for methane from manure in CH_4/kg manure.year **Table A12.7**

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cattle for breeding												
Female young stock under 1 yr	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Male young stock under 1 yr	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Female young stock, 1-2 yrs	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Male young stock, 1-2 yrs	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Female young stock, 2 yrs and over	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Cows in milk and in calf	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Bulls for service 2 yrs and over	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Cattle for fattening												
Meat calves, for rosé veal production	liquid manure	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052
Meat calves, for white veal production	liquid manure	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035
Female young stock < 1 yr	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Female young stock, 1-2 yrs	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Female young stock, 2 yrs and over	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.00169	0.00169	0.00169	0.00169	0.00169	0.00186	0.00186	0.00186	0.00186	0.00186	0.00180
Suckling cows (incl. fattening/ grazing ≥ 2 yrs)	solid manure	0.00035	0.00035	0.00035	0.00035	0.00035	0.00038	0.00038	0.00038	0.00038	0.00038	0.00037
Cattle for breeding												
Female young stock under 1 yr	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock under 1 yr	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Female young stock, 1-2 yrs	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock, 1-2 yrs												
Female young stock, 2 yrs and over	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Cows in milk and in calf	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Bulls for service 2 yrs and over												
Cattle for fattening												
Meat calves, for rosé veal production												
Meat calves, for white veal production												
Female young stock < 1 yr	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) < 1 yr												
Female young stock, 1-2 yrs	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks), 1-2 yrs												
Female young stock, 2 yrs and over	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) ≥ 2 yrs												
Suckling cows (incl. fattening/ grazing ≥ 2 yrs)	Pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011

		1990	2000	2001	2002	2003	2004	2005	2006	2007
Cattle for breeding										
Female young stock under 1 yr	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock under 1 yr	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 1-2 yrs	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock, 1-2 yrs	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 2 yrs and over	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Cows in milk and in calf	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Bulls for service 2 yrs and over	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Cattle for fattening										
Meat calves, for rosé veal production	liquid manure	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052
Meat calves, for white veal production	liquid manure	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035
Female young stock < 1 yr	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 1-2 yrs	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 2 yrs and over	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.00169	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180	0.00180
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	0.00035	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037	0.00037
Cattle for breeding										
Female young stock under 1 yr	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock under 1 yr	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Female young stock, 1-2 yrs	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock, 1-2 yrs										
Female young stock, 2 yrs and over	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Cows in milk and in calf	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Bulls for service 2 yrs and over										
Cattle for fattening										
Meat calves, for rosé veal production										
Meat calves, for white veal production										
Female young stock < 1 yr	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) < 1 yr										
Female young stock, 1-2 yrs	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks), 1-2 yrs										
Female young stock, 2 yrs and over	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) ≥ 2 yrs										
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011

Table A12.7 Emission factors for methane from manure in CH4/kg manure.year (continued)

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Pigs												
Piglets												
Fattening pigs	liquid manure	0.00383	0.00383	0.00383	0.00405	0.00405	0.00486	0.00486	0.00527	0.00527	0.00527	0.00527
Gilts not yet in pig	liquid manure	0.00268	0.00268	0.00268	0.00284	0.00284	0.00284	0.00284	0.00307	0.00307	0.00307	0.00307
Sows	liquid manure	0.00268	0.00268	0.00268	0.00284	0.00284	0.00284	0.00284	0.00307	0.00307	0.00307	0.00307
Young boars 1	liquid manure	0.00268	0.00268	0.00268	0.00284	0.00284	0.00284	0.00284	0.00307	0.00307	0.00307	0.00307
Boars for service	liquid manure	0.00268	0.00268	0.00268	0.00284	0.00284	0.00284	0.00284	0.00307	0.00307	0.00307	0.00307
Poultry												
Broilers	solid manure	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172
Broilers parents under 18 weeks	solid manure	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143
Broilers parents 18 weeks and over	solid manure	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143
Laying hens < 18 weeks, liq. manure	liquid manure	0.00790	0.00790	0.00790	0.00790	0.00790	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816
Laying hens < 18 weeks, solid manure	solid manure	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.00790	0.00790	0.00790	0.00790	0.00790	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816
Laying hens ≥ 18 weeks, solid manure	solid manure	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118
Ducks for slaughter	solid manure	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071
Turkeys for slaughter	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Turkeys parents under 7 months	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Turkeys parents 7 months and over	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Rabbits (mother animals)	solid manure	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124
Minks (mother animals)	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Foxes (mother animals)	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ruminants, not cattle												
Sheep (ewes)	solid manure	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051
Goats (mothers)	solid manure	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Horses	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ponies	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ruminants, not cattle												
Sheep (ewes)	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Goats (mothers)												
Horses	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Ponies	pasture	0.00010	0.00010	0.00010	0.00010	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011

Emission factors for methane from manure in CH_4/kg manure.year (continued) — Table A12.7 (continued)

		1990	2000	2001	2002	2003	2004	2005	2006	2007
Pigs										
Piglets										
Fattening pigs	liquid manure	0.00383	0.00527	0.00527	0.00527	0.00527	0.00527	0.00527	0.00527	0.00527
Gilts not yet in pig	liquid manure	0.00268	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307
Sows	liquid manure	0.00268	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307
Young boars 1	liquid manure	0.00268	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307
Boars for service	liquid manure	0.00268	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307	0.00307
Poultry										
Broilers	solid manure	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172
Broilers parents under 18 weeks	solid manure	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143
Broilers parents 18 weeks and over	solid manure	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143
Laying hens < 18 weeks, liq. manure	liquid manure	0.00790	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816
Laying hens < 18 weeks, solid manure	solid manure	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.00790	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816
Laying hens ≥ 18 weeks, solid manure	solid manure	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118
Ducks for slaughter	solid manure	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071
Turkeys for slaughter	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Turkeys parents under 7 months	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Turkeys parents 7 months and over	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Rabbits (mother animals)	solid manure	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124
Minks (mother animals)	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Foxes (mother animals)	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ruminants, not cattle										
Sheep (ewes)	solid manure	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051
Goats (mothers)	solid manure	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Horses	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ponies	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ruminants, not cattle										
Sheep (ewes)	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Goats (mothers)										
Horses	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Ponies	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011

Manure production kg /animal.year

Table A12.8

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cattle for breeding												
Female young stock under 1 yr	liquid manure	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Male young stock under 1 yr	liquid manure	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	5,000	5,000
Female young stock, 1-2 yrs	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Male young stock, 1-2 yrs	liquid manure	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Cows in milk and in calf	liquid manure	16,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000	18,000
Bulls for service 2 yrs and over	liquid manure	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
Cattle for fattening												
Meat calves, for rosé veal production	liquid manure	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Meat calves, for white veal production	liquid manure	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Female young stock < 1 yr	liquid manure	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Male young stock (incl. young bullocks) < 1 yr	liquid manure	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Female young stock, 1-2 yrs	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Cattle for breeding												
Female young stock under 1 yr	pasture	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Male young stock under 1 yr	pasture	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500		
Female young stock, 1-2 yrs	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Male young stock, 1-2 yrs												
Female young stock, 2 yrs and over	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Cows in milk and in calf	pasture	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Bulls for service 2 yrs and over												
Cattle for fattening												
Meat calves, for rosé veal production												
Meat calves, for white veal production												
Female young stock < 1 yr	pasture	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Male young stock (incl. young bullocks) < 1 yr												
Female young stock, 1-2 yrs	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Male young stock (incl. young bullocks), 1-2 yrs												
Female young stock, 2 yrs and over	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Male young stock (incl. young bullocks) ≥ 2 yrs												
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	pasture	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000

Manure production kg /animal.year (continued)										**Table A12.8 (continued)**
		1990	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Cattle for breeding										
Female young stock under 1 yr	liquid manure	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Male young stock under 1 yr	liquid manure	3,500	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Female young stock, 1-2 yrs	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Male young stock, 1-2 yrs	liquid manure	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Cows in milk and in calf	liquid manure	16,000	18,000	18,000	19,500	19,500	20,500	20,500	21,000	21,500
Bulls for service 2 yrs and over	liquid manure	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
Cattle for fattening										
Meat calves, for rosé veal production	liquid manure	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	4,300
Meat calves, for white veal production	liquid manure	3,500	3,500	3,500	3,500	3,500	3,000	3,000	3,000	3,000
Female young stock < 1 yr	liquid manure	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Male young stock (incl. young bullocks) < 1 yr	liquid manure	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Female young stock, 1-2 yrs	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Cattle for breeding										
Female young stock under 1 yr	pasture	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Male young stock under 1 yr	pasture	1,500								
Female young stock, 1-2 yrs	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Male young stock, 1-2 yrs										
Female young stock, 2 yrs and over	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Cows in milk and in calf	pasture	7,000	7,000	7,000	5,500	5,500	5,500	5,500	5,000	4,500
Bulls for service 2 yrs and over										
Cattle for fattening										
Meat calves, for rosé veal production										
Meat calves, for white veal production										
Female young stock < 1 yr	pasture	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Male young stock (incl. young bullocks) < 1 yr										
Female young stock, 1-2 yrs	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Male young stock (incl. young bullocks), 1-2 yrs										
Female young stock, 2 yrs and over	pasture	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Male young stock (incl. young bullocks) ≥ 2 yrs										
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	pasture	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000

Manure production kg /animal.year (continued) — Table A12.8 (continued)

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Pigs												
Piglets												
Fattening pigs	liquid manure	1,300	1,300	1,250	1,250	1,250	1,250	1,250	1,250	1,200	1,200	1,200
Gilts not yet in pig	liquid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Sows	liquid manure	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,100
Young boars 1	liquid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Boars for service	liquid manure	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200
Poultry												
Broilers	solid manure	10	10	10	10	10	11	11	11	11	11	11
Broilers parents under 18 weeks	solid manure	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4
Broilers parents 18 weeks and over	solid manure	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
Laying hens < 18 weeks, liq. Manure	liquid manure	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4
Laying hens < 18 weeks, solid manure	solid manure	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0
Laying hens ≥ 18 weeks, liq. Manure	liquid manure	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5
Laying hens ≥ 18 weeks, solid manure	solid manure	22.5	22.5	22.5	22.5	22.5	23.5	23.5	23.5	23.5	23.5	24.0
Ducks for slaughter	solid manure	86.3	86.3	86.3	86.3	86.3	70.0	70.0	70.0	70.0	70.0	70.0
Turkeys for slaughter	solid manure	37.9	37.9	37.9	37.9	37.9	45.0	45.0	45.0	45.0	45.0	45.0
Turkeys parents under 7 months	solid manure	49.4	49.4	49.4	49.4	49.4	49.4	49.4	49.4	49.4	49.4	
Turkeys parents 7 months and over	solid manure	78.6	78.6	78.6	78.6	78.6	78.6	78.6	78.6	78.6	78.6	
Rabbits (mother animals)	solid manure	377	377	377	377	377	377	377	377	377	377	377
Minks (mother animals)	solid manure	103.7	103.7	103.7	103.7	103.7	103.7	103.7	103.7	103.7	103.7	103.7
Foxes (mother animals)	solid manure	272.2	272.2	272.2	272.2	272.2	272.2	272.2	272.2	272.2	272.2	272.2
Ruminants, not cattle												
Sheep (ewes)	solid manure	325	325	325	325	325	325	325	325	325	325	325
Goats (mothers)	solid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Horses	solid manure	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200
Ponies	solid manure	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Ruminants, not cattle												
Sheep (ewes)	pasture	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Goats (mothers)												
Horses	pasture	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300
Ponies	pasture	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100

Manure production kg /animal.year (continued)

Table A12.8 (continued)

		1990	2000	2001	2002	2003	2004	2005	2006	2007
Pigs										
Piglets										
Fattening pigs	liquid manure	1,300	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Gilts not yet in pig	liquid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Sows	liquid manure	5,200	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100
Young boars 1	liquid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Boars for service	liquid manure	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200
Poultry										
Broilers	solid manure	10	11	11	11	10.9	10.9	10.9	10.9	10.9
Broilers parents under 18 weeks	solid manure	15.4	15.4	13.4	13.4	8.2	8.2	8.2	8.2	8.2
Broilers parents 18 weeks and over	solid manure	25.3	25.3	23.0	23.0	20.6	20.6	20.6	20.6	20.6
Laying hens < 18 weeks, liq. Manure	liquid manure	25.4	25.4	25.4	25.4	22.5	22.5	22.5	22.5	22.5
Laying hens < 18 weeks, solid manure	solid manure	10.0	9.0	9.1	9.1	7.6	7.6	7.6	7.6	7.6
Laying hens ≥ 18 weeks, liq. Manure	liquid manure	63.5	63.5	63.5	63.5	53.4	53.4	53.4	53.4	53.4
Laying hens ≥ 18 weeks, solid manure	solid manure	22.5	24.0	25.4	25.4	18.9	18.9	18.9	18.9	18.9
Ducks for slaughter	solid manure	86.3	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Turkeys for slaughter	solid manure	37.9	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Turkeys parents under 7 months	solid manure	49.4								
Turkeys parents 7 months and over	solid manure	78.6								
Rabbits (mother animals)	solid manure	377	377	377	377	377	377	377	377	377
Minks (mother animals)	solid manure	103.7	103.7	103.7	103.7	103.7	104	104	104	104
Foxes (mother animals)	solid manure	272.2	272.2	272.2	272.2	272.2	272	272	272	272
Ruminants, not cattle										
Sheep (ewes)	solid manure	325	325	325	325	325	325	325	325	325
Goats (mothers)	solid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Horses	solid manure	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200
Ponies	solid manure	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Ruminants, not cattle										
Sheep (ewes)	pasture	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Goats (mothers)										
Horses	pasture	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300
Ponies	pasture	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100

N-excretion (kg/animal.yr)

Table A12.9

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle for breeding																			
Female young stock under 1 yr	liquid manure	26.5	28.7	28.4	28.7	30.0	29.8	27.8	30.9	30.1	30.1	29.0	28.9	27.6	23.7	23.2	23.0	22.8	24.6
Male young stock under 1 yr	liquid manure	39.6	40.4	40.0	40.2	41.7	40.8	39.6	41.6	39.5	37.9	37.0	37.1	36.4	36.9	37.2	37.0	36.7	36.6
Female young stock, 1-2 yrs	liquid manure	43.1	47.0	46.3	46.7	49.5	48.4	45.0	51.3	50.1	48.4	46.4	46.3	43.7	44.2	43.3	42.7	40.1	42.5
Male young stock, 1-2 yrs	liquid manure	90.6	99.1	97.6	98.2	104.5	101.9	94.7	108.5	105.8	101.0	96.8	96.6	90.8	91.7	89.7	88.5	87.4	89.6
Female young stock, 2 yrs and over	liquid manure	43.0	46.9	46.3	46.6	49.4	48.4	45.0	51.2	50.0	48.3	46.3	46.3	43.7	44.2	43.3	42.7	40.1	42.5
Cows in milk and in calf	liquid manure	95.9	101.8	97.8	100.9	102.7	104.0	101.2	100.1	97.7	96.0	97.2	98.6	103.3	107.1	103.5	103.3	103.9	110.8
Bulls for service 2 yrs and over	liquid manure	90.6	99.1	97.6	98.2	104.5	101.9	94.7	108.5	105.8	101.0	96.8	96.6	90.8	91.7	89.7	88.5	87.4	89.6
Cattle for fattening																			
Meat calves, for rosé veal production	liquid manure	28.9	28.9	28.9	28.9	28.9	28.9	29.3	27.9	27.8	34.3	34.1	34.9	30.5	30.8	27.1	27.2	27.0	28.1
Meat calves, for white veal production	liquid manure	10.6	10.6	10.6	10.6	10.6	11.6	11.4	10.3	11.6	10.9	11.9	11.9	12.1	12.2	10.5	10.6	11.2	11.0
Female young stock < 1 yr	liquid manure	26.2	28.4	28.2	28.5	29.7	29.4	27.5	30.4	29.6	29.7	28.6	28.5	27.2	23.4	23.0	22.8	22.5	24.4
Male young stock (incl. young bullocks) < 1 yr	liquid manure	28.9	29.9	29.4	27.8	30.4	29.5	28.4	28.0	27.3	27.4	26.6	27.1	26.2	26.6	27.2	27.0	27.3	26.6
Female young stock, 1-2 yrs	liquid manure	43.0	46.8	46.2	46.6	49.3	48.2	44.8	50.9	49.7	48.0	46.0	45.9	43.4	43.9	43.0	42.4	39.8	42.4
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	72.6	79.3	81.8	84.1	71.5	64.7	63.6	59.0	58.1	58.4	56.1	59.1	57.4	57.8	57.5	56.8	57.3	54.5
Female young stock, 2 yrs and over	liquid manure	43.1	47.0	46.4	46.7	49.4	48.4	45.0	51.1	49.7	48.1	46.1	45.9	43.3	43.9	43.0	42.5	39.9	42.4
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	72.6	79.3	81.8	84.1	71.5	64.7	63.6	59.0	58.1	58.4	56.1	59.1	57.4	57.8	57.5	56.8	57.3	54.5
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	42.3	46.3	45.7	46.2	48.7	48.0	44.5	50.5	48.5	43.2	42.4	42.3	41.1	40.4	40.0	39.1	38.7	39.4
Cattle for breeding																			
Female young stock under 1 yr	pasture	15.3	14.7	14.5	14.5	14.4	14.4	15.0	14.9	14.2	12.4	13.0	12.9	12.8	18.4	16.9	17.0	16.6	14.3
Male young stock under 1 yr	pasture																		
Female young stock, 1-2 yrs	pasture	51.2	49.1	48.0	48.1	47.8	47.5	50.1	49.8	47.3	41.2	42.9	42.8	42.4	36.9	33.2	33.1	34.1	32.2
Male young stock, 1-2 yrs																			
Female young stock, 2 yrs and over	pasture	51.2	49.1	48.0	48.1	47.8	47.5	50.1	49.8	47.3	41.2	42.9	42.8	42.4	36.9	33.2	33.1	34.1	32.2
Cows in milk and in calf	pasture	52.6	53.6	57.6	53.7	50.9	52.5	56.0	53.5	41.3	44.4	39.3	42.0	30.6	28.9	29.3	30.8	28.8	25.7
Bulls for service 2 yrs and over																			
Cattle for fattening																			
Meat calves, for rosé veal production																			
Meat calves, for white veal production																			
Female young stock < 1 yr	pasture	15.2	14.6	14.4	14.4	14.3	14.3	14.9	14.8	14.1	12.3	12.8	12.7	12.7	18.3	16.8	16.9	16.5	14.0
Male young stock (incl. young bullocks) < 1 yr																			
Female young stock, 1-2 yrs	pasture	51.2	49.1	48.0	48.1	47.8	47.5	50.1	49.8	47.3	41.2	42.9	42.8	42.4	36.9	33.2	33.1	34.1	32.0
Male young stock (incl. young bullocks), 1-2 yrs																			
Female young stock, 2 yrs and over	pasture	51.2	49.1	48.0	48.1	47.8	47.5	50.1	49.8	47.3	41.2	42.9	42.8	42.4	36.9	33.2	33.1	34.1	32.0
Male young stock (incl. young bullocks) ≥ 2 yrs																			
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	pasture	68.4	65.4	63.9	64.0	63.7	63.1	66.7	66.4	62.8	51.6	52.7	52.8	52.6	51.4	46.0	45.8	44.5	43.4

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Pigs																			
Piglets	liquid manure																		
Fattening pigs	liquid manure	14.3	13.7	14.4	14.5	14.9	14.5	14.3	13.0	13.8	13.3	12.3	11.8	11.6	11.9	11.7	12.3	12.6	12.6
Gilts not yet in pig	liquid manure	14.0	14.1	14.0	13.7	13.6	14.4	13.9	13.8	13.4	13.9	14.2	12.9	13.1	14.2	13.2	14.3	14.6	14.2
Sows	liquid manure	33.8	30.9	31.8	31.9	30.1	31.4	31.3	29.9	29.9	30.6	30.9	30.3	29.9	29.9	28.0	30.7	30.8	31.5
Young boars 1	liquid manure	14.0	14.1	14.0	13.7	13.6	14.4	13.9	13.8	13.4	13.9	14.2	12.9	13.1	14.2	13.2	14.3	14.6	14.2
Boars for service	liquid manure	25.0	24.5	25.4	24.6	23.0	24.6	23.7	22.8	22.4	22.4	22.9	23.2	23.1	23.8	23.7	23.7	23.9	23.3
Poultry																			
Broilers	solid manure	0.61	0.64	0.64	0.62	0.57	0.63	0.61	0.59	0.52	0.54	0.51	0.49	0.53	0.53	0.52	0.55	0.53	0.53
Broilers parents under 18 weeks	solid manure	0.52	0.54	0.59	0.54	0.52	0.45	0.42	0.45	0.41	0.38	0.37	0.33	0.34	0.32	0.33	0.32	0.33	0.33
Broilers parents 18 weeks and over	solid manure	1.33	1.42	1.48	1.55	1.41	1.29	1.29	1.18	1.17	1.18	1.13	1.07	1.08	1.05	1.11	1.10	1.10	1.13
Laying hens < 18 weeks, liq. manure	liquid manure	0.38	0.39	0.43	0.39	0.38	0.36	0.34	0.36	0.33	0.33	0.31	0.29	0.29	0.30	0.33	0.32	0.33	0.34
Laying hens < 18 weeks, solid manure	solid manure	0.38	0.39	0.43	0.39	0.38	0.36	0.34	0.36	0.33	0.33	0.31	0.29	0.29	0.30	0.33	0.32	0.33	0.34
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.75	0.82	0.87	0.91	0.81	0.81	0.80	0.70	0.69	0.71	0.67	0.65	0.66	0.70	0.71	0.71	0.74	0.74
Laying hens ≥ 18 weeks, solid manure	solid manure	0.75	0.82	0.87	0.91	0.81	0.81	0.80	0.70	0.69	0.71	0.67	0.65	0.66	0.70	0.71	0.71	0.74	0.74
Ducks for slaughter	solid manure	1.12	1.12	1.12	1.12	1.12	1.09	1.09	1.09	1.10	1.00	0.99	0.95	0.95	0.90	0.96	0.89	0.91	0.85
Turkeys for slaughter	solid manure	1.98	1.98	1.98	2.08	2.08	1.97	1.97	1.97	1.89	1.84	1.85	1.70	1.68	1.76	1.74	1.81	1.66	1.69
Turkeys parents under 7 months	solid manure	2.38	2.38	2.38	2.38	2.38	2.78	2.52	2.52	2.52	0.00								
Turkeys parents 7 months and over	solid manure	3.17	3.17	3.17	3.17	3.17	3.04	3.04	3.04	3.04	0.00								
Rabbits (mother animals)	solid manure	8.7	8.7	8.7	8.69	8.69	8.1	8.1	8.1	7.9	7.9	7.6	7.6	7.6	7.8	8.0	8.2	8.1	8.0
Minks (mother animals)	solid manure	4.08	4.08	4.08	4.08	4.08	4.08	3.5	3.5	3.7	4.2	3.5	3.3	3.0	2.9	2.8	2.7	2.6	2.5
Foxes (mother animals)	solid manure	13.9	13.9	13.9	13.9	13.9	13.9	9.0	9.0	9.6	9.9	8.3	7.7	7.0	6.6	7.2	6.9	6.5	6.4
Ruminants, not cattle																			
Sheep (ewes)	solid manure	3.9	4.0	3.9	4.0	4.2	4.0	3.9	4.4	4.4	3.9	3.9	3.9	3.7	3.7	2.6	2.6	2.6	2.6
Goats (mothers)	solid manure	19.9	20.9	20.4	21.1	21.6	21.5	20.7	22.0	22.4	19.3	19.4	20.6	20.1	20.0	17.8	17.7	17.7	15.8
Horses	solid manure	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	32.1
Ponies	solid manure	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	13.8
Ruminants, not cattle																			
Sheep (ewes)	Pasture	21.1	20.7	19.7	20.2	20.3	20.3	21.9	21.0	21.6	18.8	19.5	19.1	18.9	18.8	12.1	12.2	11.7	11.1
Goats (mothers)																			
Horses	Pasture	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	29.4
Ponies	Pasture	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.4

Nitrogen flows

Table A12.10

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Nitrogen fertilizer consumption	412.4	400.1	391.8	389.9	371.6	405.8	388.9	400.6	402.9	383.3	339.5	298.3	292.2	290.6	300.5	279.2	287.8	257.5
of which ammonium fertilizer	3.6	7.1	5.4	6.4	7.9	11.2	11.2	9.9	9.7	10.8	6.6	13.3	27.8	40.1	38.7	30.6	42.9	17.2
NH_3-N emission during application	11.2	11.3	10.7	10.1	9.7	10.5	10.3	10.4	10.4	10.2	9.2	8.6	9.7	11.1	10.7	9.8	10.9	9.9
Net fertilizer to soil	401.1	388.8	381.1	379.8	361.9	395.3	378.6	390.2	392.5	373.1	330.3	289.7	282.5	279.5	289.8	269.4	276.9	247.6
Nitrogen excretion by animals	694.4	719.5	717.7	710.5	682.4	680.1	668.5	644.5	602.3	585.1	549.2	541.9	504.7	479.6	467.3	479.0	471.2	479.7
Nitrogen excretion in animals houses	506.5	528.5	526.2	529.3	512.9	508.1	488.9	476.6	460.1	450.1	424.5	414.4	399.7	380.0	375.7	385.8	382.5	398.6
of which in solid form	61.3	67.0	72.5	71.2	67.1	69.6	69.2	68.5	73.4	77.6	74.1	71.4	74.2	58.5	67.1	72.9	71.6	73.2
of which in liquid form	445.2	461.5	453.7	458.1	445.8	438.5	419.7	408.0	386.7	372.5	350.5	343.0	325.5	321.5	308.5	312.8	310.8	325.4
NH_3-N emission in animal houses	73.4	75.6	75.2	78.1	75.4	73.8	71.0	67.6	63.8	65.7	60.6	52.8	52.0	48.6	48.7	50.1	49.0	50.5
Net available manure for application	433.1	452.9	451.0	451.1	437.5	434.4	417.9	409.0	396.3	384.5	364.0	361.6	347.7	331.4	327.0	335.6	333.5	348.1
Nitrogen in manure exported abroad	6.4	6.8	11.2	15.0	21.2	22.1	13.0	11.0	9.8	12.9	14.7	18.0	19.7	11.6	15.5	14.9	15.8	15.8
NH_3-N emission during application	98.3	102.1	77.8	77.4	62.4	51.4	52.9	54.8	46.6	41.6	36.8	37.7	35.6	33.8	33.1	32.5	30.6	33.8
Net animal manure to soil	328.4	344.0	362.0	358.8	354.0	360.9	352.0	343.2	340.0	330.0	312.4	305.9	292.4	286.0	278.4	288.2	287.1	298.6
Nitrogen excretion in meadow	188.0	191.0	191.5	181.3	169.5	171.9	179.6	168.0	142.2	135.0	124.6	127.5	105.0	99.6	91.6	93.3	88.7	81.1
NH_3-N emission in meadow	13.0	13.2	12.7	12.7	11.7	11.9	12.2	12.1	10.7	9.3	8.5	8.6	6.9	7.1	7.1	7.1	6.4	6.1
Net animal manure to soil	175.0	177.7	178.8	168.5	157.8	160.0	167.4	155.9	131.4	125.7	116.2	118.9	98.1	92.5	84.6	86.2	82.3	75.0
Total nitrogen supply to soil (manure + fertilizer - export)	1100.4	1112.8	1098.3	1085.4	1032.9	1063.8	1044.4	1034.1	995.4	955.5	873.9	822.2	777.2	758.6	752.3	743.3	743.2	721.4
Nitrogen fixation in arable crops	7.8	6.8	6.2	5.7	5.3	4.9	4.9	4.7	4.7	5.0	4.7	5.1	4.7	5.2	4.8	4.5	4.6	4.5
Nitrogen in crop residues left in field	36.4	37.4	36.8	35.9	35.1	34.9	34.7	33.8	34.1	35.8	34.1	33.8	35.4	34.5	32.8	32.1	30.1	29.6
Nitrogen in histosols	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4
Nitrogen in sewage sludge on agric. land	5.0	5.0	5.7	3.8	2.5	1.5	1.6	1.2	1.0	0.9	1.5	1.4	1.6	1.6	1.1	1.2	1.1	1.0
Atmospheric deposition agr. NH_3-N em	195.9	202.2	176.3	178.4	159.2	147.5	146.4	144.8	131.5	126.7	115.1	107.8	104.1	100.5	99.5	99.5	96.9	100.3
Nitrogen lost through leaching and run off	330.1	333.8	329.5	325.6	309.9	319.1	313.3	310.2	298.6	286.7	262.2	246.7	233.2	227.6	225.7	223.0	223.0	216.4

Crop Area

Table A12.11

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Winter wheat	13,510,369	11,520,053	11,669,670	9,981,880	9,855,851	12,559,909	13,412,214	12,498,451	12,827,608	6,163,761	12,050,981
Spring wheat	549,904	803,279	1,019,505	1,821,424	2,302,819	981,302	748,533	1,252,594	1,103,776	4,114,155	1,617,586
Winter barley	994,082	712,576	604,002	439,837	250,171	309,977	267,329	262,567	307,478	197,957	363,547
Spring barley	3,044,693	3,479,062	2,805,159	3,565,683	4,116,919	3,248,038	3,281,128	3,932,906	3,665,819	5,631,310	4,353,676
Rye	860,386	699,734	620,708	743,237	560,307	817,514	689,314	497,978	632,972	265,208	596,058
Oats	340,128	332,443	364,603	515,291	551,756	291,431	190,945	195,457	206,643	251,781	240,390
Triticale		297,815	236,691	190,398	162,209	257,947	326,993	293,273	442,900	183,532	664,635
Dried and green peas	1,090,832	688,674	442,031	222,079	139,380	69,149	82,736	67,445	73,031	86,248	75,204
Peas (green to harvest)	766,724	763,507	757,907	662,761	693,051	713,143	616,991	439,458	458,934	608,526	586,657
Marrowfats	79,350	63,845	91,736	95,310	89,098	36,732	76,430	48,568	42,445	63,841	38,849
Kidney beans	373,005	409,937	267,286	234,788	203,856	222,094	285,639	203,258	195,617	193,487	112,590
Broad and field beans	316,912	203,197	166,989	127,362	80,219	53,220	66,408	100,845	75,476	64,840	67,916
Grass seed	2,631,440	2,795,739	2,686,273	2,709,774	1,975,471	2,189,274	2,130,151	2,388,186	2,841,770	2,129,861	2,196,001
Rape seed	841,501	706,977	423,406	235,025	142,391	149,268	87,833	57,928	87,320	131,928	85,416
Caraway seed	34,158	14,234	14,053	12,481	32,848	121,059	61,312	23,590	18,997	11,318	13,806
Pop seed	26,356	37,363	10,770	102,965	339,319	141,119	33,159	59,178	119,897	145,189	58,806
Flax seed	553,468	440,785	472,683	375,844	465,052	440,738	387,380	425,311	349,842	375,319	437,930
Seed potatoes on sand or peat	548,553	600,413	642,534	545,970	475,354	536,058	653,067	645,895	660,329	640,042	709,599
Seed potatoes on clay	3,010,113	3,315,164	3,481,578	3,296,340	3,226,921	3,243,815	3,220,648	3,353,349	3,334,480	3,461,361	3,470,553
Potatoes on sand or peat	1,602,484	1,641,992	1,774,215	1,441,228	1,440,068	1,845,122	2,084,197	1,732,726	2,171,043	2,442,344	2,563,153
Potatoes on clay	6,086,924	6,135,258	6,363,219	6,022,894	5,944,796	6,170,599	6,276,407	6,016,937	6,268,102	6,184,151	6,180,900
Industrial potatoes	6,283,773	6,264,985	6,470,952	6,285,443	6,015,428	6,134,453	6,288,145	6,241,370	5,696,249	5,252,560	5,095,818
Sugar beets	12,499,462	12,331,636	12,073,634	11,668,529	11,450,895	11,608,057	11,657,430	11,406,646	11,303,204	11,974,794	11,099,810
Fodder beets	302,286	281,730	257,303	215,664	206,589	157,602	135,689	116,597	115,772	99,145	89,094
Lucerne	596,017	568,603	607,535	656,574	642,491	583,627	567,484	605,536	625,661	640,771	661,606
Green maize	20,181,089	20,201,368	21,752,501	22,868,252	22,850,787	21,921,725	22,287,165	23,198,541	21,994,042	23,074,567	20,532,074
Green manure	728,159	1,212,484	1,336,796	1,574,602	1,639,654	1,224,765	562,106	228,430	234,668	293,206	261,452
Grain maize		1,116,521	778,982	1,081,909	1,162,412	900,542	1,087,219	1,268,208	1,369,760	1,603,560	2,029,838
Corn cob mix		323,724	258,307	376,706	523,602	500,473	564,416	541,579	576,073	596,995	721,918
Chicory								422,206	419,562	447,085	475,596
Hemp								124,898	108,302	114,952	79,197
Onions	1,282,770	1,377,308	1,418,311	1,357,782	1,550,379	1,608,194	1,667,445	1,556,603	1,834,929	1,968,217	1,997,942
Other horticultural crops	808,437	311,954	596,564	723,281	539,893	598,220	926,186	669,132	845,114	810,059	1,088,320
Strawberry	186,688	172,031	176,114	176,794	194,949	176,313	159,470	181,705	196,753	186,295	174,568
Endive	23,392	25,036	24,815	29,235	27,215	27,629	23,880	22,847	26,003	26,827	25,198
Asparagus	266,313	264,095	274,911	258,390	238,924	232,356	228,129	224,258	230,365	221,885	208,408
Gherkin	25,738	27,842	14,618	6,666	8,932						
Cabbage for preservation	157,620	166,897	176,807	192,952	174,343	178,353	181,231	178,257	176,472	172,669	152,753
Cauliflower	236,792	258,132	272,232	281,952	262,180	242,970	235,138	217,421	224,972	228,688	216,038
Broccoli						53,379	58,902	61,843	76,916	86,544	84,602
Cabbage (spring and autumn)	100,151	122,331	128,461	126,915	101,512	113,850	123,417	120,223	117,590	121,924	101,629
Celeriac	136,263	134,419	142,308	123,741	120,828	141,421	156,590	144,798	153,363	160,137	128,519
Beetroot						35,349	28,245	33,410	40,774	46,151	29,015
Lettuce	95,475	99,238	99,908	124,655	100,377	104,217	108,113	96,262	93,452	105,986	108,978
Leeks	287,307	355,168	411,913	393,352	424,969	385,356	364,165	374,639	364,135	372,399	318,448
Scorzonera	139,536	135,161	165,811	168,681	158,496	148,006	160,825	164,603	183,912	160,084	113,796
Spinach	115,291	94,480	92,241	90,690	88,136	96,500	95,350	106,191	119,504	133,086	120,827
Brussels sprouts	480,319	505,800	582,023	572,780	504,129	438,811	423,499	419,728	462,206	520,685	483,409
Industrial French beans	369,501	458,816	492,600	419,818	465,350	467,764	447,767	457,590	485,225	484,029	362,736
Runner beans	22,493	17,712	16,358	19,193	16,605						
Broad beans green	117,770	124,865	110,139	87,902	92,189	87,716	95,919	126,879	93,544	78,102	69,416
Carrot	302,983	312,748	323,610	301,452	322,523	327,442	319,691	298,096	293,386	316,022	298,512
Winter carrot (Danvers)	295,050	393,228	358,521	392,919	429,565	467,490	440,363	419,678	482,203	575,260	472,875
Witloof	591,896	599,118	484,238	516,055	451,937	388,881	402,018	461,482	424,169	475,882	419,858
Other outside horticultural crops	277,358	307,190	328,617	348,710	341,158	286,665	254,924	355,242	385,776	346,801	317,125

	1990	2000	2001	2002	2003	2004	2005	2006	2007
Winter wheat	13,510,369	12,050,981	9,579,145	11,319,021	10,587,882	11,722,412	11,603,963	12,150,157	12,442,902
Spring wheat	549,904	1,617,586	2,893,103	2,265,894	2,406,569	2,086,364	2,067,009	1,962,151	1,689,184
Winter barley	994,082	363,547	323,565	266,011	310,147	320,576	296,950	348,824	426,303
Spring barley	3,044,693	4,353,676	6,352,460	5,427,983	5,192,443	4,478,087	4,761,972	4,109,069	4,172,914
Rye	860,386	596,058	356,828	356,659	353,463	342,958	253,457	238,553	284,508
Oats	340,128	240,390	255,581	246,247	252,736	204,587	169,744	161,350	170,278
Triticale		664,635	480,794	500,630	424,561	429,238	408,259	369,430	388,865
Dried and green peas	1,090,832	75,204	80,097	113,789	207,479	228,412	192,508	57,381	60,594
Peas (green to harvest)	766,724	586,657	553,433	627,806	603,302	486,058	509,139	530,173	602,662
Marrowfats	79,350	38,849	70,032	63,185	76,551	43,420	39,585	48,223	27,846
Kidney beans	373,005	112,590	151,372	155,585	230,422	222,285	109,903	113,854	109,374
Broad and field beans	316,912	67,916	70,270	52,221	59,203	51,652	44,111	30,702	27,508
Grass seed	2,631,440	2,196,001	1,974,267	1,791,785	2,159,944	2,532,460	2,763,858	2,614,662	2,010,683
Rape seed	841,501	85,416	70,696	48,071	96,313	161,527	209,640	341,082	335,790
Caraway seed	34,158	13,806	16,312	17,641	18,302	15,846	9,034	2,920	3,905
Pop seed	26,356	58,806	79,783	36,770	43,625	28,087	28,286	61,241	50,295
Flax seed	553,468	437,930	475,546	409,587	455,285	448,548	473,339	442,593	345,633
Seed potatoes on sand or peat	548,553	709,599	607,879	487,065	385,513	368,335	352,313	340,510	332,014
Seed potatoes on clay	3,010,113	3,470,553	3,333,153	3,408,785	3,543,738	3,605,566	3,573,898	3,402,330	3,340,892
Potatoes on sand or peat	1,602,484	2,563,153	2,100,028	2,647,990	2,206,223	2,222,670	1,926,935	1,839,859	2,042,278
Potatoes on clay	6,086,924	6,180,900	5,490,938	5,073,275	4,849,556	5,044,274	4,656,037	5,107,937	5,204,137
Industrial potatoes	6,283,773	5,095,818	4,861,439	4,898,600	4,879,403	5,149,627	5,069,191	4,959,220	4,798,038
Sugar beets	12,499,462	11,099,810	10,912,642	10,889,367	10,278,710	9,773,625	9,131,265	8,278,170	8,202,608
Fodder beets	302,286	89,094	79,960	73,109	63,654	64,015	53,195	35,837	33,121
Lucerne	596,017	661,606	711,382	598,126	625,938	598,377	587,842	644,052	589,808
Green maize	20,181,089	20,532,074	20,387,379	21,440,327	21,689,731	22,446,834	23,508,819	21,803,584	22,155,358
Green manure	728,159	261,452	345,281	2,425,293	2,409,029	2,041,994	3,101,990	1,814,294	1,655,421
Grain maize		2,029,838	2,717,325	2,369,406	2,454,716	2,242,037	2,074,849	1,977,153	1,934,033
Corn cob mix		721,918	767,233	669,040	706,727	678,821	667,841	750,828	719,952
Chicory		475,596	484,500	431,290	479,180	491,655	433,848	236,232	258,617
Hemp		79,197	98,085	207,862	146,111	3,122	10,043	2,675	13,515
Onions	1,282,770	1,997,942	2,046,494	2,110,051	2,324,326	2,621,206	2,252,034	2,463,418	2,617,775
Other horticultural crops	808,437	1,088,320	1,027,209	979,535	876,819	939,723	1,186,888	1,006,004	875,290
Strawberry	186,688	174,568	172,141	173,434	191,512	212,765	230,089	295,921	296,381
Endive	23,392	25,198	26,221	33,044	35,484	30,043	27,971	27,812	33,169
Asparagus	266,313	208,408	211,656	217,332	242,341	236,069	233,366	246,053	238,333
Gherkin	25,738							18,190	25,293
Cabbage for preservation	157,620	152,753	138,839	147,060	157,088	147,934	139,794		
Cauliflower	236,792	216,038	217,450	226,895	232,625	232,066	239,408	266,682	263,256
Broccoli		84,602	106,362	109,948	116,548	120,994	131,115	148,472	158,682
Cabbage (spring and autumn)	100,151	101,629	101,180	114,869	111,876	109,314	107,505	273,562	286,360
Celeriac	136,263	128,519	139,608	136,297	132,747	132,570	112,772	122,737	138,531
Beetroot		29,015	35,964	37,914	33,351	31,770	27,619	35,872	36,976
Lettuce	95,475	108,978	108,233	115,117	136,068	137,338	130,353	159,596	191,860
Leeks	287,307	318,448	322,606	331,949	324,136	303,756	272,537	304,710	306,271
Scorzonera	139,536	113,796	110,418	116,893	133,883	101,993	86,697	91,680	99,631
Spinach	115,291	120,827	116,351	118,988	103,645	84,826	91,431	117,221	130,226
Brussels sprouts	480,319	483,409	439,387	388,962	423,223	346,518	309,508	335,443	335,223
Industrial French beans	369,501	362,736	366,820	381,032	414,508	440,389	425,410	389,430	375,083
Runner beans	22,493							10,903	6,842
Broad beans green	117,770	69,416	77,885	96,937	111,278	106,934	78,984	151,700	154,794
Carrot	302,983	298,512	301,246	290,955	282,978	243,501	255,140	273,072	264,776
Winter carrot (Danvers)	295,050	472,875	483,666	498,131	543,861	545,128	470,043	593,583	547,765
Witloof	591,896	419,858	376,663	369,157	356,643	293,698	342,321	359,158	347,839
Other outside horticultural crops	277,358	317,125	307,215	563,426	488,671	442,863	431,248	379,975	317,252

N-content per crop, crop residue and N fixation for crops

Table A12.12

	N content	Crop residue	N fixation
	kg N/ha	Frac	
Winter wheat	28	0.1	
Spring wheat	28	0.1	
Winter barley	19	0.1	
Spring barley	19	0.1	
Rye	16	0.1	
Oats	19	0.1	
Triticale	24	0.1	
Dried and green peas	74	1.0	164
Peas (green to harvest)	194	1.0	164
Marrowfats	74	1.0	164
Kidney beans	74	1.0	164
Broad and field beans	16	1.0	325
Grass seed	28	1.0	
Rape seed	42	1.0	
Caraway seed	37	1.0	
Pop seed	20	1.0	
Flax seed	23	1.0	
Seed potatoes on sand or peat	26	1.0	
Seed potatoes on clay	26	1.0	
Potatoes on sand or peat	26	1.0	
Potatoes on clay	26	1.0	
Industrial potatoes	26	1.0	
Sugar beets	174	1.0	
Fodder beets	92	1.0	
Lucerne	23	1.0	422
Green maize	22	0.1	
Green manure	80	1.0	
Grain maize	70	1.0	
Corn cob mix	70	1.0	
Chicory	40	1.0	
Hemp	40	1.0	
Onions	4	1.0	
Other horticultural crops	40	1.0	
Strawberry	23	1.0	
Endive	78	1.0	
Asparagus	24	1.0	
Gherkin	78	1.0	
Cabbage for preservation	206	1.0	
Cauliflower	89	1.0	
Broccoli	89	1.0	
Cabbage (spring and autumn)	206	1.0	
Celeriac	78	1.0	
Beetroot	78	1.0	
Lettuce	25	1.0	
Leeks	62	1.0	
Scorzonera	78	1.0	
Spinach	62	1.0	
Brussels sprouts	206	1.0	
Industrial French beans	61	1.0	75
Runner beans	61	1.0	75
Broad beans green	13	1.0	185
Carrot	99	1.0	
Winter carrot (Danvers)	99	1.0	
Witloof	78	1.0	
Other outside horticultural crops	78	1.0	