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Greenhouse Gas Emissions in the Netherlands 1990-2004

National Inventory Report 2006

L.J. Brandes, G.E.M. Alkemade,
P.G. Ruyssenaars, H.H.J. Vreuls[1],
P.W.H.G. Coenen[2]

Contacts: Laurens Brandes (MNP/IMP) (laurens.brandes@mnp.nl)
Harry Vreuls(NIE/SenterNovem) (h.vreuls@senternovem.nl)

Contributing authors: K. Baas[4] (wastewater handling), G. van den Berghe[3] (waste), G.J. van den Born (LULUCF), B. Guis[4] and J.W.F. Huurman[4] (energy, industrial processes), A. Hoen (transport, bunkers), R. te Molder (trends, key sources), D.S. Nijdam (small combustion, solvent and product use), J.G.J. Olivier (energy), C.J. Peek (fugitive emissions, industrial processes, other waste), M.W. van Schijndel (agriculture).

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 2004]

[1] SenterNovem, P.O. Box 17, NL-6130 AA Sittard
[2] Netherlands Organisation for Applied Scientific Research (TNO), P.O. Box 342, NL-7300 AH Apeldoorn
[3] SenterNovem, P.O. Box 8242, NL-3503 RE Utrecht
[4] Statistics Netherlands (CBS), P.O. Box 4000, NL-2270 JM Voorburg

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Netherlands Environmental Assessment Agency (MNP), P.O. Box 303, 3720 AH Bilthoven, the Netherlands; Tel: +31-30-274 274 5; Fax: +31-30-274 44 79; www.mnp.nl/en

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Many colleagues from a number of organizations (CBS, EC-LNV, LEI, SenterNovem, MNP and TNO) have been involved in the annual update of the Netherlands Pollutant Emission Register (PER), also called the Emission Registration (ER) system, which contains emissions data on about 170 pollutants. This annual project is led by the Netherlands Environmental Assessment Agency (MNP). The emission calculations, including those for greenhouse gas emissions, are performed by members of so-called ER Task Forces. This is a major task, since the Netherlands' inventory contains many detailed emission sources.
Subsequently, the emissions and activity data of the Netherlands' inventory is converted by TNO 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. Anco Hoen (transport, bunkers), 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) and Mrs. Marian van Schijndel (agriculture). In addition, Mr. Bas Guis and Mr. Joost Huurman of CBS have 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 Dirk Wever and Mr Jeroen Peters, for their contribution to data processing and quality control.

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Abstract

This report documents the Netherlands' annual submission of the greenhouse gas emission inventory in accordance with the United Nation's Framework Convention on Climate Change (UNFCCC) and the European Union's Greenhouse Gas Monitoring Mechanism. The report comprises explanations of observed trends in emissions; a description of an assessment of key sources and their uncertainty; documentation of methods, data sources and emission factors applied; and a description of the quality assurance system and the verification activities performed on the data.
From the inventory it can be concluded that total CO_2-equivalent emissions of the six greenhouse gases together increased in 2004 by about 2% compared to the base year (1990 for CO_2, CH_4, N_2O and 1995 for fluorinated gases; excluding LULUCF). Emissions of CO_2 excluding LULUCF increased by 13% in the period 1990-2004, while CH_4 and N_2O emissions decreased by about 32% and 16%, respectively. For the fluorinated greenhouse gases, total emissions decreased by 75% in 2004 compared to 1995 (base year for these gases). Emissions of HFCs and PFCs decreased by 75% and 85% in 2004, respectively. SF_6 emissions increased by 9% compared to the 1995 level.

Keywords: greenhouse gases, emissions, trends, methodology, climate

Contents

Samenvatting

Inleiding

Het National Inventory Report (NIR) 2006 bevat de rapportage van broeikasgasemissies (CO_2, N_2O, CH_4 en de F-gassen) over de periode 1990 tot en met 2004.

In de afgelopen jaren zijn onder regie van MNP en SenterNovem de methoden voor het berekenen van de broeikasgasemissies geactualiseerd conform de eisen van de IPCC Good Practice guidance and Uncertainty Management (IPCC, 2001). Nederland voldoet hiermee naar verwachting aan de eisen die in het Kyoto Protocol aan het 'Nationaal Systeem' voor de monitoring van broeikasgassen worden gesteld.

De NIR 2006 is de eerste rapportage waarin integraal gebruik is gemaakt van de geactualiseerde methoden, zoals vastgelegd in protocollen. Deze protocollen vormen onderdeel van het 'National System' en leggen de methoden vast 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. Deze NIR 2006 is daarnaast van extra belang, omdat dit rapport mede onderdeel vormt van het Initial Report onder het Kyoto Protocol. Mede op basis van dit rapport wordt dan ook door de UNFCCC beoordeeld of het Nederlandse monitoring en accountingsysteem voldoet aan de eisen van het Kyoto protocol en of de toegestane emissie onder het Kyoto Protocol ('Assigned Amount') wordt geaccepteerd.

National Inventory Report (NIR)

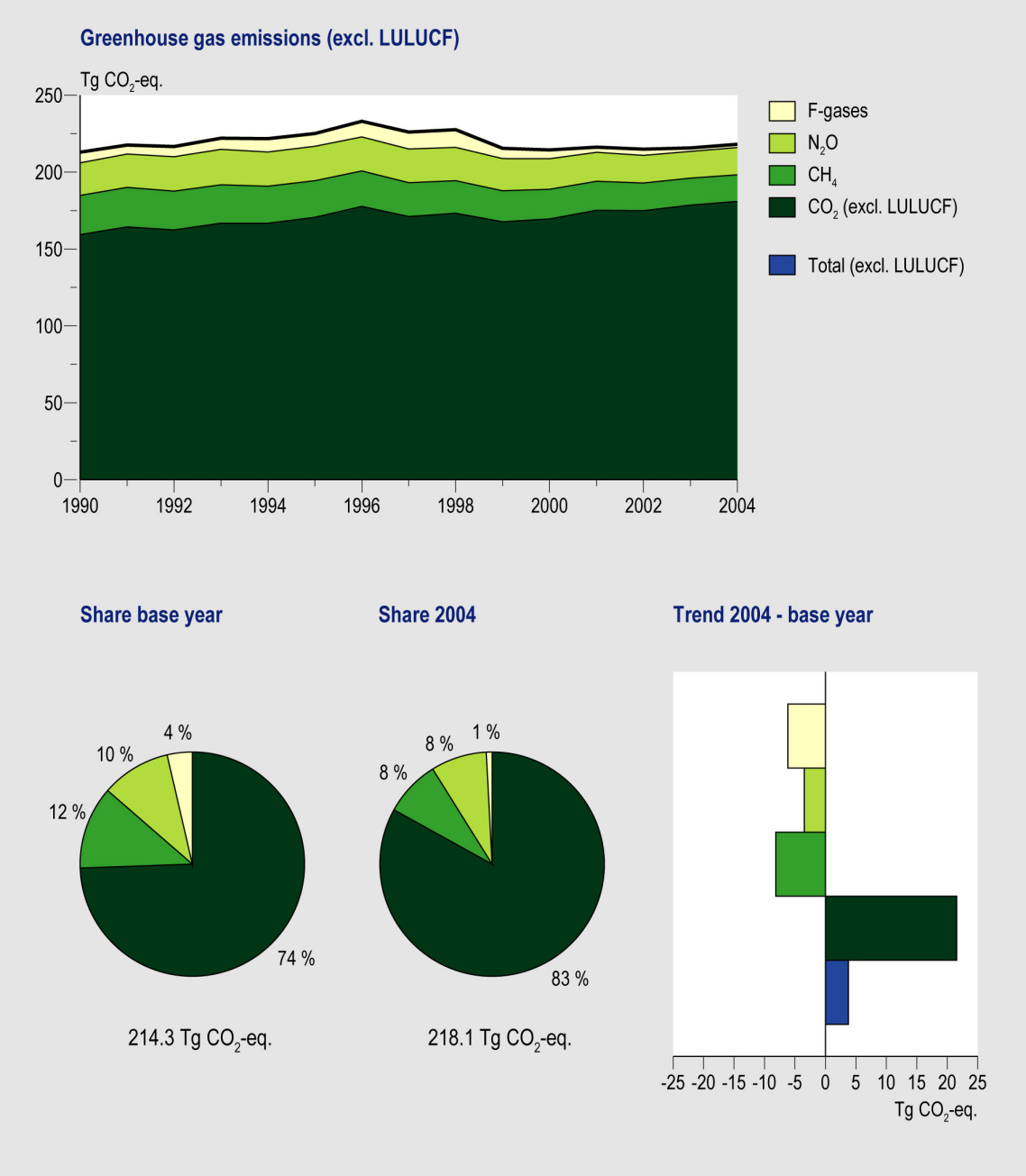
Dit rapport over de Nederlandse inventarisatie van broeikasgasemissies is op verzoek van het ministerie van VROM opgesteld om te voldoen aan de nationale rapportageverplichtingen in 2006 van het Klimaatverdrag van de Verenigde Naties (UNFCCC) en van het Bewakingsmechanisme Broeikasgassen van de Europese Unie. Dit rapport bevat de volgende informatie:

- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2004;
- 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.

Een aparte annex bij dit rapport omvat elektronische data over (met name) emissies in het zogenaamde *Common Reporting Format* (CRF), waar door het secretariaat van het VN-Klimaatverdrag om wordt verzocht. In de appendices bij dit rapport zijn de samenvattende emissie - en trendtabellen '7A' en 10 op basis van het CRF opgenomen voor 1990-2004. Daarnaast bevatten de appendices ondermeer een overzicht van sleutelbonnen 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 begin 2006 is verschenen.

Ontwikkeling van de broeikasgasemissies

De emissieontwikkeling in Nederland wordt beschreven en toegelicht in dit *National Inventory Report* (NIR 2006). *Figuur.ES.1* geeft het emissieverloop over de periode 1990-2004 aan. De totale emissies [zonder landgebruik en bossen (LULUCF)] bedroegen in 2004 circa 218,1 Tg (Mton) CO_2 equivalenten en waren daarmee circa 2% hoger *(Box ES.1)* dan de emissies in het basisjaar (214,3 Tg CO_2 eq.). De emissie van CO_2 is sinds 1990 met circa 13% toegenomen (ca.1-2% per jaar), terwijl de emissies van de andere broeikasgassen met circa 32% zijn afgenomen sinds 1990. De CO_2 emissies worden daarmee steeds dominanter in de totale broeikasgasemissies van Nederland.



Figuur.ES.1. Broeikasgassen: emissieniveaus, bijdragen per gas en emissietrends, 1990-2004.

Box ES.1 onzekerheden

De emissies van broeikasgassen kunnen niet exact worden gemeten of berekend. Onzekerheden zijn daarom onvermijdelijk. Het MNP schat de onzekerheid in de jaarlijkse totale broeikasgasemissie 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 emissie van broeikasgassen ligt daarmee met 95% betrouwbaarheid tussen de 207 en 229 Tg (Mton). De onzekerheid in de emissietrend tussen het basisjaar (1990/1995) en 2004 is geschat op circa 3%-punt; dat wil zeggen dat de emissietrend met 95% betrouwbaarheid ligt tussen de -1 tot +5%.
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.

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 budget periode. Deze vastgestelde methoden zullen de komende jaren (tot 2014) worden gehanteerd; tenzij er grote veranderingen plaatsvinden in bijvoorbeeld de basisdata beschikbaarheid of de implementatie van beleidsmaatregelen aanleiding geeft de methoden aan te passen.

Voor de definitieve bepaling van het basisjaar, zal het nationaal systeem nog worden gereviewd onder artikel 8 van het Kyoto Protocol. Hoewel er geen harde garanties gegeven kunnen worden over de uitkomst van deze review, zijn de methoden naar de mening van de nationale deskundigen op dit moment in overeenstemming met de IPCC Good Practice guidance and Uncertainty Management, hetgeen als belangrijkste voorwaarde is gesteld aan de te hanteren methoden voor de berekening van broeikasgassen.

Belangrijkste methodische wijzigingen ten opzichte van de NIR 2005

De in de afgelopen jaren aan de IPCC Good Practice aangepaste methoden, werden voor een belangrijk deel al toegepast voor- en gedocumenteerd in de NIR 2005. In de afgelopen periode zijn (naast enkele kleinere correcties/wijzigingen/verschuivingen) een paar substantiële methodewijzigingen doorgevoerd. Een overzicht van alle methodewijzigingen is te vinden in paragraaf 10.1.1.

De eerste methodewijziging heeft betrekking op de emissies van *olie en gas winning, transport en distributie*. Op basis van meer gedetailleerde informatie en een meetcampagne vanuit de sector, is onder andere de methode voor het berekenen van de emissies verfijnd (andere toedeling: bijvoorbeeld voor wat betreft het zogenaamde ‘flaring and venting’), en zijn land-specifieke emissiefactoren ontwikkeld (in de vorige NIR werden Duitse emissiefactoren gebruikt voor lekverliezen). De emissies in het basisjaar zijn hierdoor circa 0,5 Mton CO_2-equivalenten hoger geworden; in de afgelopen jaren is de toename lager geschat.

De emissies van biomassa zijn verbeterd op basis van nieuwe activiteitendata uit de Energiestatistieken (protocol duurzame energie).

Op gebied van landbouw nader onderzoek gedaan naar *CH_4-emissies door pensfermentatie en directe N_2O-emissies uit de bodem*. Voor pensfermentatie is de beschikbare methode verfijnd. Dit leidt niet direct tot grote wijzigingen in emissies ten opzichte van eerdere rapportages, maar maakt het wel mogelijk om voor de toekomst het effect van maatregelen in de voederrantsoenering tot uiting te laten komen in de emissies. Bovendien voldoet Nederland beter aan de IPCC eisen.

Onderzoek naar directe N_2O emissies uit de bodem heeft te weinig gegevens opgeleverd om de nieuwe inzichten voldoende te onderbouwen en te verwerken in een nieuwe consistente methode.

Daar is dan uiteindelijk ook van afgezien. Wel zijn de N_2O emissies herzien op basis van nieuwe inzichten over de *aanwending van mest en dierlijke productie*. De effecten van deze aanpassingen op de totale emissie voor N_2O zijn beperkt.

Naar aanleiding van een peer-review van de concept versie van dit rapport zijn nog enkele kleine (methodische) wijzigingen doorgevoerd: een nieuwe bron is toegevoegd (de productie van ethyleen oxide en de emissiefactor voor CO_2 emissie ten gevolge van rookgasontzwaveling is herzien.

Tot slot zijn ook verbeteringen in (basis)data doorgevoerd. De belangrijkste wijziging is de nieuwe CO_2-emissiefactor die Nederland hanteert voor *aardgas*. Een meetcampagne en tijdreeksanalyse van Gasunie Transport Services heeft geleid tot een herziening van de emissiefactor over de gehele tijdreeks (van 56,1 naar 56,8 kg CO_2/GJ). Het effect hiervan bedraagt in de orde van grootte van 1 Mton CO_2-equivalenten over de gehele tijdreeks. Andere verbeteringen in basisdata zijn dorogevoerd in de berekeningen van landgebruik en bossen (*hoofdstuk 7*) en fluorhoudende gassen (herziening van diverse historische jaren, *hoofdstuk 4*). Een compleet overzicht van de verbeteringen in basisdata is te vinden in paragraaf 10.1.1.

Executive Summary

ES1 Background information on greenhouse gas inventories and climate change

This report documents the 2006 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) 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) 2006* therefore provides explanations of the trends in greenhouse gas emissions, activity data and (implied) emission factors for the 1990-2004 period. 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 gives 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* (MNP) 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.

Climate Convention and Kyoto Protocol
Although this *NIR 2006* 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. A party may enter the Protocol after review of its national system and the national inventory based on this system, and after solving any problems of implementation.
This *NIR 2006* is based upon the envisaged National System of the Netherlands under article 5.1 of the Protocol, as developed in the past few years and finalised by December 2005.

Key sources
For identification of so-called 'key sources' according to the *IPCC Good Practice approach* we allocated the national emissions according to the IPCC potential key source list wherever possible (emission figures based on CRF tables version 1.6, submitted to UNFCCC in September 2006). However, this new list of key categories is not updated in the CRF Reporter and CRF files (see *Annex 1* for details). 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 31 sources for annual level assessment and 29 sources for the trend assessment, out of a total of 72 sources. Both lists can be combined to get an overview of sources, which meet any of these two criteria. Next, we used the IPCC Tier 2 method for identification of key sources, which requires the incorporation of the uncertainty to each of these sources before ordering the list of shares. The result is a list of 42 source categories out of a total of 72 that could be identified as 'key sources' according to the definition of the *IPCC Good Practice Guidance* report. Finally, we found 3 key sources in the LULUCF sector (sector 5), after inclusion of 9 LULUCF subcategories in the key source analysis.

Institutional arrangements for inventory preparation
The greenhouse gas inventory of the Netherlands is based on the national *Pollutant Emission Register* (PER). 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 PER into a National System, according to the requirements under Article 5.1 of the *Kyoto Protocol*.
The Netherlands Environmental Assessment Agency (MNP) is responsible for the PER process (see *Figure ES.2*). The Climate Change and Industry Directorate (KvI) of the Ministry of Housing, Spatial Planning and the Environment (VROM) is responsible for organising the reporting process.
In December 2005, SenterNovem was designated by law as the National Inventory Entity (NIE). The tasks of SenterNovem include the overall co-ordination of QA/QC activities and co-ordination of 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 present CRF/NIR is based on the improved methodologies. Monitoring protocols describing the methodology, 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 sources 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 the different sectors. *Chapter 10* presents information on recalculations, improvements and response to issues raised in external reviews of the NIR 2005. In addition, the report provides more detailed information on key sources, methodologies, other relevant reports and summary emission tables selected from the CRF files (IPCC tables 7A and 10) in 10 *Annexes*.

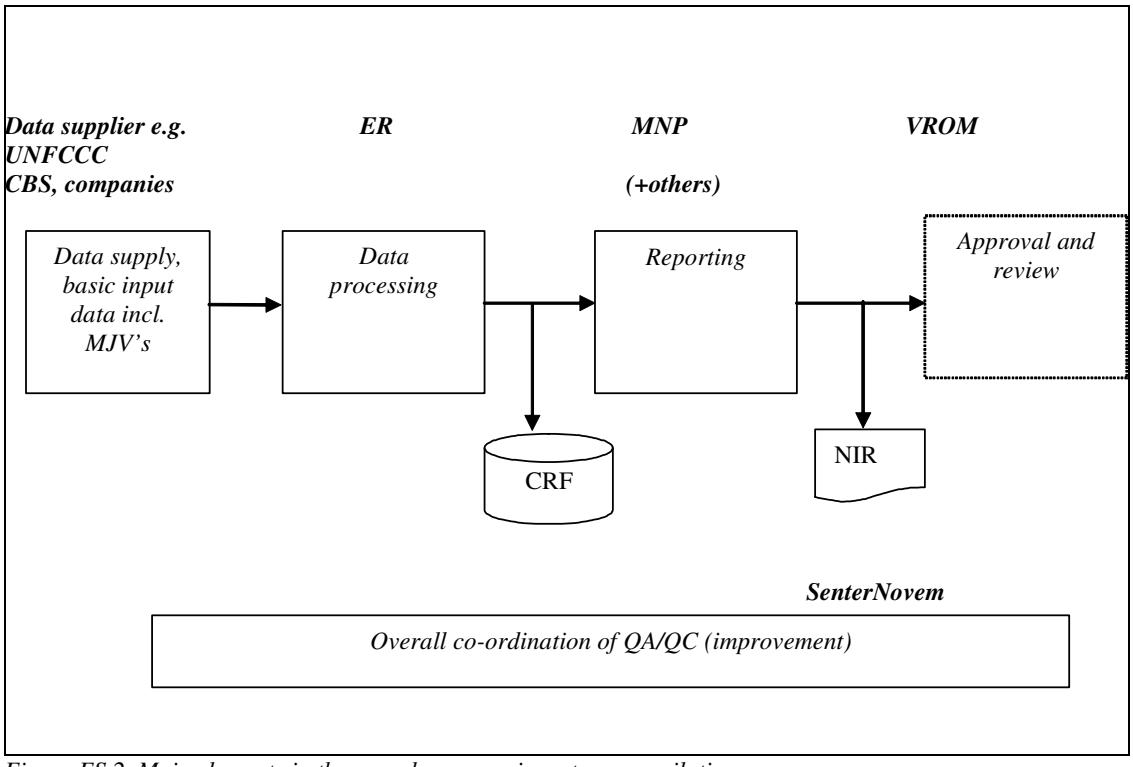


Figure ES.2. Main elements in the greenhouse gas inventory compilation process.

ES2 Summary of national emission and removal related trends

Figure ES.1 (see *Dutch Summary*) provides an overview of the emission trends for greenhouse gas emissions since 1990. In 2004 total direct greenhouse gas emissions (excluding emissions from LULUCF) in The Netherlands are estimated 218.1 Tg CO_2 equivalents (eq.). This is a 2% increase compared to 214.3 Tg CO_2 eq. in the base year (1990 and 1995 for fluorinated gases). CO_2 emissions (excluding LULUCF) increased by about 13% from 1990 to 2004, mainly due to the increase in the emissions in the 1A1a *Public electricity sector* (+42%) and 1A3 *Transport sector* (+34%). CH_4 emissions decreased by 32% in 2004 compared to the 1990 level, mainly due to decrease in the waste sector (-45%), the agricultural sector (-16%) and fugitive emissions in the energy sector (-56%). N_2O emissions decreased by about 16% in 2004 compared to 1990, mainly due to the decrease in the emissions from agriculture (-18%) and from industrial processes (-17%), 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 2004 by about 75% and 85% respectively, while SF_6 emissions increased by 9%. Total emissions of all F-gases decreased by about 75% compared to the 1995 level (chosen as the base year).

ES3 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. It clearly shows the *Energy sector* (category 1) to be by far the largest contributor to national total greenhouse gas emissions. The contribution of the energy sector to the total emissions increased from 72% in the base year to 81% in 2004. In contrast, emissions of the other sectors decreased compared to the base year, the largest being those of *Industrial Processes* (from 12 to 8% share), *Waste* (from 6 to 3% share) and *Agriculture* (from 10 to 8% in 2004).

Sectors showing the largest growth in CO_2-equivalent emissions since the base year (1990/1995) are *Transport* (1A3) and *Energy industries* (1A1) (both more than 30%). However, 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). Clear exceptions to the growth in the *Energy sector* are the *Waste sector* (6), *Industrial Processes* (2) and *Agriculture* (4), which showed decreases in CO_2-eq. emissions of 43%, 34%, and 17% respectively.

Table ES.1. Summary of emission trend per gas and source category (unit: Tg CO_2-equivalents).

	CO2 incl. LULUCF	CO2 excl. LULUCF	CH4	N2O	HFCs	PFCs	SF6	Total incl. LULUCF	Total excl. LULUCF 1)
Base year	161.8	159.4	25.4	21.2	6.0	1.9	0.3	216.7	214.3
1990	161.8	159.4	25.4	21.2	4.4	2.3	0.2	215.4	213.0
1991	166.7	164.4	25.7	21.6	3.5	2.2	0.1	219.9	217.6
1992	164.6	162.4	25.2	22.4	4.4	2.0	0.1	218.8	216.6
1993	169.0	166.8	24.9	23.1	5.0	2.1	0.1	224.2	222.0
1994	168.9	166.7	24.1	22.3	6.5	2.0	0.2	223.9	221.8
1995	172.8	170.6	23.8	22.4	6.0	1.9	0.3	227.3	225.1
1996	179.9	177.7	23.0	22.2	7.7	2.2	0.3	235.3	233.0
1997	173.5	171.1	22.0	21.9	8.3	2.3	0.3	228.5	226.0
1998	175.6	173.2	21.2	21.7	9.3	1.8	0.3	229.9	227.6
1999	170.0	167.7	20.1	20.9	4.9	1.5	0.3	217.8	215.4
2000	172.0	169.6	19.3	19.9	3.8	1.6	0.3	216.8	214.4
2001	177.6	175.2	18.9	18.8	1.5	1.5	0.4	218.6	216.2
2002	177.3	174.9	18.0	18.0	1.5	2.2	0.3	217.3	214.9
2003	180.9	178.5	17.5	17.4	1.3	0.6	0.3	218.1	215.7
2004	183.3	180.9	17.3	17.7	1.5	0.3	0.3	220.4	218.1

1) The national total does not include the CO_2 emissions reported under category 5 (LULUCF).

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

	1. Energy	2. Industrial Processes 2)	3. Solvent and Other Product Use	4. Agri-culture	5. LU-LUCF	6. Waste	7. Other 3)	Total incl. LULUCF	Total excl. LULUCF
Base year	154.0	25.0	0.5	22.0	2.4	12.8	NA	216.7	214.3
1990	154.0	23.6	0.5	22.0	2.4	12.8	NA	215.4	213.0
1991	159.0	22.7	0.5	22.4	2.3	13.0	NA	219.9	217.6
1992	157.7	23.0	0.4	22.8	2.2	12.7	NA	218.8	216.6
1993	162.4	23.9	0.4	23.0	2.2	12.4	NA	224.2	222.0
1994	161.6	25.6	0.4	22.2	2.2	11.9	NA	223.9	221.8
1995	165.5	24.8	0.4	23.0	2.2	11.3	NA	227.3	225.1
1996	173.3	26.0	0.4	22.4	2.2	11.0	NA	235.3	233.0
1997	165.6	27.3	0.3	22.2	2.4	10.6	NA	228.5	226.0
1998	167.9	27.6	0.4	21.5	2.3	10.2	NA	229.9	227.6
1999	162.2	22.5	0.4	21.0	2.3	9.4	NA	217.8	215.4
2000	164.2	21.3	0.3	19.8	2.4	8.9	NA	216.8	214.4
2001	170.3	17.7	0.3	19.5	2.4	8.4	NA	218.6	216.2
2002	170.1	18.1	0.2	18.4	2.4	8.0	NA	217.3	214.9
2003	173.6	16.1	0.2	18.2	2.4	7.5	NA	218.1	215.7
2004	175.9	16.4	0.2	18.2	2.4	7.3	NA	220.4	218.1

2) Emissions from the use of the F-gases HFCs, PFCs and SF_6 are according to the IPCC reporting guidelines all reported under source category 2 *Industrial processes*.

3) NA = Not Applicable.

ES4 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 (based CRF tables submitted to EU/EEA in March 2006). 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%, 18%, 45% and 27% 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 MNP at:

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

Table A1.4 of *Annex 1* summarises the estimate of the *trend uncertainty 1990-2004* 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 -2004 (1995 for F-gases) of ±3% points. This means that the increase in total CO_2-eq. emissions between 1990 and 2004, which is calculated to be 2%, will be between -1% and +5%. 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 ±3%, ±11%, ±15% and ±7% points, respectively. More details on the level and trend uncertainty assessment can be found in *Annex 1* on key sources.

Completeness of the national inventory

The Netherlands greenhouse gas emission inventory includes all sources identified by the *Revised 1996 IPCC Guidelines (IPCC, 1996),* except for 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 *Slugdge application on land* (4D4), due to missing activity data;
- CH_4 from *poultry* (4A9), due to missing emission factors;

- N_2O from *Industrial wastewater* (6B1), due to negligible amounts.
- A survey to check on unidentified sources of non-CO_2 emissions in The Netherlands showed that some minor sources of *PFCs* and *SF_6* are not included in the present greenhouse gas inventory (DHV, 2000).

The above mentioned sources have been examined by the *Dutch Working Group Emission Monitoring of Greenhouse Gases* and only negleglible amounts have been found. Since no regular monitoring data are available, these sources are not included.

- Precursor emissions (i.e. CO, NO_x, NMVOC and SO_2) from Memo item international bunkers (international transport) have not been estimated.

Methodological changes, recalculations and improvements

This *NIR 2006* is based upon the envisaged National System of the Netherlands under article 5.1 of the Protocol, as developed in the past few years and finalised by December 2005. In past years the results of various improvement actions are implemented in the methodologies and processes of the preparation of the greenhouse gas inventory of the Netherlands. Compared to the NIR/CRF 2005 several major and many small recalculations were undertaken for the (final) submission of 2006, specially focussing on key sources.

Compared to the NIR/CRF 2005, the following changes were made in the greenhouse gas inventory:

1. Changed methodology:

- Re-calculation of CH_4 emissions from 1B2b-iv *Gas distribution* based on detailed data (Gastec/KIWA, 2005) and country-specific emission factors determined by the gas distribution sector;
- Re-calculation of emissions from *Oil and gas production* (1B2c) from venting and flaring based on the assessment of past activities of individual companies by the industry association NOGEPA and the PER.
- Re-calculation of CH_4 from 4A *Enteric fermentation* based on a country-specific, method Tier 2 emission factors, calculated for each year (sector 4).
- Improved emissions for biomass combustion based on new activity data from the Energy statistics. The new activity data is based on the protocol for monitoring renewable energy (Abeelen and Bosselaar, 2004) for the whole time-series. This had impact on the total inventory of CH_4 and N_2O emissions and the memo item 'CO_2 from biomass'.
- Re-calculation of N_2O emissions from *Manure management and agricultural soils* [inclusion of horse manure, sludge application and some error corrections on N-input manure (sectors 4B, and 4D)].

2. Data improvement and updated information:

- Re-calculation of CO_2 emissions from the *Combustion of natural gas* based on the revised emission factor of 56.8 kg/GJ (sector 1);
- Re-calculation of CO_2 , CH_4 and N_2O emissions from *Navigation* based on the IPCC default emission factors;
- Improved activity data for the years 2000–2003 for *Navigation* (category 1A3d);
- Re-calculation of the emissions (CO_2, CH_4, N_2O) from *Oil and natural gas production* based on detailed data from the industry (category 1B2); see *Section 3.14.6*;
- Improved activity data for the *Clinker production* in 1990 and 1991 (CO_2 in sector 2A1);
- Improved data on lime use in the *Flue gas desulphurization* (CO_2 in sector 2A3);
- Improved emission factor for CO_2 emissions in the glass industry (CO_2 in sector 2A7);
- Addition of the source *Ethylene oxide production* for the whole time series (sector 2B5);
- Based on more accurate data (based on measurements) the PFC emissions from 2C3 *Primary aluminium production* are re-calculated for the whole-time series;
- Based on more accurate data the HFC emission from 1994 is improved (sector 2E and F);
- Based on more accurate data, improvement of the SF_6 emissions for 2001–2003;
- Re-calculation and update of CO_2 from *LULUCF*. The land use change matrix was improved. As a result, the land use change dynamics decreased, affecting all source categories of LULUCF. In addition, the soil carbon calculation was improved (using more detailed data on soil stratification), thereby affecting the CO_2 figures included in 5B.

Table ES.3 provides the results of recalculations in the NIR 2006 compared to the NIR 2005.

Table ES.3 Differences between NIR 2005 and NIR 2006 for 1990-2003 due to recalculations

Gas	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2 [Tg]	NIR2005	160.9	165.7	163.8	168.2	168.2	172.3	180.0	173.0	174.9	169.7	171.7	177.1	176.7	179.6
Incl.	NIR2006	161.8	166.7	164.6	169.0	168.9	172.8	179.9	173.5	175.6	170.0	172.0	177.6	177.3	180.9
LULUCF	***Difference***	*0.9*	*1.0*	*0.8*	*0.8*	*0.7*	*0.5*	*0.0*	*0.5*	*0.7*	*0.4*	*0.3*	*0.4*	*0.6*	*1.3*
CO2 [Tg]	NIR2005	**158.0**	162.9	161.1	165.5	165.5	169.7	177.3	170.2	172.2	166.9	168.9	174.4	173.9	176.9
Excl.	NIR2006	**159.4**	164.4	162.4	166.8	166.7	170.6	177.7	171.1	173.2	167.7	169.6	175.2	174.9	178.5
LULUCF	*Difference*	***1.4***	*1.5*	*1.3*	*1.3*	*1.2*	*1.0*	*0.4*	*0.9*	*1.1*	*0.8*	*0.7*	*0.8*	*1.0*	*1.7*
CH4 [Gg	NIR2005	**25,630**	25,890	25,431	24,959	24,247	23,829	23,231	22,090	21,280	20,223	19,518	19,005	18,221	17,455
CO2-eq]	NIR2006	**25,441**	25,718	25,208	24,933	24,107	23,792	23,027	22,010	21,166	20,135	19,251	18,884	17,992	17,547
	Difference	-189	-171	-223	-27	-140	-37	-204	-80	-113	-88	-268	-121	-229	92
N2O [Gg	NIR2005	**21,312**	21,708	22,397	23,126	22,276	22,421	22,186	21,958	21,694	20,948	19,894	18,878	17,971	17,321
CO2-eq]	NIR2006	**21,219**	21,634	22,361	23,077	22,251	22,394	22,154	21,922	21,668	20,941	19,867	18,844	17,970	17,374
	Difference	**-93**	-74	-36	-49	-24	-27	-31	-36	-26	-7	-27	-34	-1	54
PFC [Gg	NIR2005	2,115	2,095	1,905	1,926	1,853	**1,806**	2,002	2,177	1,730	1,466	1,521	1,417	1,416	1,396
CO2-eq]	NIR2006	2,264	2,245	2,043	2,068	1,990	**1,938**	2,155	2,344	1,829	1,471	1,581	1,489	2,186	620
	Difference	*149*	*150*	*137*	*142*	*136*	***132***	*154*	*167*	*100*	*5*	*60*	*72*	*769*	*-777*
HFC [Gg	NIR2005	4,432	3,452	4,447	4,998	6,518	**6,011**	7,664	8,295	9,348	4,868	3,839	1,492	1,566	1,450
CO2-eq]	NIR2006	4,432	3,452	4,447	4,998	6,480	**6,020**	7,678	8,300	9,341	4,859	3,824	1,469	1,541	1,319
	Difference	*0*	*0*	*0*	*0*	*-37*	***9***	*13*	*5*	*-6*	*-9*	*-15*	*-23*	*-25*	*-131*
SF6 [Gg	NIR2005	217	134	143	150	191	**301**	312	345	329	317	335	357	359	334
CO2-eq]	NIR2006	217	134	143	150	191	**301**	312	345	329	317	335	356	332	309
	Difference	*0*	*0*	*0*	*0*	*0*	***0***	*0*	*0*	*0*	*0*	*0*	*-1*	*-27*	*-25*
Total [Tg	NIR2005	214.6	219.0	218.1	223.3	223.3	226.7	235.4	227.9	229.3	217.5	216.8	218.3	216.2	217.6
CO2-eq.]	NIR2006	215.4	219.9	218.8	224.2	223.9	227.3	235.3	228.5	229.9	217.8	216.8	218.6	217.3	218.1
Incl.															
LULUCF	***Difference***	*0.8*	*0.9*	*0.7*	*0.9*	*0.7*	*0.6*	*-0.1*	*0.6*	*0.6*	*0.3*	*0.1*	*0.3*	*1.1*	*0.5*
Total [Tg	NIR2005	211.7	216.2	215.4	220.7	220.6	224.0	232.7	225.0	226.5	214.8	214.0	215.5	213.5	214.8
CO2-eq.]	NIR2006	213.0	217.6	216.6	222.0	221.8	225.1	233.0	226.0	227.6	215.4	214.4	216.2	214.9	215.7
Excl.															
LULUCF	***Difference***	*1.3*	*1.4*	*1.2*	*1.3*	*1.1*	*1.0*	*0.3*	*1.0*	*1.0*	*0.7*	*0.5*	*0.7*	*1.5*	*0.9*

Note: base year values are indicated in bold.

Improving the QA/QC system

As announced in the NIR 2005, the QA/QC programme is updated and most procedures and process are established to meet the National System requirements (a.o. as part of the annual activity programme of the Netherlands PER). QA/QC activities to be undertaken as part of the National System have been described in *Chapter 1*. Some actions, however, still remain:

- The update of the description of QA/QC of external agencies;
- Results of a TIER 2 uncertainty analysis are available. The results will be taken into account in next years QA/QC programme. They will be also included in the monitoring protocols.

Emission trends and uncertainties for indirect greenhouse gases and SO_2

Compared to 1990, the CO and NMVOC emissions were reduced in 2004 by 46% and 61% respectively. For SO_2 this is even 67%, and for NO_x, the 2004 emissions are 37% 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 directly related to transport statistics on vehicle-km, which differs to some extent from the IPCC approach. Recalculations (due to changing methodologies), have not been performed for 1991-1994 for all sources. Therefore, the trends showed a discontinuity for these years. For that reason the precursor gas emissions were interpolated between 1990 and 1995.

Most of the NO_x, CO and SO_2 emissions are caused by fuel combustion. The uncertainty in the emission factor for NO_x, CO and NMVOC is estimated to be in the range of 10-50%. For SO_2 emission factors from fuel combustion (basically the sulphur content of the fuels) the uncertainty is estimated 5%. For most compounds the uncertainty in the activity data is relatively small compared to the accuracy of 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 NO_x, 5% for SO_2, and about 25% for NMVOC.

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

	NOx	CO	NMVOC	SO2
1990	559.3	1137.3	465.8	190.1
1991	460.9	1026.3	412.1	140.5
1992	447.1	981.9	388.8	133.5
1993	429.3	925.3	361.2	126.0
1994	412.4	896.4	339.9	118.5
1995	470.2	862.0	332.7	128.1
1996	456.6	850.8	293.3	121.3
1997	417.2	772.4	263.6	102.0
1998	405.6	759.4	262.6	93.7
1999	411.1	738.7	248.7	87.8
2000	396.4	715.6	234.6	71.6
2001	385.2	680.1	212.6	73.4
2002	377.5	647.5	202.0	66.7
2003	375.5	626.8	187.0	62.8
2004	354.8	617.2	180.0	63.6

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 came 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 report documents the 2006 Greenhouse Gas Emission Inventory for The Netherlands. The estimates provided in the report are consistent with the *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, we refer the reader to the annual *Environmental Balance* (MNP 2005, in Dutch), the *Fourth Netherlands' National Communication under the United Nations Framework Convention on Climate Change* (VROM, 2006a) and *The Netherlands' Report on demonstrable Progress under Article 3.2 of the Kyoto Protocol* (VROM, 2006b). The *Common Reporting Format* (CRF) spreadsheet files accompany this report as electronic annexes[1]. These files contain data on emissions, activities and implied emission factors. 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.

The Netherlands also reports emissions under other international agreements, such as the UNECE *Convention on Long Range Transboundary Air Pollutants* (CLRTAP) and the European Union's *National Emission Ceilings* (NEC) directive. These estimates are provided by The Netherlands' *Pollution Emission Register* (PER), which is also compiled by the Environmental Assessment Agency. The greenhouse gas inventory and the PER 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 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 (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC), as wel as Sulphur oxides (SO_x).

This report provides explanations of the trends in greenhouse gas emissions per gas and per sector for the 1990–2004 period and summarises 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.

As a part of the National System under Article 5.1 of the *Kyoto Protocol*, methodologies were established (and documented) in monitoring protocols. These monitoring protocols and the general description of the National System are available on the website www.greenhousegases.nl. The emissions reported in the *NIR 2006* are based on these methodologies, which have been incorporated in the National System for greenhouse gases.

[1]The CRF files are compressed into four zip files for this submission: crf-nld-2006-v-1-6-90-93.zip; crf-nld-2006-v-1-6-94-97.zip; crf-nld-2006-v-1-6-98-01.zip. crf-nld-2006-v-1-6-02-04.zip

A small number of (methodological) changes have been implemented in the *NIR 2006* relative to the NIR of the preceding year. A detailed overview of these changes is provided in *Section 10.1*. By implementing these changes, The Netherlands envisages its National System to be complete – under the restriction of the review process as described by Article 8 of the *Kyoto Protocol*.
The Netherlands will base its calculation of the ***Assigned Amount*** under the *Kyoto Protocol* on this *NIR 2006*.

The structure of this report complies with the format required by the UNFCCC (FCCC/SBTSA/2004/8). 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 CO_2 equivalents). In accordance with the *Kyoto Protocol*, the IPPC GWP for a time horizon of 100 years is used. The GWP of each individual greenhouse gas is provided individually in *Annex 9*.

1.1.1 CRF files: greenhouse gas emissions and background data

The CRF files (version 1.6) contain detailed information on greenhouse gas emissions, activity data and (implied) emission factors specified by sector, source category and greenhouse gas. Detailed information on specific source categories can be found in the CRF files. Some summary tables are included in this report. *Annex 8* of this report contains a summary of the following CRF files:

- IPCC summary *Table 7A* for 1990, 1995, 2000, 2003 and 2004 (CRF Summaries 1);
- trend *Table 10* for each gas individually, and for all gases and sources in CO_2-eq.

Section 10.4 provides details on the extent to which the CRF data files for 1990–2004 have been completed. For this NIR report, a special effort was made to:

- finalise the planned improvements as indicated in the previous submission and bring all key sources in line with *IPCC Good Practice* by using transparent or higher tier methodologies;
- improve on the notation keys included, where applicable.

1.1.2 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 liberalisation of the European electricity markets in that year, the net import increased by 55%. 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. The ministry is also responsible for forwarding the NIR and CRF to the EU and UNFCCC. The Netherlands Environmental Assessment Agency (MNP) is the agency designated to compile and maintain the national greenhouse gas inventory and to co-ordinate the preparation of the NIR and filling the CRF.

1.2.2 Responsibility for 'designing the National System'

A monitoring improvement programme, with the aim of adapting the greenhouse gas inventory system to meet the requirements for National Systems under the *Kyoto Protocol*, was implemented in 2001. This programme, the final result of which was the implementation of a number of new methodologies and recalculations in the preparation phase of this NIR, was co-ordinated by SenterNovem. The results of the programme were implemented in the PER as a part of the National System for the greenhouse gas inventory.

In August 2004 the Ministry of VROM assigned SenterNovem executive tasks bearing on the *National Inventory Entity* (NIE) required for the *Kyoto Protocol*; in December 2005, SenterNovem

was designated by law as the NIE. In addition to co-ordinating the establishment of a National System, the tasks of SenterNovem include the overall co-ordination of (improved) QC/QA activities as part of the National System and co-ordination of the support/response to the UNFCCC review process. The National System is described in more detail in SenterNovem *et al.* (2005).

1.2.3 Responsibility for emission estimates

A PER system 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 are produced in an annual (project) cycle (MNP, 2005). This system is also the basis for the national greenhouse gas inventory. In April 2004 full co-ordination of the PER was outsourced by the Ministry of VROM to the MNP. This has resulted in a clearer definition and separation of responsibilities as well as a clustering of tasks.

The main objective of the PER is to produce an annual set of unequivocal emission data that are up-to-date, complete, transparent, comparable, consistent and accurate. In addition to MNP, various external agencies contribute to the PER by performing calculations or submitting activity data (see following section), these include: CBS (Statistics Netherlands), TNO (Netherlands Organisation for Applied Scientific Research) (see *Section 1.3.3*), RIZA (Institute for Inland Water Management) and several institutes related to the Wageningen University and Research Centre (WUR).

1.2.4 Responsibility for reporting

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

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 summarised in *Figure 1.1*. This process includes three major steps that are described in more detail in the following sections.

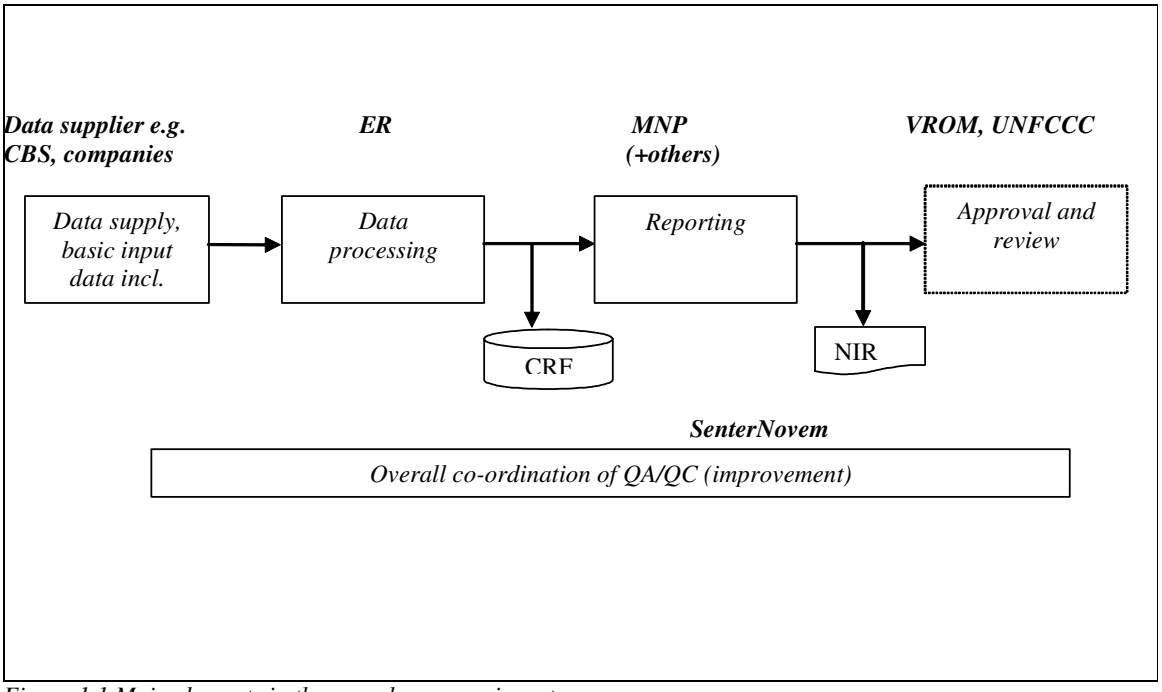


Figure 1.1 Main elements in the greenhouse gas inventory process.

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 (general statistics) and SenterNovem. An agreement with the Ministry of Agriculture, Nature and Food Security (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 a MJV that includes – in addition to other pertinent information – emission data validated by the competent authorities [usually provincial (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 primarily used for verifying the calculated CO_2 emissions from energy statistics for industry, energy and refineries. If reports from major industries contain plant-specific information on activity data and emission factors of sufficient quality and transparency, these data are used in the calculation of 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. 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. This means that only a limited number of the MJVs compiled each year can be used. Furthermore, the number of companies providing emission information has decreased over time (see, for example, *NIR 2005*).
- *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 MNP) 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 MNP, these activities are also part of the PER.

1.3.3 Data processing and storage

Data processing and storage are co-ordinated by MNP; these processes consist most notably of the elaboration of emission estimates and data preparation in the CRF. The emission data are stored in a central database, thereby satisfying – in an efficient and effective manner – (inter)national criteria on emission reporting.

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

- 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 2005, in addition to the MNP, these included TNO, CBS, RIZA, FO-I (the Facilitating Organisation for Industry, which coordinates annual environmental reporting by companies), SenterNovem (Waste Management division) and various agricultural research institutes, one of which was Alterra (sinks). The task forces are responsible for assessing emission estimates based on the input data and emission factors provided. MNP commissioned TNO to carry out the task of collecting data from the various task forces and to compile these into the CRF.

The methodologies and procedures used for the collection and processing of the data from which the emissions are estimated are defined in the monitoring protocols (see: www.greenhousegases.nl). These are elaborated, together with relevant experts and institutes, as part of the monitoring improvement programme.

1.3.4 Reporting, QA/QC, archiving and overall co-ordination

The NIR is prepared by MNP with input from the experts in the relevant PER 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 CRF have been submitted. SenterNovem is also responsible (in collaboration with MNP) for coordinating the submission of supporting data to the UNFCCC review panel.

1.4 Brief general 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*.

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) agricultural gas and diesel consumption (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 firms; (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;
- anaesthetic gas: data provided by Hoekloos, the major supplier of this gas;
- spray cans containing N_2O : the Dutch Association of Aerosol Producers (Nederlandse Aerosol Vereniging, NAV);
- animal numbers: from the CBS/LEI-DLO agricultural database, plus data from the annual agricultural census;

Table 1.1 CRF Summary table 3 with methods and emission factors applied

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,T 3	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	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	T2,T3	CS,PS	T1b,T2,T3	CS,D,PS	NA	NA						
2. Industrial Processes	**CS,T1a,T1 b,T2**	**CS,D,PS**	**CS,T1,T2**	**CS,D**	**CS,T1b,T2**	**CS,D,PS**	**T2**	**CS,PS**	**CS,T1,T2**	**PS**	**CS,T2**	**D,PS**
A. Mineral Products	CS	CS,D,PS	NA	NA	NA	NA						
B. Chemical Industry	CS,T1b	CS,PS	T1,T2	D	T2	PS					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							T2	PS	T1	PS	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,T1b	CS,D			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,T2**	**CS**	**NA**	**NA**	**NA**	**NA**						
A. Forest Land	CS,T2	CS	NA	NA	NA	NA						
B. Cropland	CS	CS	NA	NA	NA	NA						
C. Grassland	T2	CS	NA	NA	NA	NA						
D. Wetlands	NA	NA	NA	NA	NA	NA						
E. Settlements	CS	CS	NA	NA	NA	NA						
F. Other Land	CS	CS	NA	NA	NA	NA						
G. Other			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**

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 available, NO, not occurring; NE, not estimated; IE, included elsewhere.

Data sources (continued):

- manure production and handling: from the CBS/LEI-DLO national statistics;
- fertiliser statistics: from the LEI-DLO agricultural statistics;
- forest and wood statistics: (1) forest surface area 1980, 2000 and after 2000: CBS (1985), Dirkse *et al*. (2003), supplemented with agricultural statistics on orchards and nurseries from LEI/CBS (2000); CBS (1985, 1989), Daamen (1998) and Edelenbosch (1996) for the intermediary years; (2) stem-volume, annual growth and fellings: Dirksen *et al.* (2003);
- 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;
- methane recovery from landfills: Association of Waste Handling Companies (VVAV).

Many recent statistics are available on the internet at CBS's statistical website Statline and CBS/MNP environmental data compendium. However, it should be noted that the units and definitions used for domestic purposes occasionally differ from those used in this report. In particular, CO_2 data are given, with or without temperature correction, 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 source categories

The analysis of key sources is performed in accordance with the *IPCC Good Practice Guidance* (IPCC, 2001). As a means 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*. This year we reviewed the spreadsheet for the key source analysis and uncertainty analysis and took a closer look at the IPCC guidelines on this subject, paying particular attention to the special considerations presented in *Table 7.1* of the *IPCC Good Practice Guidance* and the *Good Practice Guideline for LULUCF*. We found an error in the calculation of the Tier 2 trend key source calculation and now use a 90% cumulative share instead of a 95% cumulative share for the Tier 2 level and trend key sources.

Relative to previous NIRs, *NIR 2006* contains an increased number of sources that are specifically distinguished in the analysis. The main difference is the distinction of fuel types (liquid, solid, gas) for combustion in the source categories 1A1, 1A2, 1A3 en 1A4. From sources in these categories the following are ***non-key***: 1A1c 'Manufacturing of Solid Fuels and Other Energy Industries, liquids', 1A3 Mobile combustion aircraft, 1A3 Mobile combustion railways, 1A3 Mobile combustion other (CO_2 and CH_4), 1A3 Mobile combustion road vehicles (CH_4) and 1A4 'Other sectors, solids'.

CO_2 emissions from 'Mobile combustion: Road vehicles' (1A3) are assessed separately by fuel type. As the CH_4 and N_2O emissions from aircrafts and ships are relatively small (about 1-2 Gg CO_2-eq.), the other mobile sources are not assessed separately by gas.

Fugitive emissions from oil and gas operations (1B) are an important source of greenhouse gas emissions in The Netherlands. Therefore, the most important gas/source combinations in this category are separately assessed. The emissions in the other IPCC sectors are disaggregated, as suggested by IPCC.

This resulted in the following changes in the *NIR 2006*:

- SF_6 emissions from SF_6 use: no key source;
- CH_4 emissions from 'Manure management, poultry': new key source: Tier 2 trend;
- N_2O emissions from 'Animal production on agricultural soils': new key source;
- N_2O emissions from 'Wastewater handling': no key source.

For LULUCF:

- CO_2 emissions from 5A1 'Forest land remaining Forest land': new key source;
- CO_2 emissions from 5C1 'Grassland remaining Grassland': new key source;
- CO_2 emissions from 5F2 'Land converted to Other land': new key source.

A detailed description of the key source analysis is provided in *Annex 1* of this report. The key source assessment presented in Annex 1 is based on emission figures in CRF version 1.6, submitted to UNFCCC in September 2006. However, this new list of key categories is not updated in the CRF Reporter and CRF version 1.6 files (see *Annex 1* for details). Per sector, the key sources are also listed in the Introduction of each of *Chapters 3–8*.

1.6 Information on the QA/QC plan

As part of its National System, The Netherlands has developed and implemented a QA/QC programme (SenterNovem et al., 2005). This section summarises the main elements, notably those related to the current NIR. The QA/QC programme is one of the results of the national inventory improvement programme.

1.6.1 QA/QC activities for the CRF/NIR 2006

- An inventory improvement programme was finalized in September 2005. Methods, activity data and emission factors were assessed and subsequently adapted where necessary.
- Monitoring protocols were elaborated and implemented in order to improve the transparency of the inventory. This involved assessing and – where necessary – redefining processes and 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 National System website (www.greenhousegases.nl) provides addition information on the protocols and relevant background documents.

- General QC checks are performed. To facilitate these general QC checks, a checklist was developed and implemented. A number of general QC checks have also been introduced as part of the annual work plan of the PER. The checklist aims at checking the completeness of the monitoring protocols (including completeness of the information on methods and among others, activity data (AD) and emission factors (EF). The QC checks build into the work plan aim at covering such issues as consistency, completeness, correctness of the CRF data, among others. The general QC for the present inventory is largely performed in the PER, as an integrated part of the working processes, and is to a large extent similar to that carried out in recent years. The PER task forces fill in a standard-format database supplied by TNO with emission data for 1990–2004. The specific task force first checks the emission file before it is submitted; this is followed by a check of the emission files by TNO for completeness, consistency and formats. The (corrected) data are then processed into a comprehensive draft data file. The task forces have access to information about the relevant emissions in the draft data file. They also have access to it via the internet in order to check how TNO handled the data in preparation for the annual trend analysis workshop (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 2006. 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 – especially the in-country review that took place in September 2004, but also the *Synthesis and Assessment Report of NIR 2005* – have been taken into account in *Chapters 3–8*.
  - An intra-EU mutual collaborative review of parts of the inventory with Belgium took place in the period June–September 2005. The review focussed on the *NIR 2005*. The results have been included in this NIR.

Box 1.1. Trend verification workshops

Several weeks in advance of a trend analysis meeting, a draft database file is made available by TNO to all involved institutes and experts (ER task forces). In this way the task forces can check for level errors and consistency in the algorithm/method used for calculations throughout the time series. The task forces perform checks for CO_2, CH_4 and N_2O 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 the subject of discussion at the trend analysis workshop and subsequently documented.

TNO also provides the task forces with time series of emissions per substance for the individual target sectors and the CRF. The task forces examine these time series. During the trend analysis the greenhouse gas emissions for all of the years between 1990 and 2004 were checked on the level of the IPCC Summary Table 7A for outliers in two manners: (a) the levels in any one year were compared with those published the previous year; (b) based on the trends for each gas in the period 1990–2004. Special emphasis was put on checking the year 1990 (1995 for F-gases). The checks of outliers were carried out on a more detailed level of 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 have to be processed within 2 weeks or be dealt with in the following year's inventory.

Both the UNFCCC review and the mutual review resulted in an improved transparency of a number of the emission factors used and of background information on LULUCF. One emission factor of a very small source was further substantiated and changed. It should be noted that these improvements had already been identified as part of the monitoring protocol development. Since these concerned the LULUCF sector (for which the new guidelines could be used only in the *NIR 2005*) and the very small sources, implementation of these improvements had been planned only for elaboration of the *NIR*

2006. The mutual review further recommended the more integrated and systematic use of Implied Emission Factor (IEF) analyses as an extra QC tool. This has since been included in the update of the QA/QC programme.

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 PER and the National System, taking into account the ISO 9001/2000 certification of MNP and the international QA/QC requirements (*IPPC Good Practice*). Furthermore, the 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, 2005) that has been developed and implemented as part of the National System. This programme includes quality objectives for the National System, the QA/QC plan and a time schedule for implementation of the activities. It will updated annually as part of a yearly 'evaluation and improvement cycle' for the inventory and National System and be held available for review.
- The annual activity programme of the PER (MNP, 2005) that is part of the requirements under the MNP ISO 9001/200 certification. The work plan describes tasks and responsibilities of the parties involved in the PER process, products and the time schedule (planning), emission estimation methods – among which are the monitoring protocols for the greenhouse gases – as well as 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*). In addition, the work plan consists of an inventory and QA/QC improvement programme.
- 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 PER 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 MNP and institutes ('outside agencies') that are involved in the annual PER 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 PER work plan.
- Specific procedures that have been established to fulfil the QA/QC requirements as prescribed by the *UNFCCC* and *Kyoto Protocol.* General agreements on these procedures are described in the QA/QC programme 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 PER 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 obliged 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 (acting as NIE) and institutions not basically involved in the PER process. In addition, MNP will assign some institutions to review the data set.
  - Public review of the draft NIR: SenterNovem organises every year a public review (by means of internet). Relevant comments are incorporated in the final NIR.
  - Mutual reviews: see S*ection 1.6.1* for the mutual review with Belgium in 2005.
  - Audits: in the context of the annual work plan, it has been agreed upon that the involved institutions send the report of internal audits to MNP as coordinating agency for the CRF/NIR. Furthermore, SenterNovem is assigned the task of organising audits, if needed, of relevant processes or organisational issues within the National System.
  - Archiving and documentation: internal procedures are agreed upon in the PER work plan for general data collection and the storage of fixed datasets in the MNP database, including the documentation/archiving of QA/QC checks. The improved monitoring protocols have been documented and will be published on the website www.greenhousegases.nl. To improve transparency, the newly implemented checklists for QC checks have been documented and

archived. The QA/QC plan foresees the upgrading of the documentation and archiving system.
- 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 yearly to evaluate the process. In this review, 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 programme (including the improvement programme) 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 programme. Because it did not seem possible to considerably reduce uncertainties by independent verification (measurements) – at least not on the national scale – this issue has received less priority. In the context of a large research programme on climate change in The Netherlands, the issue is being studied once again at the present time. 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*.).

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. Secondly, these uncertainty estimates can be 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 used

The following information sources were used for estimating the uncertainty in activity data and emission factors (Olivier and Brandes, 2006):

- 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).

These data sources were supplemented with expert judgements from MNP and CBS emission experts (also for the new key sources). This was followed by an estimation of the uncertainty in the emissions in 1990 and 2004 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 with 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 summarised 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 2004, based on calculated uncertainties of 1.9%, 18%, 45% and 27% for CO_2 (excluding LULUCF), CH_4, N_2O and F-gases, respectively. The uncertainty in CO_2 emissions including emissions from LULUCF is calculated to be 2.4%.

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; these values are currently estimated by MNP to be:

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

The most important changes in the uncertainty analysis are:

- (des)aggregation of emission sources in the 1A1-1A4 categories by fuel type and sub-category and inclusion of uncertainty estimates for these emission sources provided by emission experts;
- a lower uncertainty estimate for the CO_2 emission factor for gasoline and diesel in sub-categories 1A3, based on 50 samples of petrol and diesel fuel from petrol stations in The Netherlands in 2004 (see *Section 3.4.3*).

Ranking the sources according to their contribution to the uncertainty in total national emissions (using the column 'Combined Uncertainty as a percentage of total national emissions in 2004' in *Table A7.1),* the top ten sources contributing most to total ***annual uncertainty*** in 2004 are:

IPCC category no.	Category	Gas	Combined uncertainty as a percentage of total national emissions in 2004
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3.0%
4D1	Direct N_2O emissions from agricultural soils	N_2O	1.3%
2B2	Nitric acid production	N_2O	1.3%
1A4a	Stationary combustion: Other sectors: Commercial/Institutional, gases	CO_2	1.0%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	1.0%
4B1	Emissions from manure management: cattle	CH_4	0.7%
1A1b	Stationary combustion: Petroleum refining, liquids	CO_2	0.6%
2G	Indirect N_2O from NO_2 from combustion and industrial processes	N_2O	0.6%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	0.5%
1A3b	Mobile combustion: road vehicles, diesel oil	CO_2	0.4%

Table A7.1 of *Annex 7* summarises the estimate of the ***trend uncertainty*** 1990–2004 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-equivalent emissions (excluding LULUCF) for 1990–2004 (1995 for F-gases) of ±3% points. This means that the increase in total CO_2-eq. emissions between 1990 and 2004, which is calculated to be 2%, will be between –1% and +5%.

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 ±3%, ±11%, ±15% and ±7% points, respectively. More details on the level and trend uncertainty assessment can be found in *Annex 7*. The top ten sources contributing most to ***trend uncertainty*** in the national total (using the column 'Uncertainty introduced into the trend in total national emissions' in *Table A7.1*) are:

IPCC cat. no.	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	1.5%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	1.4%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	0.6%
1A1b	Stationary combustion: Petroleum refining, liquids	CO_2	0.6%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	0.6%
1A4c	Stationary comb.: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	0.5%
2B2	Nitric acid production	N_2O	0.4%
1A4c	Stationary combination: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	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. For a number of sources, it

is clear that activity data or emission factors are correlated, which may change the overall uncertainty of the sum to an unknown extent. For some sources, it is also known 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 judgement of the expert. On occasion there is only limited reference to actual data for The Netherlands is 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 in The Netherlands.

Furthermore, a Tier 2 uncertainty assessment and a subsequent comparison with a Tier 1 uncertainty estimate based on similar data demonstrated that the simplified Tier 1 approach provides results that are quite close to those obtained from a comprehensive Tier 2 analysis (Olsthoorn and Pielaat, 2003). This conclusion holds for both annual uncertainties and the trend uncertainty (see the comparisons presented in *Table 1.4* and *Table 1.5*, respectively). This range of confidence is similar to the trend uncertainty found in comparable studies for the UK, Norway and Austria (Rypdal and Winiwarter, 2001).

Table 1.4 Effects of simplifying Tier 1 assumptions on the uncertainties of emissions for 1999.

Greenhouse gas	**Tier 1 uncertainty**[1)]	**Tier 2 uncertainty**
Carbon dioxide	2.7%	1.6%
Methane	16.2%	14.6%
Nitrous oxide	35.5%	29.3%
F-gases	20.3%	20.0%
Total	**4.5%**	**3.6%**

[1)] Calculated in *NIR 2001*. Source: Olsthoorn and Pielaat (2003).

Table 1.5 Effects of simplifying Tier 1 assumptions on the 1990–1999 emission trend and trend uncertainties.

Emission trend	**Tier 1 uncertainty**[1)]	**Tier 2 uncertainty**
CO_2-eq.	6.1%	5.8%
Confidence range	4.5–8.4%	3.5–8.6%.
Range (±) (relative)	**2.6% points** (65%)	**2.8% points** (45%)

[1)] Calculated in NIR 2001. Source: Olsthoorn and Pielaat (2003).

As part of an updated Tier 2 analysis for The Netherlands that is presently being conducted by Utrecht University (Ramirez, 2006), the expert judgements and assumptions made for uncertainty ranges in emission factors and activity data for The Netherlands (focussing on the key sources) 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. Although a straightforward comparison is somewhat blurred due to differences in the aggregation level at which the assumptions have been made, preliminary 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 preliminary 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.

The most recent Netherlands' Tier 2 study used the same uncertainty assumption as the Tier 1 study but accounted for correlations and non-Gaussian distributions. Preliminary 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. Further, the Tier 2 uncertainty for 1990 emissions is slightly higher (about 1.5%- points) 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. The results of the most recent Netherlands' Tier 2 will be presented in the *NIR 2007.*

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 by, 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 Programme on Global Air Pollution and Climate Change* (NOP-MLK) or by the Dutch *Reduction Programme on Other Greenhouse Gases* (ROB). The results of these studies can be found in Berdowski *et al.* (2001), Roemer and Tarasova (2002) and Roemer e*t al.* (2003).

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 results of the completeness checks of this submission of the NIR and the CRF.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Emission trends for aggregated greenhouse gas emissions

Chapter 2 summarises the trends in greenhouse gas emissions during the period 1990–2004, by both, greenhouse gas and by sector. Detailed explanations of these trends are provided in *Chapters 3–8*. Emission trends specified per source category are published on the website www.greenhousegases.nl and provide emission trends of the direct greenhouse gases specified by gas and by source category.

In 2004 total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands are estimated to have been 218.1 Tg CO_2-eq., which is an increase of 2% relative to the 214.3 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.

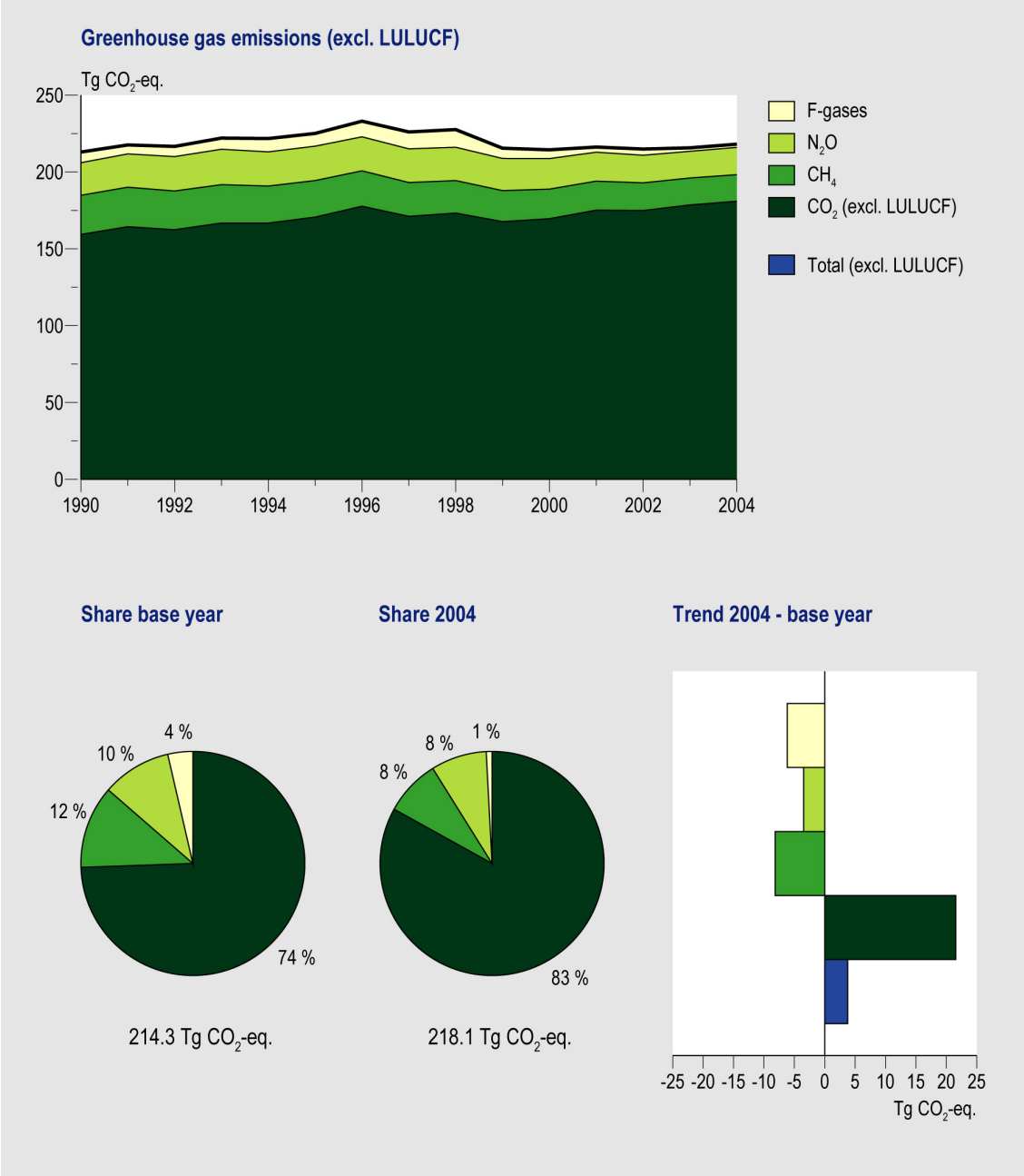


Figure 2.1 Direct greenhouse gases: trends, emission levels and share of gases, 1990–2004.

The contribution of non-CO_2 greenhouse gases (CH_4, N_2O and F-gases) to the aggregated total emissions decreased between 1990 and 2004 (26% in the base year compared to 17% in 2004). Consequently, the trend shown by aggregated greenhouse gas emissions in the Netherlands is that of an increasing dominance by CO_2 emissions.

In the period 1990–2004 emissions of CO_2 increased by 13% (excluding LULUCF), while emissions of non-CO_2 greenhouse gases decreased by 32% compared with the base year emissions. CH_4, N_2O and the F-gases individually decreased 32%, 16% and 75%, respectively. Emissions of LULUCF decreased 1.5%, from 2.39 Tg in 1990 to 2.36 Tg CO_2-eq. in 2004.

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 IPCC, to the trend in total national CO_2 emissions (excluding LULUCF). In the period 1990–2004 the total inventory of national CO_2 emissions increased by 13% (from 159.4 to 180.9 Tg). The IPCC sector *Energy* is by far the largest contributor to CO_2 emissions in the Netherlands (96%), with the categories 1A1 'Energy industries' (+35%) and 1A3 'Transport' (+34%) contributing the most to the increased CO_2 emissions. Fuel combustion emissions in category 1A2 'Manufacturing industries and construction' decreased by 17%. This decrease is explained by a re-allocation of CO_2 emissions to category 1A1a 'Public electricity and heat production' as a result of changes in the ownership (joint-ventures) of the co-generation plants during this period. The increased emissions included in category 1A1 'Energy industries' are partly explained by this (see *Section 3.3.1*).

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. From 2000 onwards, the pre-1999 annual increase in CO_2 emissions from this category – about 1–2% – resumes (see *Section 3.3.1*).

Total CO_2 emissions in 2004 increased by approximately 1% (+2.4 Tg) compared to 2003, mainly due to increased emissions from category 1A1 'Energy industries' (+2.3 Tg).

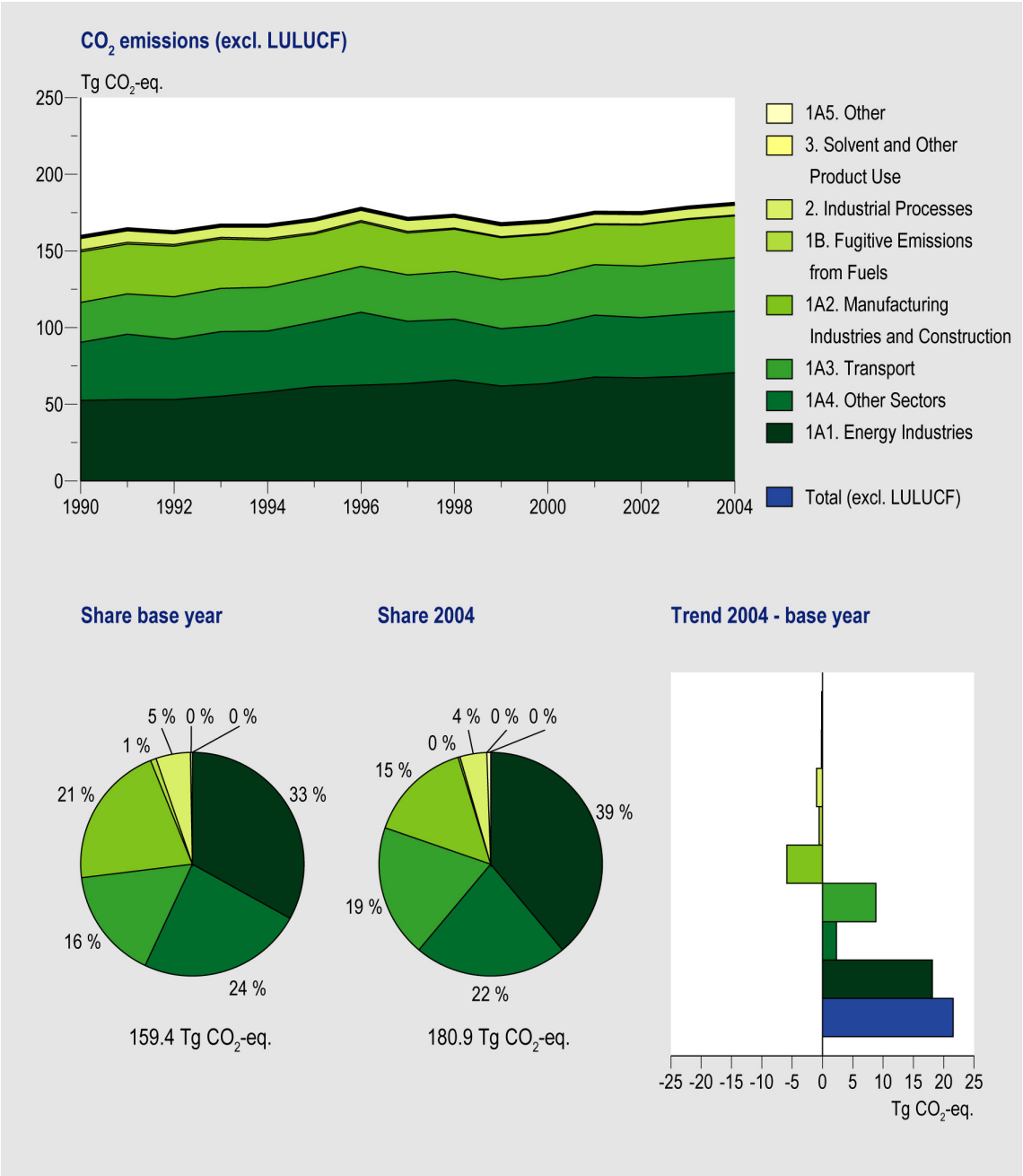


Figure 2.2 CO_2: trend, emission levels and share of sectors, 1990–2004.

2.2.2 Methane

Figure 2.3 presents the contribution of the most important IPCC sectors to the trend in national total CH_4 emissions. The total inventory of national CH_4 emissions decreased 32%, from 1211 Gg in 1990 to 824 Gg in 2004 (25.4 to 17.3 Tg CO_2-eq.). Sectors contributing the most to the reported decrease are *Waste* (–45%), *Agriculture* (–16%) and the fugitive emissions from *Energy* (–56%).

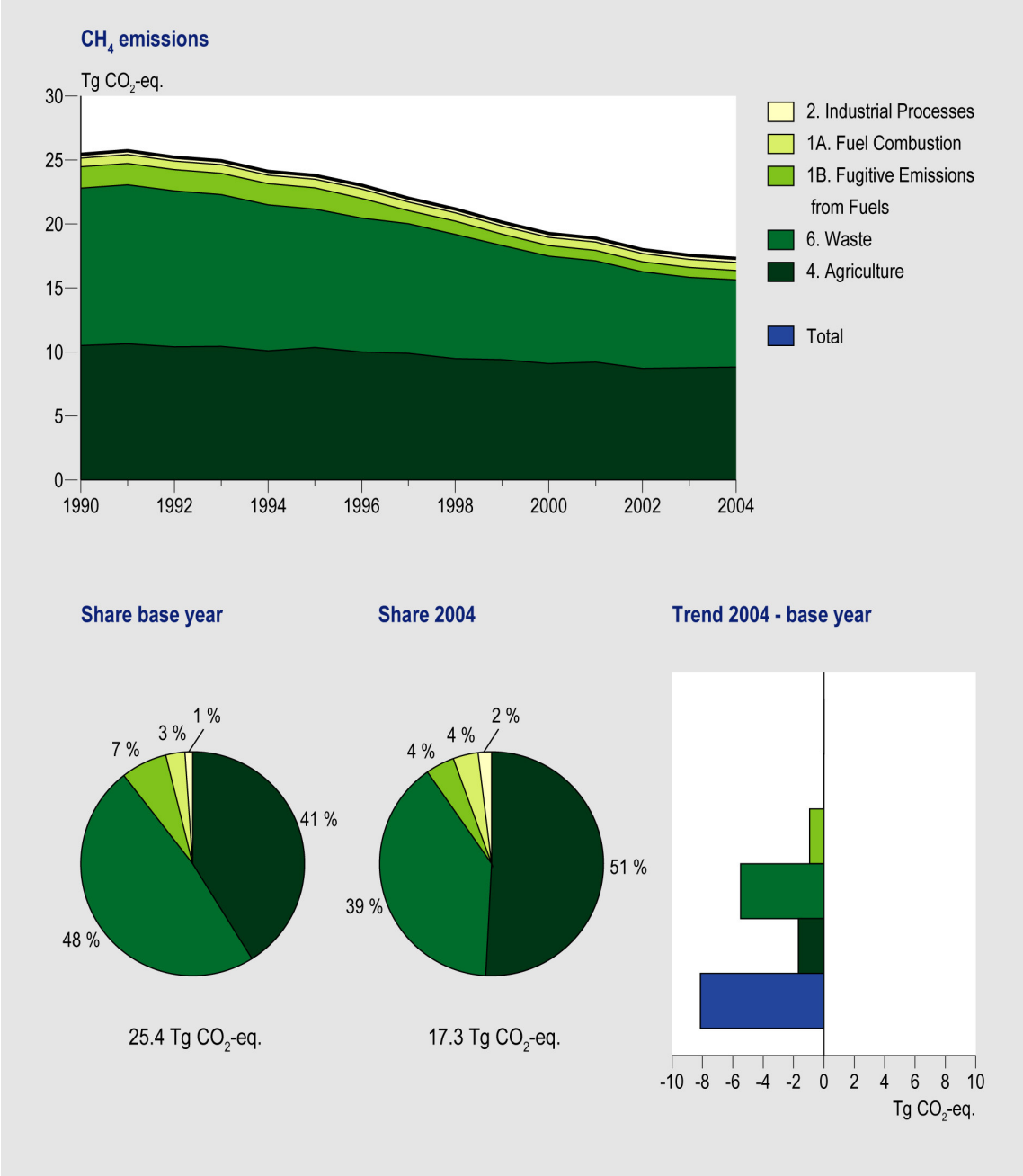


Figure 2.3 CH_4: trend, emission levels and share of sectors, 1990-2004.

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 16%, from 68 Gg in 1990 to 57 Gg in 2004 (from 21.2 to 17.7 Tg CO_2-eq.). Sectors contributing the most to this decrease in N_2O emissions are sectors 2 'Industrial Processes' (–17%) and 4 'Agriculture' (–18%). During the same period N_2O emissions from fossil fuel combustion increased. This latter trend can be largely clarified by increased emissions from *Transport*, which are partly compensated for by decreased emission levels from the Sectors *Industrial Processes* and *Agriculture*.

Total N_2O emissions increased by 2% from 2003 to 2004, an increase largely due to increased emissions from sector 2 'Industrial processes' (+1.2 Gg N_2O or +0.4 Tg CO_2-eq.) due to increased nitric acid production. N_2O emissions from sector 4 'Agriculture' remained stable between 2003 and 2004.

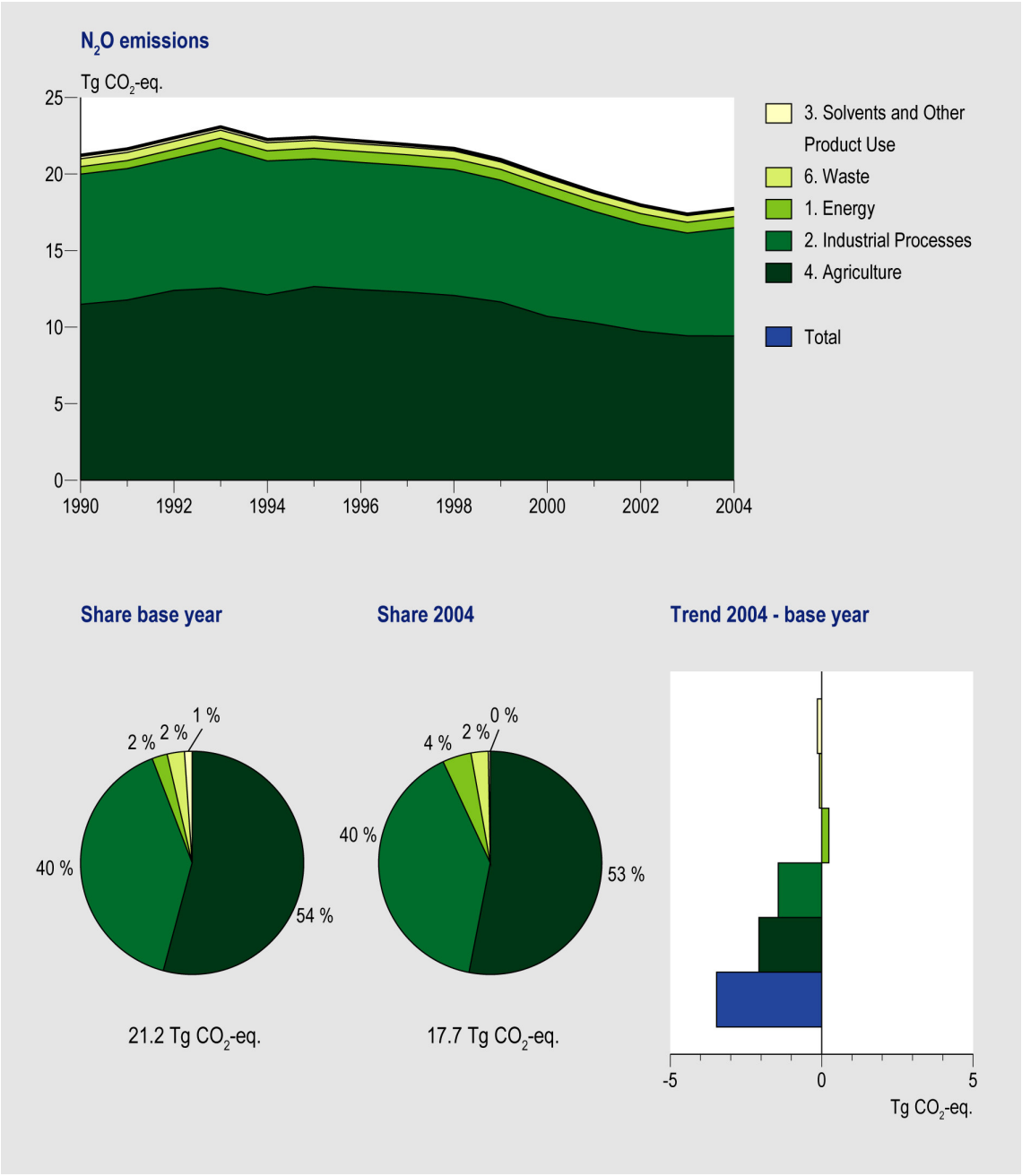


Figure 2.4 N_2O: trend, emission levels and share of sectors, 1990–2004.

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 75% between 1995 and 2004, from 8.3 Tg CO_2-eq. in 1995 (base year for F-gases) to 2.1 Tg CO_2-eq. in 2004. Emissions of HFCs and PFCs decreased by approximately 75% and 85%, respectively, during this same period, while SF_6 emissions increased by 9%.

The aggregated emissions of F-gases decreased by 7% from 2003 to 2004, mainly due to the large decrease in PFC14 (CF4) emissions. This decrease can be explained by decreased emissions from primary aluminium production; see *Section 4.4* for more details.

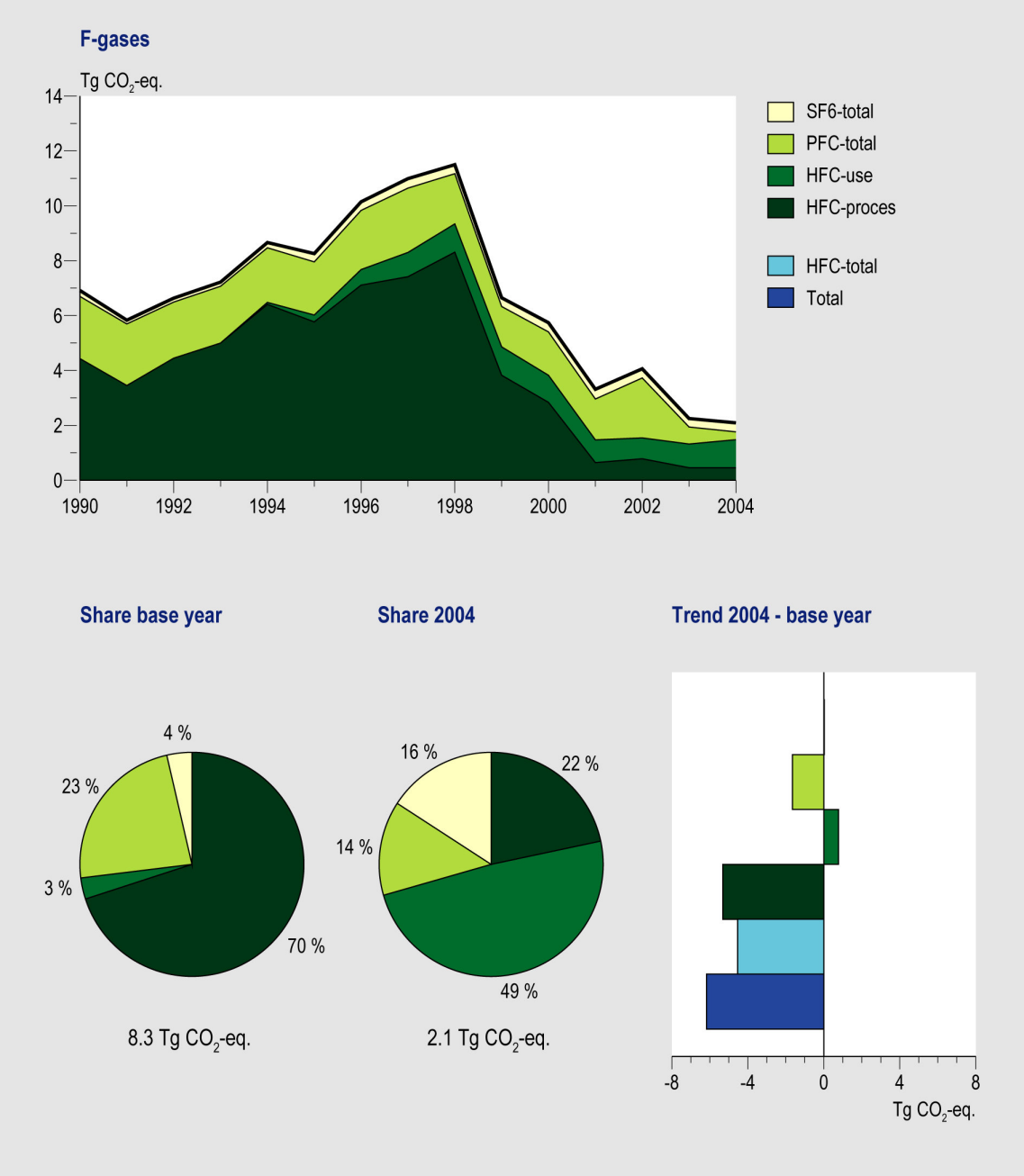


Figure 2.5 Fluorinated gases: trend, emission levels and share of individual F-gases, 1990–2004.

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 in the 2% increase, 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 ±3%-, ±11%-, ±15%- and ±7%-points, respectively. For all greenhouse gases taken together the uncertainty estimate in ***annual*** emissions is ±5% and for CO_2 ±3%. 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.

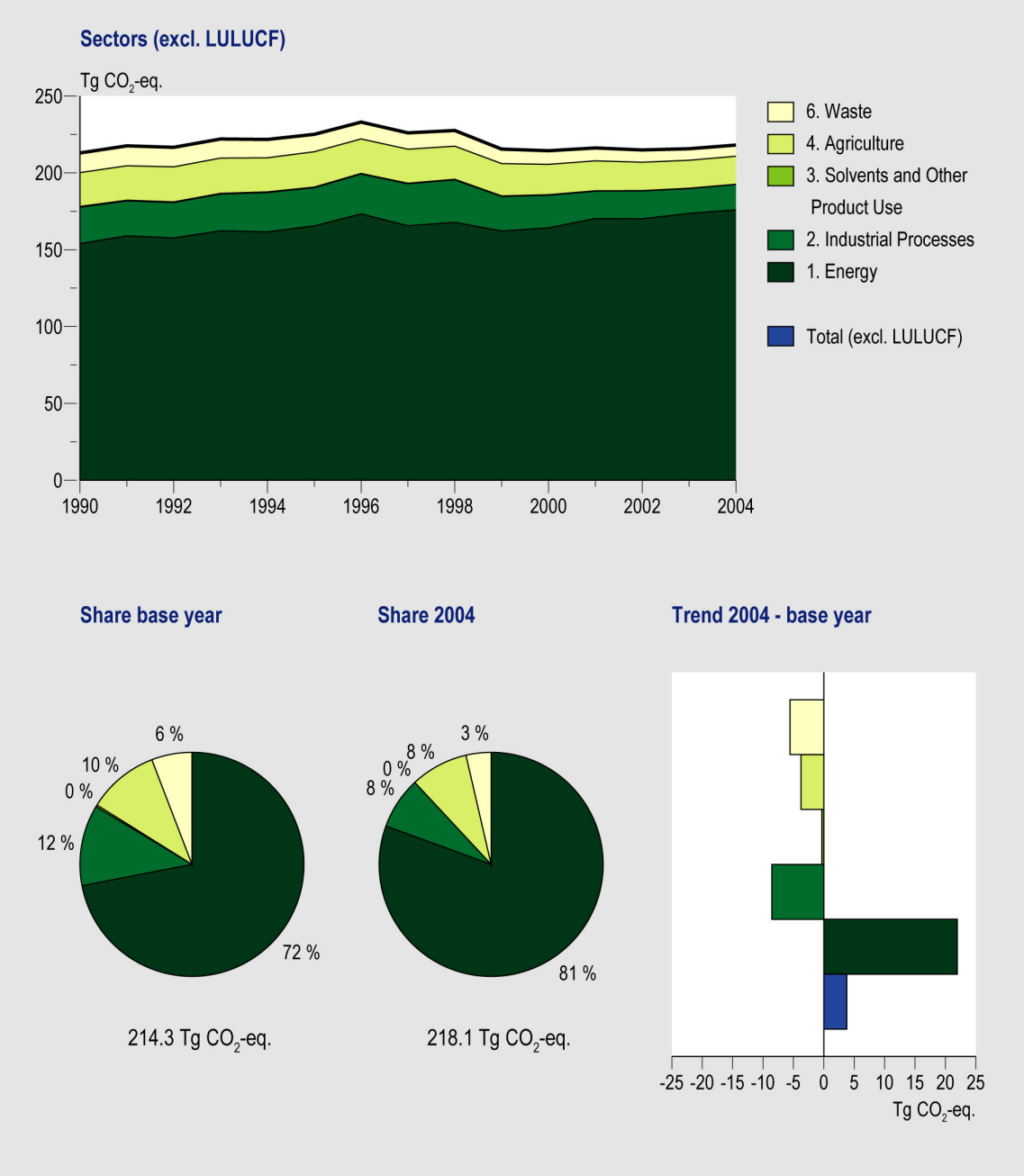


Figure 2.6 Aggregated greenhouse gases: trend, emission levels and share of sectors, 1990-2004.

The IPCC sector 1 *Energy* 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 2004). In contrast, the emissions from the other sectors decreased.

The emission level of the sector *Energy* increased approximately 14% in the period 1990–2004, and total greenhouse gas emissions from the sectors *Waste*, *Industrial processes* and *Agriculture* decreased 43%, 34%, and 17%, respectively, in 2004 compared to the base year. The following sections explain the reported emissions in more detail per relevant source category.

2.3.1 Energy sector [1]

Total greenhouse gas emissions from the *Energy* sector in 2004 are dominated by CO_2 emissions from category 1A 'Fuel combustion' (accounting for 98%), with the other emissions from this sector originating from 1B 'Fugitive emissions from gas and oil' (mainly CH_4 and CO_2). About 47% of the CO_2 emissions from fuel combustion stems from the combustion of natural gas, 18% from solid fuels

(coal) and 33% from liquid fuels. CH_4 and N_2O emissions from fuel combustion contribute less than 1% to the total emissions from this sector.

Category 1A1 'Energy industries' is the main source category contributing to the *Energy* sector, accounting for 40% of the greenhouse gas emissions from this sector in 2004. Categories 1A2 'Manufacturing and construction industries', 1A3 'Transport' and 1A4 'Other sectors' (residential, services and agriculture/fisheries) contributed 15%, 20% and 23% of the total emissions, respectively (see *Figure 2.7*).

Since 1990, emissions from the *Energy* sector have increased approximately 14% (154.0 to 175.9 Tg CO_2-eq.), mainly due to increased CO_2 emissions in categories 1A1 'Energy industries' (35%) and 1A3 'Transport' (34%). Emissions from 1A4 'Other sectors' have increased by 6%. Total *Fugitive emissions from oil and natural gas'* [1B] decreased by 52% in the period 1990–2004 (from 2.8 to 1.4 Tg CO_2-eq.), of which CH_4 emissions decreased by 56% and CO_2 by 46%.

Between 2003 and 2004, total *Energy* sector emissions increased by 1%, mainly as a result of increased emissions from gas combustion from category 1A1a 'Public electricity and heating'.

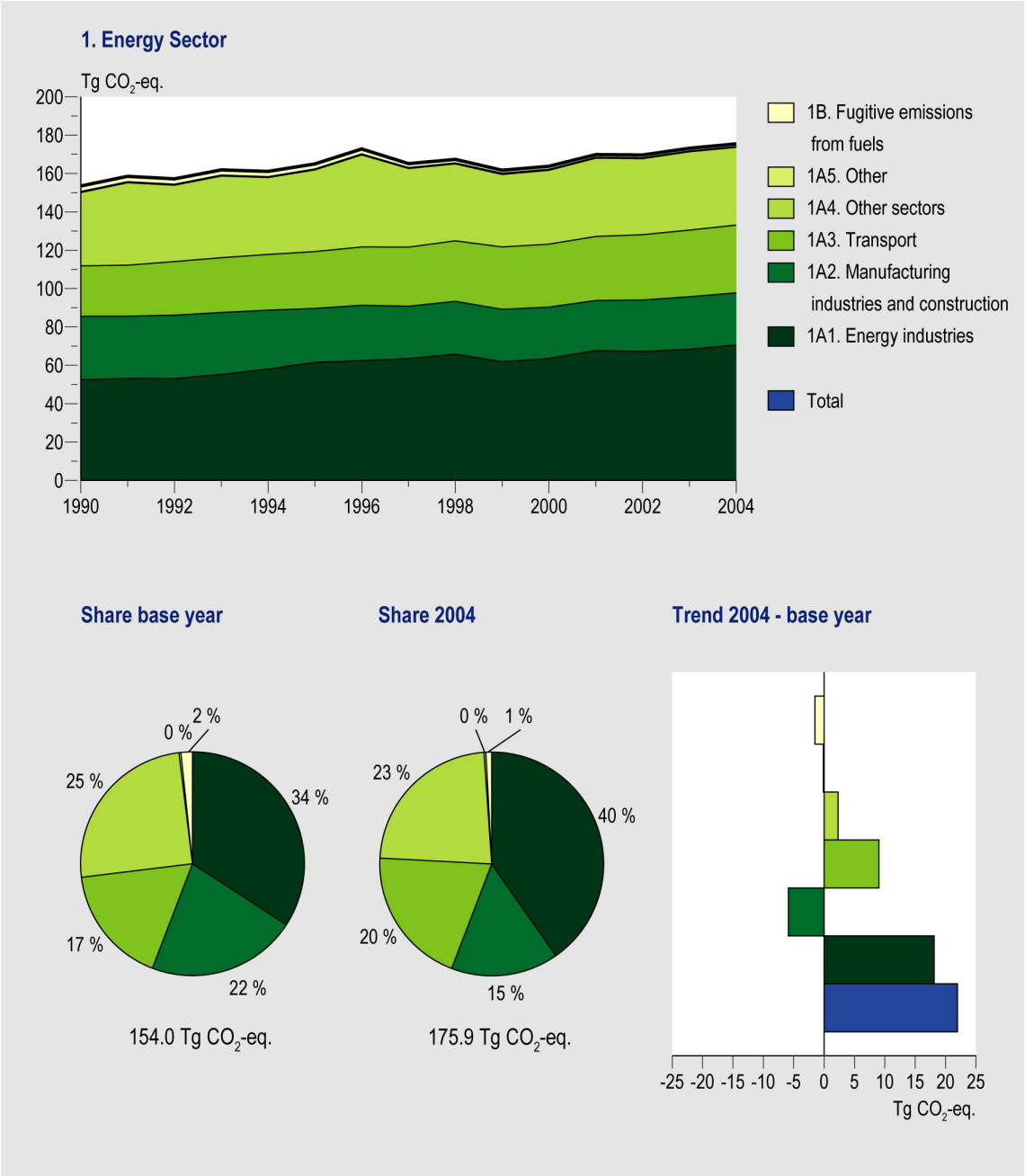


Figure 2.7 Sector 1 'Energy': trend, emission levels and share of source categories in sector 1, 1990-2004.

Energy industries [1A1]

In 2004 CO_2 emissions from category 1A1 'Energy industries' contributed 33% to the total national greenhouse gas emission inventory (excluding LULUCF) compared to 25% in 1990, while CH_4 and N_2O emissions from this same category standardly contribute relatively little to the total national greenhouse gas emissions. The share contributed by 1A1 'Energy industries' to the total greenhouse gas emissions from *Energy* sector increased from 34% in 1990 to 40% in 2004 (see *Figure 2.7*).

Between 1990 and 2004, total CO_2 emissions from 1A1 'Energy industries' increased 35%, from 52.5 to 70.6 Tg (see *Figure 2.8*). Due to an increasing demand for electricity, 1A1a 'Public electricity and heat production' (+16.9 Tg CO_2), is the most important source category responsible for the increased emissions in the category 1A1 'Energy industries'.

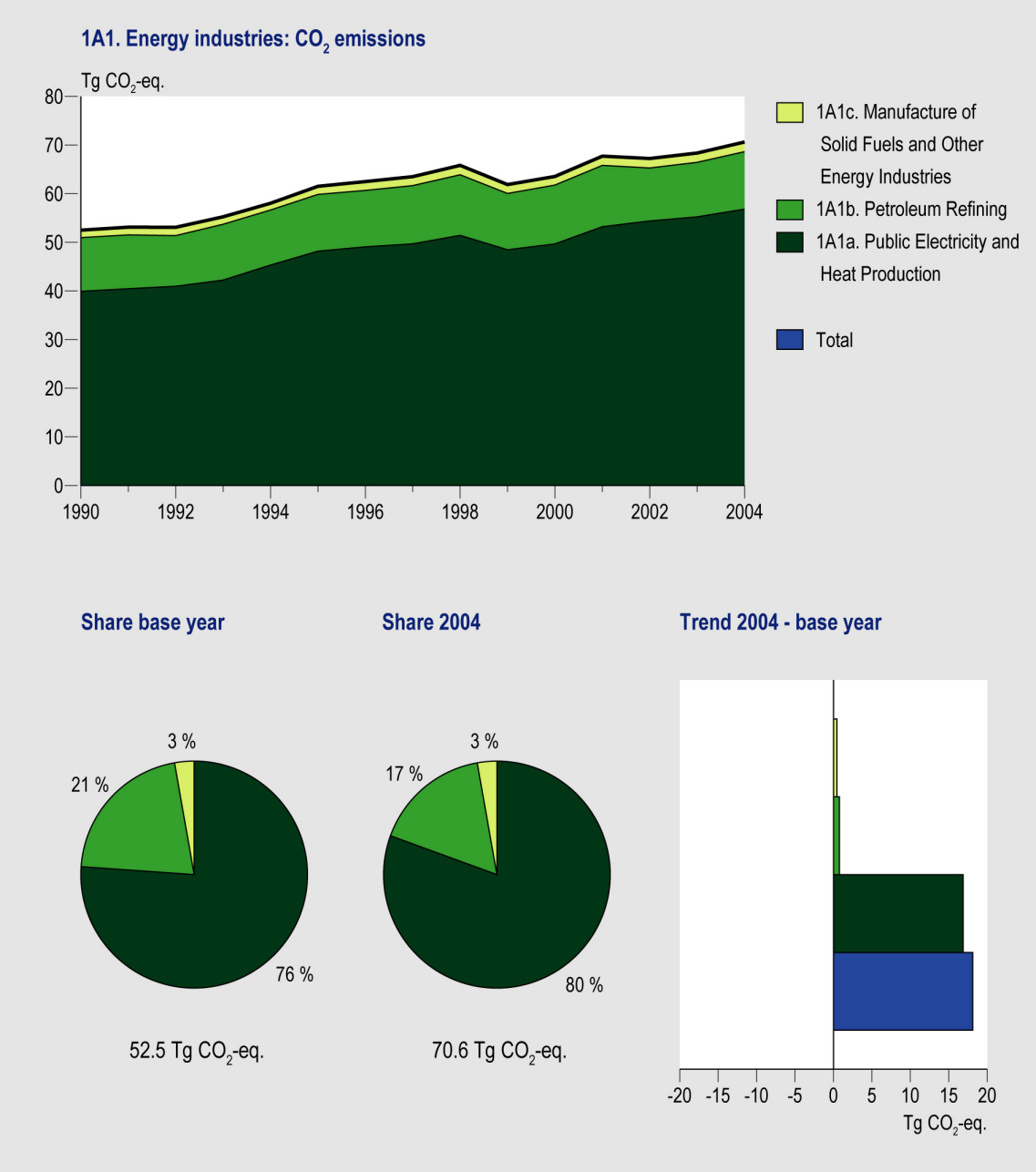


Figure 2.8 1A1 'Energy industries': trend, emission levels and share of source categories in 1A1, 1990-2004.

Public Electricity and Heat Production [1A1a]
In 2004, 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 sector (compared to 76% in 1990) *(*see *Figure 2.8)*. CO_2 emissions from waste incineration of fossil carbon represent only a few percent of the total greenhouse gas emissions in 1A1a *Public electricity and heat production*.

Between 1990 and 2004, total CO_2 emissions from 'Public electricity and heat production' increased by 42%, from 39.9 to 56.8 Tg. This increase in CO_2 emissions are 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 2.1 Tg CO_2 due to the increasing amounts of municipal waste that are combusted instead of being used for land-fill. 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 co-generation plants from *Manufacturing industries* [1A2] 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.

Figure 2.8 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 period 1990–1998 and 2000 and thereafter. In actual fact, electricity consumption in the Netherlands was in 1999 2% higher than in 1998 (see *Section 3.3.1*). 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 residual chemical 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.

In 2001 the net import of electricity once again decreased, but the effect on CO_2 emissions was compensated by the increased electricity production by the *Public electricity* sector from gas and coal combustion. In 2004, CO_2 emissions increased 3% compared to 2003. This increase is explained by an 8% increase in gas combustion, partially due to the start-up of a large new gas-fired 790 MW co-generation plant in June 2004 and to a 2% decrease in coal combustion in this source category.

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 17% in 2004. Between 1990 and 2004 total CO_2 emissions from the refineries fluctuated between 11 and 12 Tg (11.0 Tg in 1990 and 11.8 Tg in 2004).

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 2004. This category comprises mostly CO_2 emissions from the combustion of natural gas. The dominating source is the use for energy purposes of oil and gas production and the transmission industry. CO_2 emissions from this source category increased from 1.5 Tg in 1990 to 2.0 Tg CO_2 in 2004 due to the exploitation of less favourable production sites compared with those exploited in the past.

Manufacturing and construction industries [1A2]
In the period 1990–2004, CO_2 emissions from combustion in 1A2 'Manufacturing and construction industries' decreased 18% (from 33.0 to 27.2 Tg; see *Figure 2.9*). The chemical industry contributes the most to this decrease in emissions in this source category, with its contribution to CO_2 emissions decreasing by 31%, or 5.4 Tg. When the re-allocations of CO_2 emissions to the *Energy industry* due to the above-mentioned 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*).

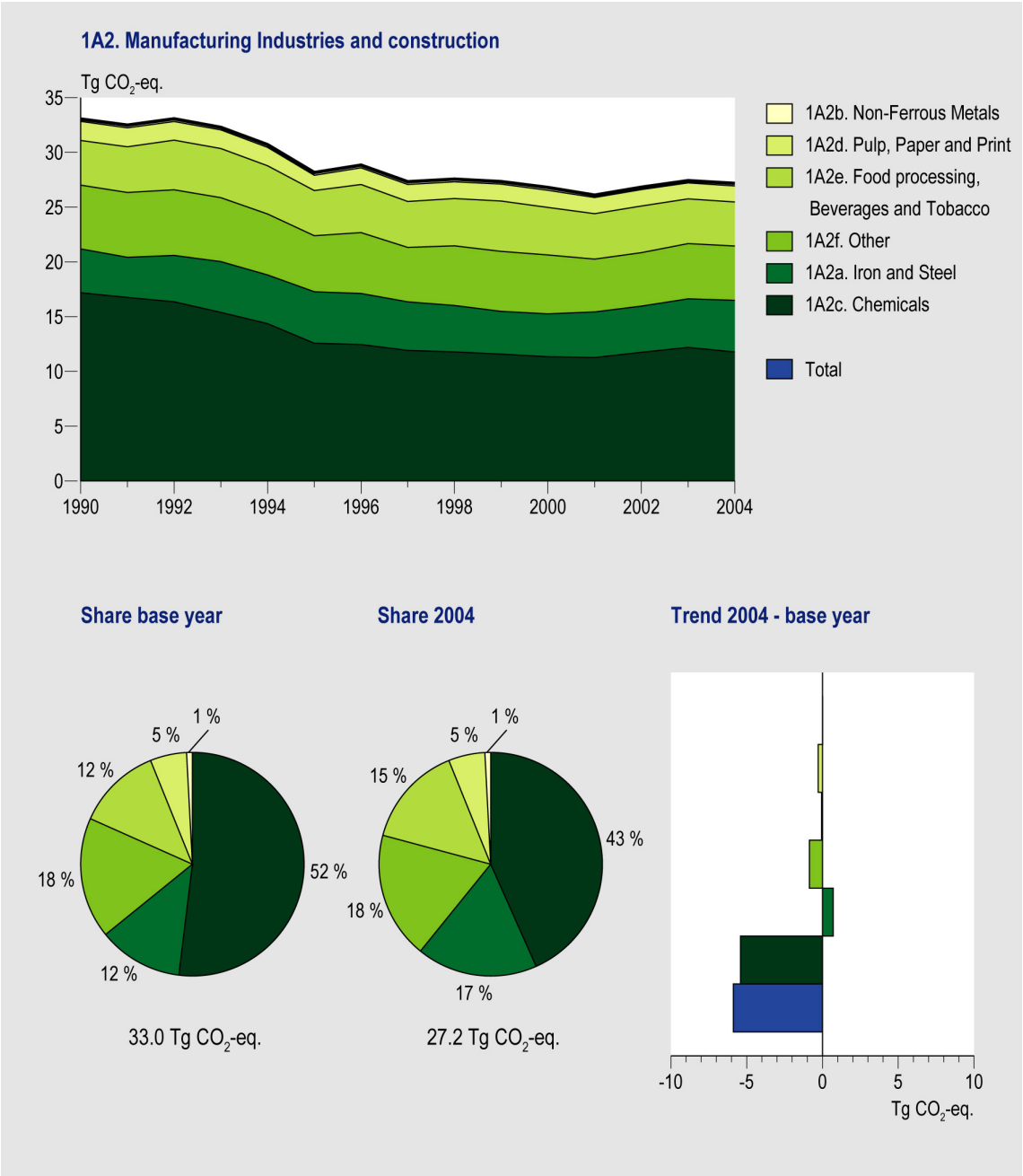


Figure 2.9 1A2 'Manufacturing and construction industries': trend, emission levels and share of source categories in 1A2, 1990-2004.

In 2004 the share of CO_2 emissions from 1A2 'Manufacturing and construction industries' in the total national greenhouse gas emission inventory was estimated to be 13% compared to 15% 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 52% in 1990 and 43% in 2004 of the total emissions from the manufacturing industry.

Total CO_2 emissions from 1A2 *'Manufacturing and construction industries'* in 2004 remained stable compared to the level estimated for 2003. The increased emissions from solid fuel combustion in 1A2a 'Iron and steel industry (+12%) were largely compensated by the decreased emissions from gas combustion in 1A2c 'Chemical industry' (–3%) and from fossil fuel use in 1A2e 'Food processing, beverages and tobacco industry' (–2%).

Iron and Steel [1A2a]
The contribution of 1A2a 'Iron and steel' to the CO_2 emissions from 1A2 'Manufacturing and construction industries' was about 12% in 1990 and 17% in 2004. Interannual 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 2004 CO_2 emissions from solid fuel combustion of the iron and steel industry increased by about 0.3 Tg CO_2 compared to the 2003 level.

Non-ferrous metals [1A2b]
This small source category only contributes about 0.2 Tg CO_2 to the total national greenhouse gas inventory, predominantly from the combustion of natural gas. Energy use in the aluminium industry is largely based on electricity, the emissions of which are included in 1A1a 'Public electricity and heat production.

Chemicals [1A2c]
The contribution of 1A2c 'Chemical industry' to CO_2 emissions from 1A2 'Manufacturing and construction industries' decreased from 52% in 1990 to 43% in 2004. The combustion of natural gas and liquid fuels, both account for approximately 50% in the CO_2 emissions from the *Chemical industry* (see *Table 3.6*). CO_2 emissions from this source category have decreased by approximately 31% since 1990, which can be correlated with the 41% decrease in the consumption of natural gas during the same period.

In 2004 the combustion of natural gas in this source category decreased by 1% compared to 2003. The steady decline in the amount of natural gas used for combustion by the chemical industry can be explained largely by the decreasing use of fuels for combustion and the re-allocation of the emissions to 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 1990–2004. 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 and construction industries' is estimated to be approximately 5% in both 1990 and 2004. In line with the decreased consumption of natural gas, predominantly due to its decreased use for combustion purposes, CO_2 emissions have decreased approximately 16% since 1990, of which a large fraction (approximately 65%) is used for co-generation. CO_2 emissions in 1995 are relatively low, which can be explained by re-allocation of emissions to the energy sector due to the above-mentioned formation of joint-ventures.

Food Processing, Beverages and Tobacco [1A2e]
The contribution of 1A2e 'Food processing, beverages and tobacco industries' to CO_2 emissions from 1A2 'Manufacturing and construction industries' was 12% in 1990 and 15% in 2004. The CO_2 emissions, which originate largely from the combustion of natural gas, remained almost constant in the period 1990–2004: the 9% increase in gas consumption since 1990 is compensated by the decrease use of other fuels for combustion. In 2004 CO_2 emissions from fossil fuel combustion in this source category decreased about 2% compared to the 2003 level.

Other [1A2f]
The share of category 1A2f 'Other' (including construction and off-road) in the CO_2 emissions from 1A2 'Manufacturing and construction industries' was approximately 18% in 1990 and 2004. Most of the 5 Tg CO_2 emissions from this source category stem from gas combustion (about 3.5 Tg), while almost all of the remaining CO_2 emissions are associated with the combustion of liquid fuels (1–2 Tg CO_2), of which off-road machinery accounts for 0.7–1.4 Tg CO_2. A very small part (0.2 Tg) is emitted by co-generation plants.

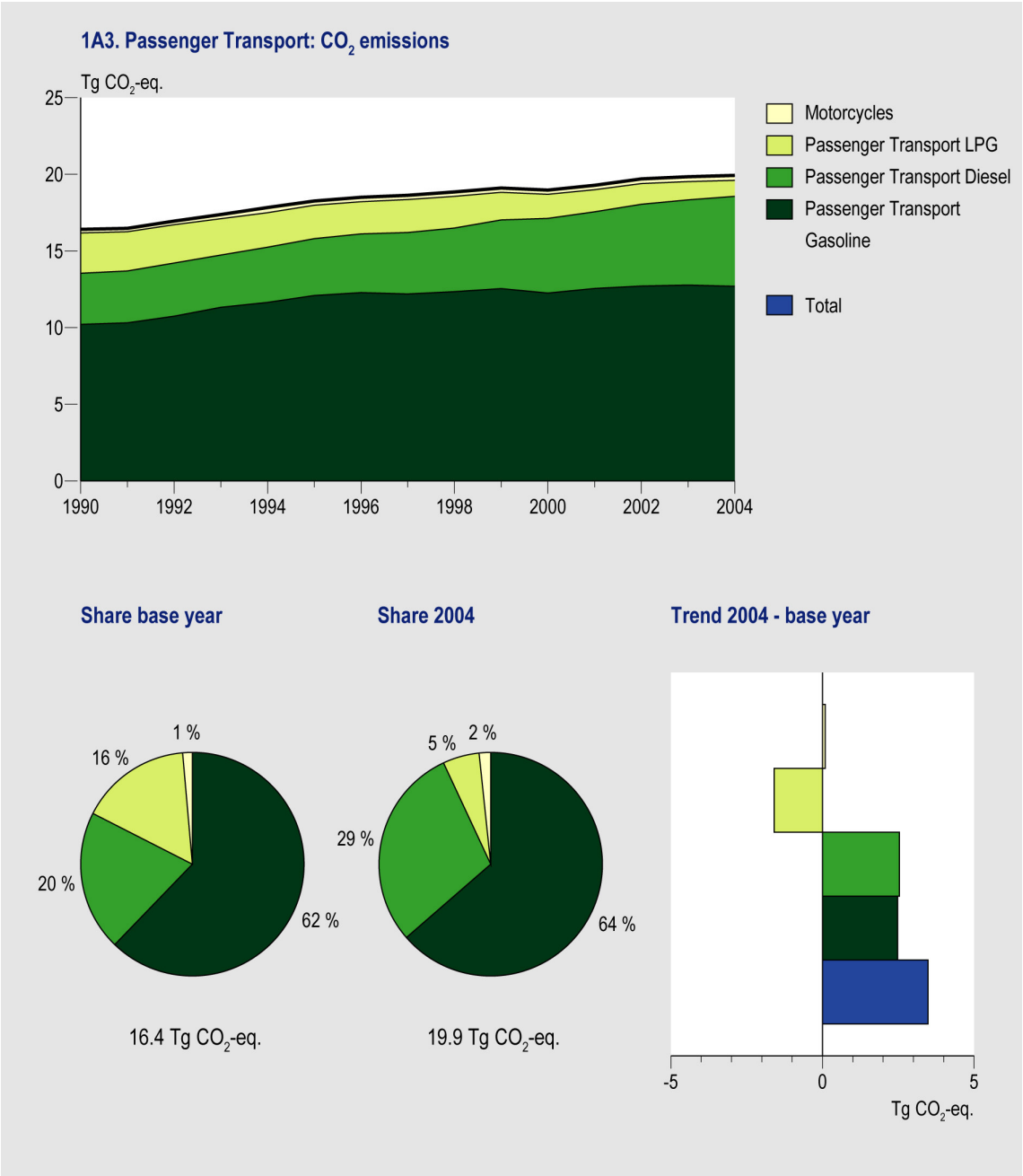


Figure 2.10 Category 1A3 'road transport': passengers: trend, emission levels and share of source categories in 1A3b 'Road transport-passengers', 1990-2004.

Transport [1A3]

Between 1990 and 2004, total greenhouse gas emissions from 1A3 'Transport' increased 34%, from 26.4 Tg CO_2 equivalents in 1990 to 35.4 Tg CO_2 equivalents in 2004. The greenhouse gas emissions from the transport sector are summarised in *Figures 2.10 and 2.11*. CO_2 emissions from 1A3b 'Road transport' prevail in this category (more than 97% during the whole period), N_2O emissions in the *Energy* sector are also caused by this source category. In the period 1990–2004, total CO_2 emissions from 1A3 'Transport' increased 34%, mainly due to the 33% increase in fuel consumption by road transport.

Civil aviation [1A3a]

The contribution of 1A3a 'Civil aviation' to the national inventory of CO_2 emissions was less than 1% in both 1990 and 2004. Domestic aviation in The Netherlands emitted 0.04 Tg CO_2 in both 1990 and 2004.

Road transport [1A3b]
The contribution of 1A3b 'Road transport' to the national inventory of CO_2 emissions was 16% in 1990 and 19% in 2004. By far the largest contributors to this source category are passenger cars, which account for 64% in 1990 and 59% in 2004 (*Figure 2.10*). The share of CO_2 emissions contributed by freight transport to the total CO_2 emissions from road transport increased from 36% in 1990 to 41% in 2004.

CO_2 emissions from road transport increased by 8.4 Tg (33%) to 33.8 Tg in 2004. This increase is mainly caused by the increased use of passenger cars (+21%, or 3.5 Tg) and vans (+140%, or 3.4 Tg).

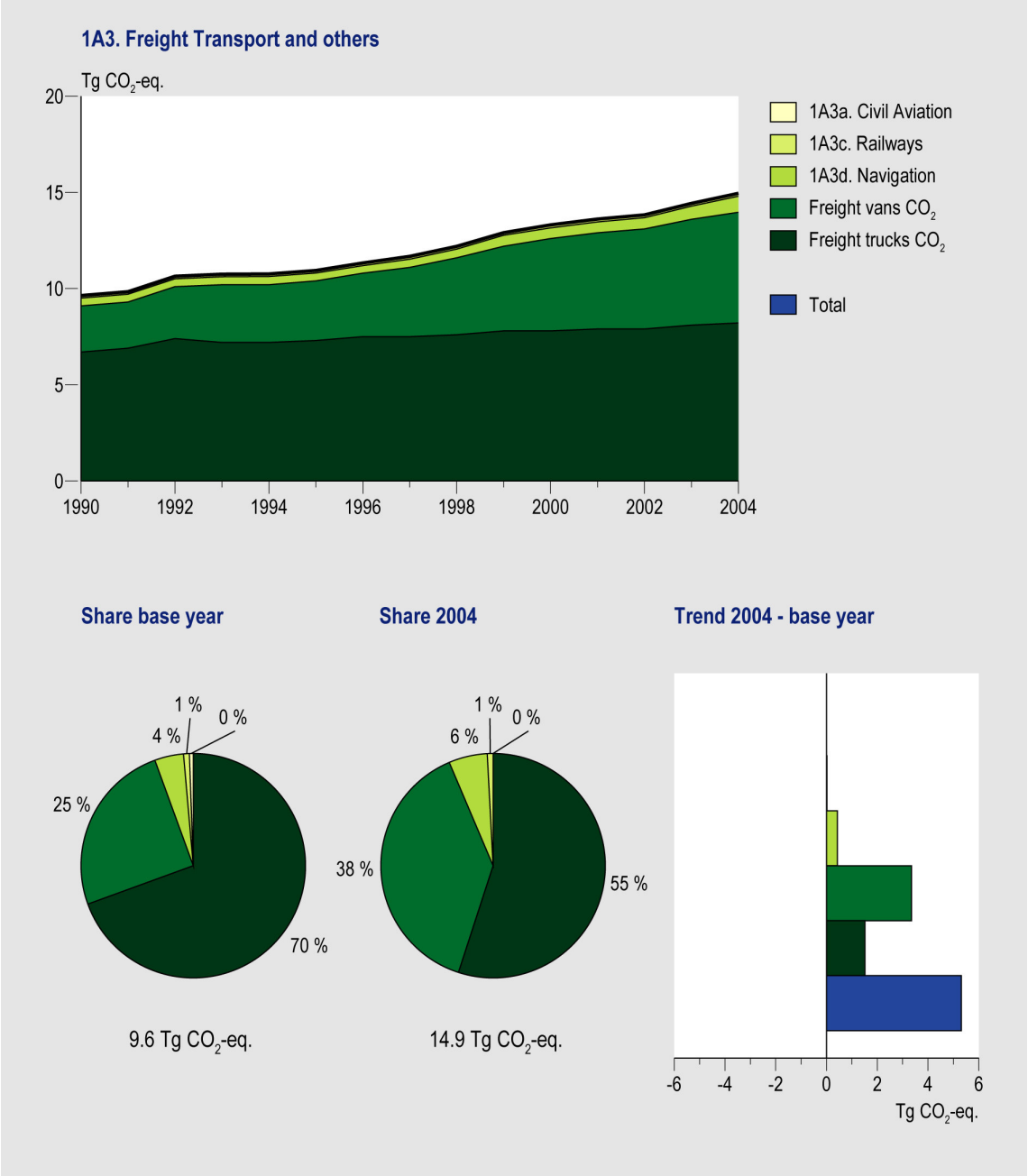


Figure 2.11 Category 1A3b' freight transport': trends, emission level and share in the emissions of source categories in 1A3b' freight transport', 1990-2004.

In addition, the energy efficiency of both passenger cars and vans did not rise significantly between 1990 and 1999. European, Korean and Japanese car manufacturers are committed to the sale of new cars in the European Union in 2008 that emit 25% CO_2 per kilometre less than in those sold in 1995. While this commitment has probably led to a slight decrease in average fuel use per kilometre driven in the last few years, this supposition cannot be proven because data on car use have become more and more uncertain since 1999. In 1999 Statistics Netherlands cancelled the annual passenger car use survey that supplied data on car use and fuel efficiency per fuel type.

CH_4 emissions from road transport fell by almost 57% between 1990 and 2004: this translates to a decrease in CH_4 emissions from 7.5 to 3.2 Gg. In 2004 passenger cars accounted for 66% of the total CH_4 emissions from road transport. This reduction is correlated to a reduction in total VOC emissions that has resulted from the implementation of European Union emission legislation for new road vehicles: total combustion and fugitive VOC emissions by road transport decreased by approximately 50% during the period 1990–2004, primarily due to the effect of the increasing number of catalyst-equipped passenger cars on the road.

N_2O emissions from road transport increased from 0.9 Tg in 1990 to 1.6 Tg N_2O in 1999 and remained more or less constant between 1999 and 2004. The increasing trend up to 1999 can be explained by the increased kilometres driven per vehicle and the increasing proportion of petrol cars equipped with a catalytic converter as such vehicles have a higher emission factor than cars without this emission control technology. The fact that N_2O emissions from transport remained constant between 1999 and 2004, despite the increase in vehicle kilometres, can be explained from a mix of developments:

- subsequent generations of catalytic converters appear to have lower N_2O emission factors;
- the share of diesel cars in road passenger transport, which are assumed to have a lower emission factor than catalyst-equipped petrol cars, has increased over the last few years.

Rail transport [1A3c]
The share of 'Rail transport' (1A3c) in national CO_2 emissions was less than 1% in 1990 and 2004.

Navigation [1A3d]
The share of 'Domestic waterborne navigation' (1A3d) in national CO_2 emissions was small (0.5%) in both 1990 and 2004. Emissions are estimated to be approximately 0.4 Tg in 1990 and 0.8 Tg CO_2 in 2004.

Other sectors [1A4]
The share of CO_2 emissions from 1A4 'Other sectors' in the national total inventory of greenhouse gas emissions (in CO_2-equivalents) was approximately 18% in 1990 and 2004, with the residential sector alone having a share of about 9%. The contribution of CH_4 and N_2O to the total national inventory is relatively small. About 70% of the CH_4 emissions (0.4 Tg CO_2-eq.) stem from residential gas combustion, particularly losses during cooking. The second largest source of CH_4 is the combustion of biofuels in the residential sector. CH_4 and N_2O emissions from 1A4 'Other sectors' remained constant in the period 1990–2004.

CO_2 emissions of 1A4 'Other sectors' increased 2.3 Tg or 6% in the period 1990–2004. The main contributor this increase is 1A4a 'Commercial/Institutional' (*Figure 2.12*), for which emissions increased approximately 51% (from 7.5 Tg to 11.5 Tg CO_2). This increase is partially compensated by the 11% (1.2 Tg) decrease in emissions from 1A4c 'Agricultural'. The increased emissions from 'Commercial/Institutional' can be explained by the strong growth of this category during this period. 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 emissions from category 1A4c (total CO_2 emissions from 1A4c: approximately 9.6 Tg CO_2). CO_2 emissions from 1A4b 'Residential' remained almost constant during this period, largely due to the improved insulation of dwellings and increased efficiency of heating apparatuses (increased use of high-efficient boilers for central heating) (see *Section 3.6.1*).

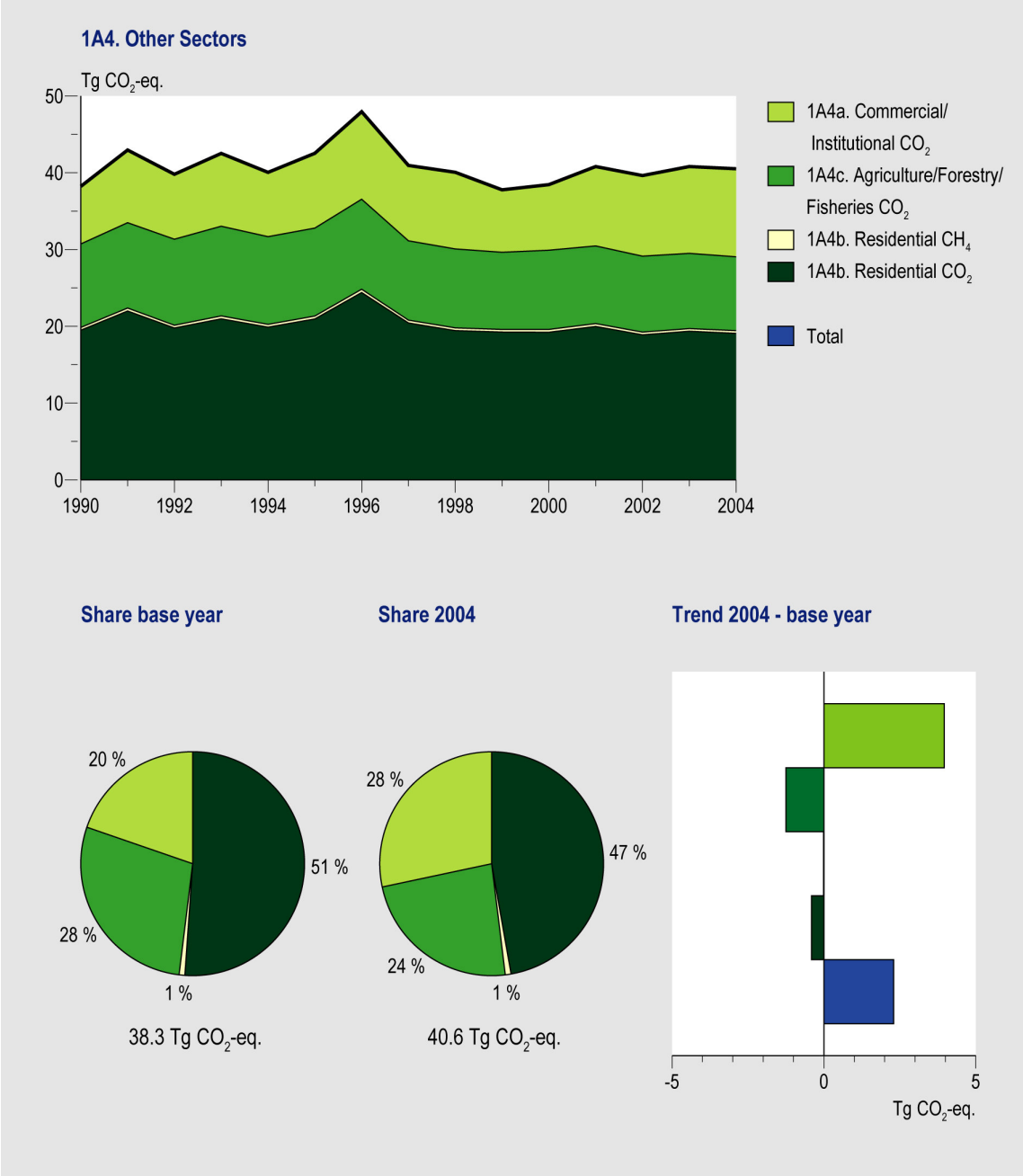


Figure 2.12 Category 1A4: trend, emission levels and share of source categories in emissions of 1A4 'Other sectors', 1990-2004.

The CO_2 emissions from the 'Other sectors' tend to vary considerably across years due to variations in weather patterns over time (warm versus cold winters), thereby necessitating either more or less space heating depending on the weather. The residential sector in particular is quite sensitive to weather conditions since the largest part of the fuel use in this sector is related to space heating. The greenhouse gas emissions in 1996 are relatively high due to the relatively cold winter in that year.

In 2004 CO_2 emissions from 1A4 'Other sectors' decreased by 1% compared to the 2003 level due to decreased gas combustion (1%) in the residential and service sectors.

Other combustion [1A5]

Category 1A5 'Others' includes the emissions from military ships and aircraft (under 1A5b).

The CO_2 emissions from this source category are about 0.5 Tg, with some interannual variation caused by different levels of operations. The emissions of CH_4 and N_2O are negligible.

Fugitive emissions from fuels [1B]

The contribution of emissions from category 1B to the total national greenhouse gas emissions inventory was 1.3% in 1990 and 0.6% in 2004. CO_2 and CH_4 emissions in this category contribute 47% and 53%, respectively, to source category 1B. Between 1990 and 2004 total greenhouse gas emissions in this category decreased from 2.8 Tg to 1.4 Tg. The decrease in CO_2 and CH_4 emissions from oil and gas production resulted from the implementation of environmental measures aimed at reducing venting and flaring, while the reduction in CH_4 emissions from gas distribution is due to the gradual replacement and expansion of the pipeline network.

2.3.2 Industrial processes [2]

Figure 2.13 shows the trends in total greenhouse gas emissions from the sector *Industrial processes.* In 2004 *Industrial processes* contributed 8% to the total national emissions (without LULUCF) in comparison to 12% in 1990.

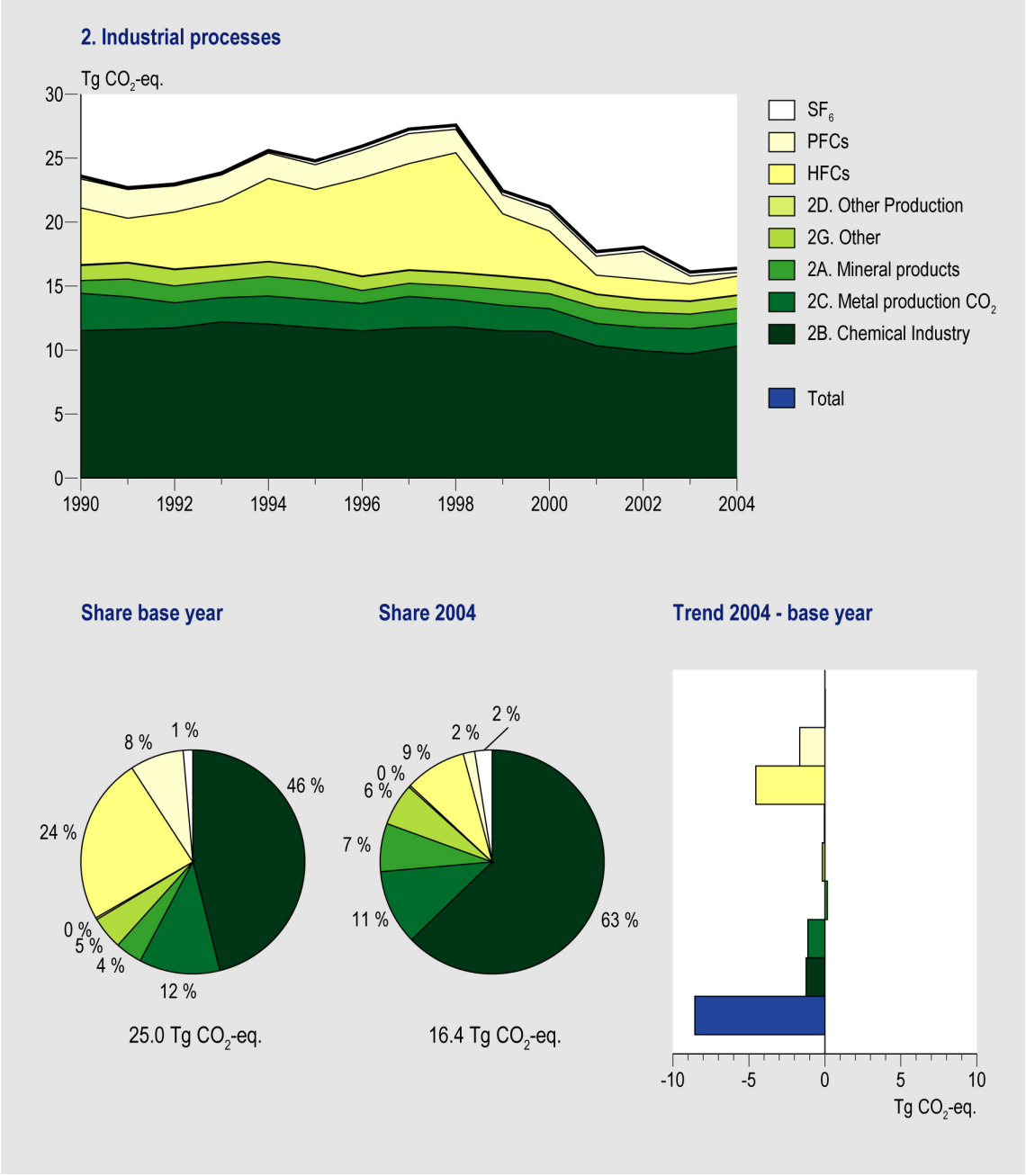


Figure 2.13 Sector 2 'Industrial processes: trend', emission levels and share of source categories in emissions from industrial processes, 1990-2004.

CO_2 and N_2O emissions accounted for 42% and 43%, respectively, of the total CO_2-equivalent emissions from sector 2 *Industrial processes*. In 2004 CH_4, HFCs, PFCs and SF_6 emissions accounted for 2%, 9%, 2% and 2%, respectively, of the total CO_2-equivalent emissions from the sector. Emissions of N_2O from *Industrial processes* accounted for 40% 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 8.6 Tg to 16.4 Tg CO_2-eq. in 2004 (–34%). This is mainly caused by the decreasing HFC emissions (75% reduction since 1995), which is primarily due to decreased HFC-23 emissions from HCFC-22 manufacture.

Total CO_2 emissions from *Industrial processes* decreased 12% during the period 1990–2004, mainly due to decreased emissions from iron and steel production (carbon inputs). N_2O emissions decreased 17% in the same period, largely as a result of the 20% decrease in emissions from nitric acid production that continued up to 2003. In 2004 the production of nitric acid increased, resulting in an 11% increase in N_2O emissions relative to the 2003 level.

Total emissions of fluorinated gases (F-gasses) have been strongly reduced due to a substantial reduction in by-product HFC emissions: an afterburner was installed at the HCFC-23 production plant in 1998. PFC emissions are strongly reduced due to the switch from side feed to point feed technology by two aluminium producers in 1998 and in 2002/2003. HFC and PFC emissions from the *use* of these compounds increased substantially over time as a result of their substitution for traditional (H)CFCs and halons.

Mineral products [2A]

In 1990 and 2004 CO_2 emissions from 2A 'Mineral products' contribute approximately 0.5% to the total national greenhouse gas emission inventory. N_2O and CH_4 emissions are not included in this category.

2A1 'Cement clinker production', 2A3 'Limestone and dolomite use', 2A4 'Soda ash production and use' and 2A7 'Other' (glass production) contributed 45%, 30%, 17% and 25%, respectively, to the emissions of category 2A. Total CO_2 emissions (1.0 Tg in 1990 and 1.2 Tg in 2004) in category 2A have remained stable since 1990, since the activities of the industries in this category have not changed structurally.

Chemical industry [2B]

Figure 2.14 shows the trend in CO_2-equivalent emissions from 2B 'Chemical industry' in the period 1990–2004. Emissions from this category contributed 5% to the total national emissions (without LULUCF) in 1990 and 2004. The contribution of CO_2 emissions from category 2B 'Chemical industry' to the total national CO_2 emissions is 2%, primarily from 'Ammonia production' (2B1). The contribution of N_2O emissions from 2B 'Chemical industry' to the total national N_2O emissions was 36% in 1990 and 2004 (3% to the total national greenhouse gas emission inventory).

The trend shown by CO_2 emissions from 'Ammonia production' and production of 'Other chemicals' is generally smooth, with a few exceptions. Most interannual variations relate basically to conjunctural changes. Increased emissions in 1995 and decreased emissions in 1998 from the production of 'Industrial gases' (included in 2B5) can be explained by the inclusion of the combustion of phosphorous oven gas as fuel since 1998. This causes a re-allocation of emissions included in 2B5 to emissions from solids included in 1A2c. Increased emissions since 2001 are due to a switch to the use of petroleum cokes.

Nitric acid production is the most important source of N_2O emissions from industrial processes in The Netherlands. N_2O emissions from 2B 'Chemical industry' remained rather constant during the period 1990–2000 since no policy to control emissions was implemented (see also *Table 4.2*). In 2001 technical measures were implemented at one of the nitric acid plants, resulting in an 8% reduction in emissions compared to 2000.

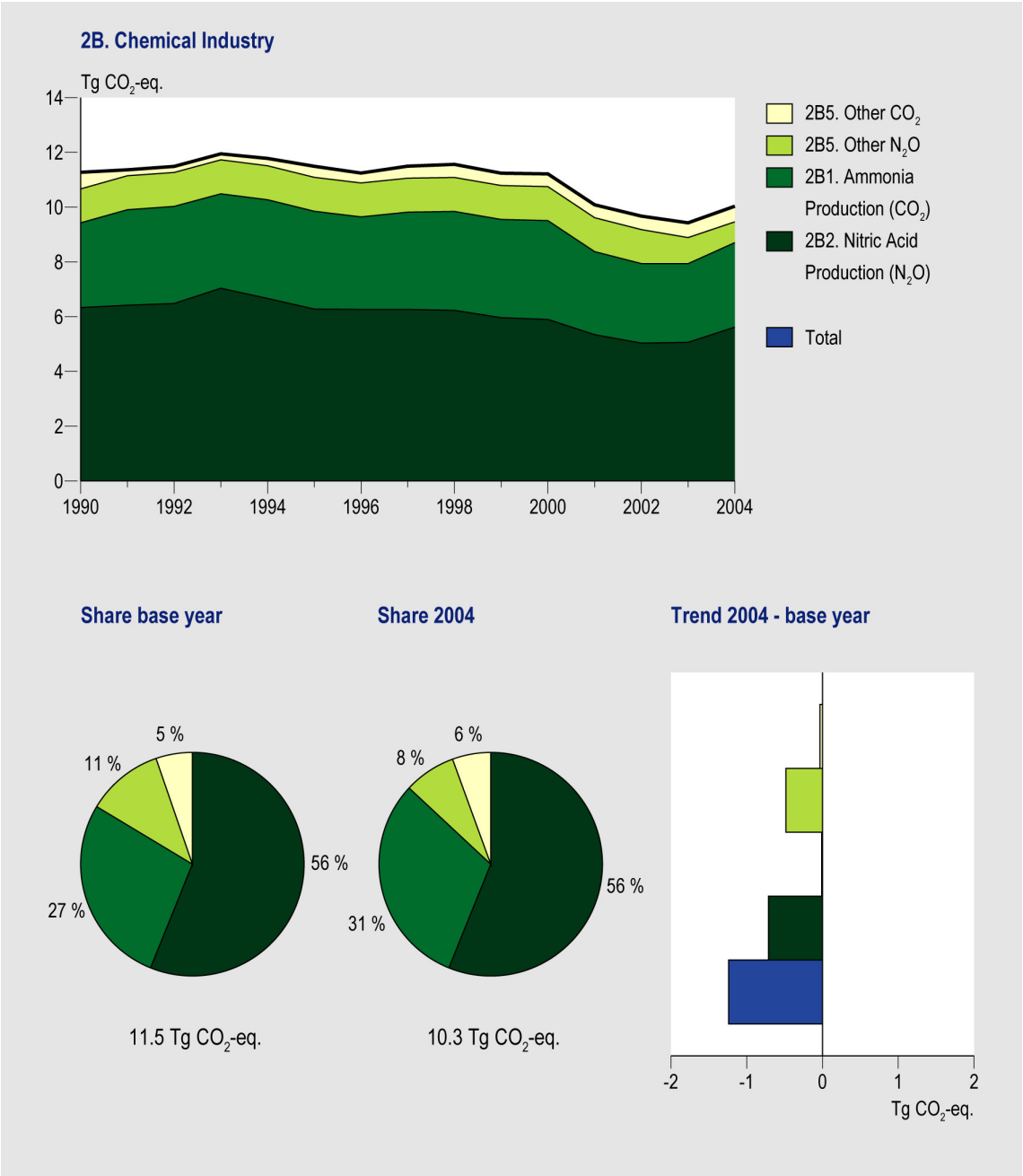


Figure 2.14 Category 2B 'Chemical industry: trend', emission levels and share of source categories in emissions from 2B 'Chemical industry', 1990-2004.

The 6% decrease in emission level from 2001 to 2002 is related to the decreased production level of nitric acid in that year. In 2003 emissions and production did not fluctuate relative to preceding years, while in 2004 emissions are higher due to the marked increase in production.

In 2003 and 2004 the measurements performed to estimate N_2O emissions from *Caprolactam production* (2B5) were more accurate, which resulted in a 25% reduction in emissions compared to levels reported in preceding years. The emissions reported for the time span prior to 2003 and 2004 are based on measurements made in the mid-1990s and are believed to be more representative for the years before 2003 than the more recently measured data. In 2004, emissions from *Caprolactam production* decreased 20% from 1.0 Tg in 2003 to 0.8 Tg CO_2-eq. in 2004.

Finally, minor CH_4 emissions are estimated for the production of carbides, carbon black, ethylene, dichloro-ethene, styrene and methanol.

Metal production [2C]
The contribution of category 2C 'Metal production' to the total national greenhouse gas emission inventory was 2.2% in 1990 and 0.9% in 2004. In 2004 approximately 69% of this contribution consists of CO_2 emissions from 2C1 'Iron and steel production' and 6% of PFC emissions from 2C3 'Aluminium production'.

Total CO_2 emissions from 2C1 'Iron and steel production' decreased by 1.4 Tg during the period 1990–2004. The interannual variation in CO_2 emissions from 'Iron and steel production' is influenced by the accuracy of the data provided on the blast furnace and on the oxygen furnace gas that is produced, as these data are used to subtract the carbon contents in order to estimate the process emissions included in 2C1. The net carbon losses calculated vary inversely with the amounts of by-product gases captured. Therefore, in order to show the consistency of total CO_2 emissions from 'Iron and steel production', total CO_2 emissions from steel production (including combustion emissions from on-site coke production) are presented together with the total CO_2/kton steel index in *Table 3.5*. The trend in total emissions follows the production index quite closely; efficiency improvements and stock changes affect the interannual variation.

PFC emissions have been strongly reduced since 1995. The share of PFC emissions from primary 'Aluminium production' in the national total PFC emissions was 98% in 1995 and 37% in 2004. PFC emissions from primary 'Aluminium industry' (2C3) decreased by 1.8 Tg CO_2-eq. between 1995 and 2004. Between 1995 and 2001, PFC emissions decreased by about 30% due to the switch from side feed to point feed in 1998 at one of the production companies; the other producer followed suit in 2003. The observed interannual changes relate to variations in annual production levels.

Production of halocarbons and SF_6 [2E]
Total HFC emissions in category 2E were 5.8 Tg in 1995 and 0.5 Tg CO_2-eq. in 2004, with HFC-23 emissions from HCFC-22 production being the major source of HFC emissions. Other HFC emissions from handling contributed 21% to the total HFC emissions from this category in 2004.

HCFC-22 production increased during the period 1995–1998, resulting in increased emissions of HFC-23 (35%). However, between 1998 and 2000 the emission of HFC-23 decreased by 69% following the installation of a thermal afterburner. The operation time of this thermal afterburner is the main causal factor of the varying emission levels between 2000 and 2002. The decreased emissions (33%) in 2003 can largely be explained by a lower production level. Despite a higher production level in 2004, the emissions remain stable because the operation time of the thermal afterburner increased – from 92% in 2003 to 96% in 2004. The large interannual variation of handling emissions can be explained by variation in handling activities over time.

Consumption of halocarbons and SF_6 [2F]
The contribution of HFC emissions from category 2F to the total national inventory of F-gas emissions was 3% in the base year 1995 and 49% in 2004. This corresponds to 1.0 Tg CO_2-eq. and accounts for 0.5% in the national total greenhouse gas emissions in 2004.

HFC emissions increased by a factor of three between 1995 and 2004, mainly due to increased HFC consumption as a substitute for (H)CFC use. Only the use of HFC134a decreased after 1999. The large interannual variation in consumption and emissions of some sources can be explained by the variation in production levels of specific industries and service sectors.

The actual emissions of SF_6 between 1995 - 2004 remained almost constant at about 0.3 Tg CO_2-eq.

Other industrial processes [2G]
The small CO_2 and CH_4 emissions remained rather constant between 1990 and 2004, whereas the indirect N_2O emissions from the deposition of NO_x decreased by about 25% during this same period. This decrease is mainly caused by the decrease in NO_x emissions from *Combustion in road transport Power generation* and the *Manufacturing industry*.

2.3.3 Solvents and other product use [3]
In 2004 the emissions from sector 3 'Solvent and Other Product Use' contributed only 0.1% (0.2 Tg CO_2-eq.) to the total national emissions (without LULUCF); this figure was 0.3% in 1990. Indirect emissions of CO_2 and N_2O for dispersive uses accounted for 62% and 38%, respectively, of the CO_2-equivalent emissions from the sector.

Total emissions of the sector declined by 57% between 1990 and 2003, and remained stable between 2003 and 2004. CO_2 emissions from the sector decreased by 55% between 1990 and 2004, mainly due to decreasing indirect emissions from paints that resulted from the implementation of the emission reduction programme for NMVOC. N_2O emissions fell by 61% from 1990 to 2004 due to the better dosing of anaesthesia in hospitals and other medical institutions.

2.3.4 Agriculture [4]

In 2004 CO_2-equivalent emissions from sector 4 'Agriculture' contributed 8% to the total inventory of national emissions (without LULUCF) compared to 10% in 1990. N_2O emissions accounted for 52% of the CO_2-equivalent emissions from the sector in 2004, with the remainder accounted for by CH_4 emissions. 4A 'Enteric fermentation' is the main source of CH_4 emissions and 4D 'Agricultural soils is the largest source of N_2O emissions included in this sector.

Total greenhouse gas emissions from the sector *Agriculture* were 22.0 Tg CO_2-eq. in 1990 and 18.2 Tg CO_2-eq. in 2004 (see *Figure 2.15*). This represents a decrease of approximately 17% between 1990 and 2004, which is largely the result of decreasing numbers of livestock, a decreased application of animal waste and a decreased use of synthetic fertilizers. From 2003 to 2004, N_2O and CH_4 emissions increased slightly due to increases in the number of poultry animals following the recovery of the industry from the avian flu epidemic in 2004.

Enteric Fermentation [4A]

In 2004, *Enteric fermentation* accounted for 35% of the total greenhouse gas emissions from the agricultural sector. In The Netherlands, CH_4 emissions from enteric fermentation are closely associated with the production of cattle, with the latter contributing 31% to the total greenhouse gas emissions from the agricultural sector in 2004. The second largest CH_4 emission source in category 4A is pig production. 4A 'Other' (sources of enteric fermentation) consists of pigs, sheep, goats and horses.

CH_4 emissions from *Enteric fermentation* decreased from 7.5 Tg CO_2-eq. to 6.3 Tg (–16%) between 1990 and 2004, with CH_4 emissions from enteric fermentation by cattle and swine decreasing by 16% and 20%, respectively. The decreased CH_4 emission from cattle largely results from the 24% decrease in the number of cattle.

The number of (adult female) dairy cattle is determined mainly by the EU policy on milk quotas. These numbers decreased by 22% during the period 1990–2004. (See *Table 6.2*). In addition, by regulating the amount of manure production and manure application, the Dutch policy on manure management is directly influencing livestock numbers in The Netherlands. As a result, the numbers of (dairy and non-dairy) young cattle and swine have decreased by 27 and 19%, respectively. Decreasing animal numbers are not the only parameter influencing the emissions from enteric fermentation. The decreased methane emissions in the period 1990–2004 are also affected by the change in total feed intake, the share of feed components and the nutrient composition of feed components during the same period. A more detailed explanation of the emission trends in this category can be found in *Section 6.2.1*.

Manure Management [4B]

In 2004, *Manure management* accounted for 17% of the total greenhouse gas emissions from the agricultural sector. In The Netherlands, CH_4 emissions from manure management are strongly related to the production of cattle and swine, which in 2004 contributed 8% and 5%, respectively, to the CH_4 emissions from *Manure management*. Furthermore, N_2O emissions from 'Manure management' contribute 4% of the total greenhouse gas emissions from the agricultural sector.

Between 1990 and 2004, the emission of CH_4 from *Manure management* decreased by 17%. Emissions from cattle, swine and poultry decreased by 6%, 19% and 77%, respectively, during this same period. Emissions from cattle are mainly determined by dairy cattle. The number of dairy cattle in the Netherlands decreased by 22% from 1990 to 2004 (*Table 6.2).* This decrease does not reflect the 7% increase in the CH_4 emissions from dairy cattle during the same period (*Figure 6.1*). Between 1990 and 2004, the increased manure production per cow (+13%) and volatile solids content of manure (+6%) combined with a shift to more stable manure (+12%) resulted in increased methane emissions of 34% from manure management per cow. Combined with the decreased animal numbers, this explains the increased CH_4 emissions (7%) of milk producing cows.

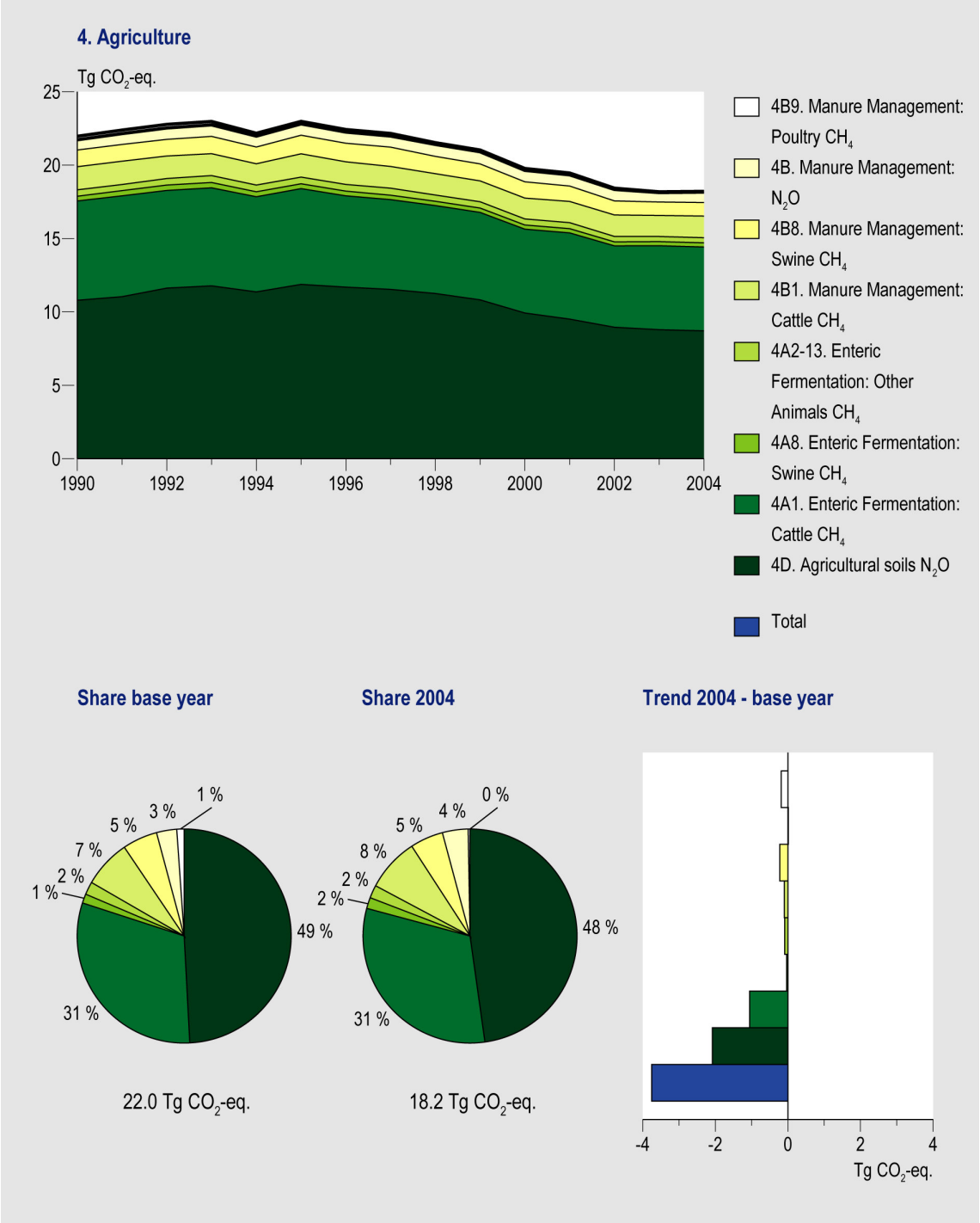


Figure 2.15 Category 4 'Agriculture: trend', emission levels and share of source categories in emissions of 4 'Agriculture', 1990-2004.

For '*Manure management*: *swine*', the decreased CH_4 emissions of 19% are closely related to the decrease in animal numbers (–19%) (*Table 6.2*).

Poultry numbers decreased by 7% between 1990 and 2004. In 2003 poultry animal numbers decreased by almost 30% relative to preceding years as a result of the avian flu epidemic. In 2004, the poultry population partly recovered. For poultry, the 77% decrease in CH_4 emissions between 1990 and 2004 cannot be explained by the 7% decrease in animal numbers during this same period.

In the period 1990–2004 there was a shift in the proportion of the two poultry manure management systems (solid and liquid manure). The proportion of solid manure production increased from 44% to 86%. Relative to the liquid manure system the CH_4 emission factor for the solid system is approximately 15-fold lower. Both of these factors have results in a decreased Implied Emission Factor (IEF) of 75%. This decreased IEF in combination with the 7% decrease in animal numbers explains the 72% decrease in CH_4 emissions.

The emissions of N_2O from *Manure management* increased 2% between 1990 and 2004, from 2.24 to 2.28 Gg N_2O in 2004 (*Table 6.8*). Between 1990 and 2004 the proportion of total solid manure N excretion increased from 13% to 18%. Compared to the liquid manure system, the N_2O emission factor for the solid system is about 20-fold higher. This resulted in an increased overall IEF of 34%. This higher IEF in combination with a 24% decrease in total N excretion explains the 2% increase in N_2O emission.
In 2003 N_2O emissions of solid manure decreased as a result of the decrease in the amount of poultry animal manure. The direct cause of the latter was the reduction in poultry animal numbers as a consequence of the avian flu. N_2O emissions increased once again in 2004 following the recovery of poultry animal numbers.

Agricultural Soils [4D]
N_2O emissions from *Agricultural soils* contributed approximately 50% to the total national inventory of N_2O emissions in 1990 and 2004. The most important sources of N_2O emissions from *Agricultural soils* are direct emissions that result from the application of synthetic fertilisers and animal manure to soil and indirect emissions caused by nitrogen leaching and run off. The share of direct N_2O emissions in the national total N_2O emissions was approximately 22% in 1990 and approximately 27% in 2004. The share of indirect N_2O emissions in the national total N_2O emissions was about 23% in 1990 and about 18% in 2004 (see also *Table 6.1*).

Total N_2O emissions from *Agricultural soils* decreased by 19% between 1990 and 2004 (see *Figure 2.16*). This decrease is caused by: (1) the decrease in N-input to soil by manure and chemical fertiliser application and animal production and (2) the increased implied emission factor in this period that resulted from a shift from the surface spreading of manure to the incorporation of manure into soil.

N_2O emissions from manure application (4D1.2) increased by approximately 94% between 1990 and 1995. This increase cannot be explained by the decrease in N input to the soil. During this time span there was a change in the method of animal manure application to agricultural soils. Up to 1990 manure was applied by spreading on the surface of grasslands and agricultural soils. Initiated by The Netherlands' policy to reduce ammonia emissions, this practice changed in 1991 into manure incorporation into the soil (e.g. sod injection and ploughing in). The N_2O emission factor for the incorporation into the mineral soils is twice as high as the N_2O emissions factor for surface spreading. Combined with the 3% decease in N input, this factor explains the 94% increase in the N_2O emissions by manure application during the period 1990–1995.

Direct soil N_2O emissions from manure application (4D1.2) decreased by 20% between 1995 and 2004. This decrease is reflected by the 24% decrease in N input during the same period.

The 34% decrease between 1990 and 2004 in indirect N_2O emissions is reflected in the 37% decreased N-input by atmospheric deposition and by nitrogen leaching and run off. The decrease in N-input by atmospheric deposition was relatively high as a result of legislation implemented for ammonia.

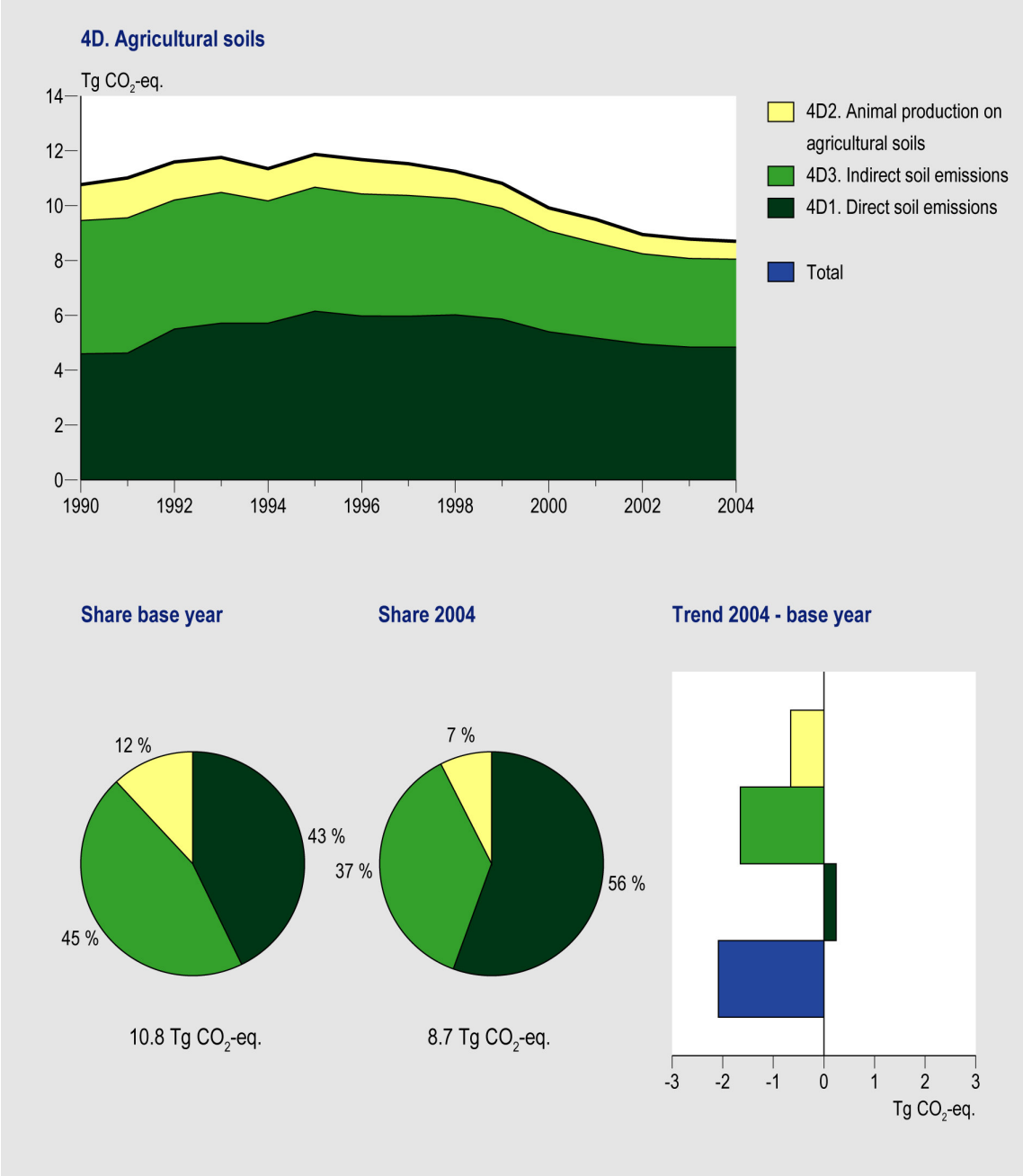


Figure 2.16 N_2O emissions from 4D Agricultural soils, 1990-2004.

2.3.5 Land use, land use change and forestry (LULUCF) [5]

Sector 5 'Land use, land use change and forestry' (LULUCF) accounted for 1.1% of the total national CO_2 emission in 1990 and 2004. For 1990 and 2004, the total net emissions are estimated to be approximately 2.4 Tg CO_2, with the major source being CO_2 emissions from the decrease in C-stored in organic soils and peat lands: 4.2 Tg CO_2, included in 5C1 'Grassland remaining grassland', resulting from agricultural and water management. The major sink is the storage of carbon in forests: –2.3 Tg CO_2, included in 5A1 'Forest Land remaining forest land'.

2.3.6 Waste [6]

The *Waste* sector accounted for 3% of total national emissions (without LULUCF) in 2004 compared with 6% in 1990, with the emissions of CH_4 and N_2O accounting for 94% and 6% of CO_2-equivalent emissions from the sector, respectively. Emissions of CH_4 from waste – almost all (96%) from *Landfills* (6A) – accounted for 39% of the national total CH_4 emissions in 2004. 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 most large-scale incinerators also produce electricity or heat for energetic purposes.

Emissions from the *Waste* sector decreased by 43% between 1990 and 2004 (see *Figure 2.17*), mainly due to a 46% reduction in CH_4 from *Landfills* (6A1 'Managed waste disposal on land). Between 2003 and 2004 the emissions decreased by approximately 3%. The decreased methane emissions from 'Landfills' since 1990 is the result of: (1) the consideable reduction in municipal solid waste (MSW) disposal at landfills through the increased recovery and recycling of waste for composting and/or incineration; (2) the decrease in the organic waste fraction of the waste disposed; (3) the increase in methane recovery from the landfills (from 5% in 1990 to 16% in 2004).

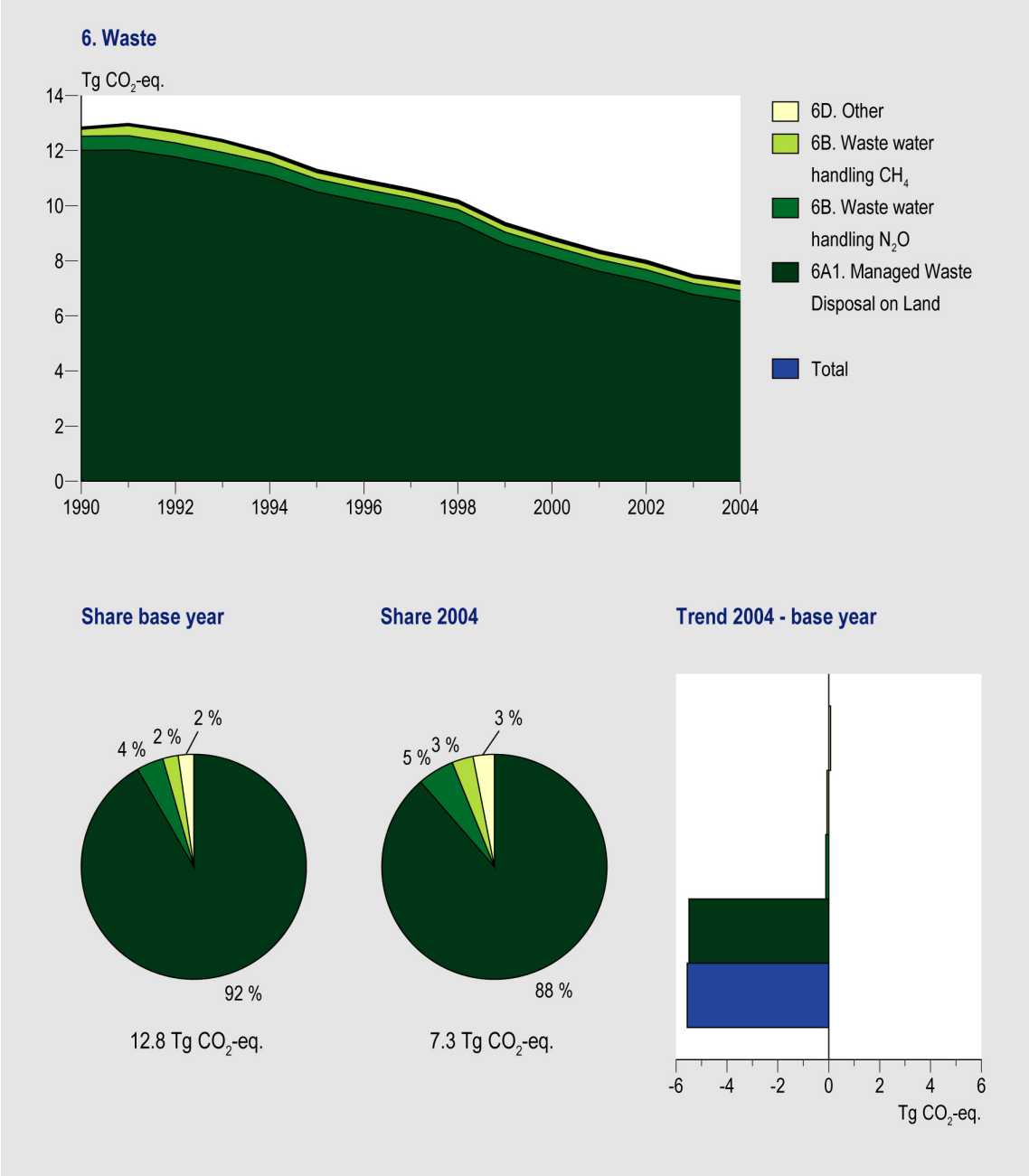


Figure 2.17 Sector 6 'Waste': trend, emission levels and share of source categories in emissions of 6 'Waste', 1990-2004.

Solid waste disposal on land [6A]
In 2004 the share of CH_4 emissions from *Landfills* in the total national inventory of greenhouse gas emissions was 6% in 1990 and 3% in 2004. Between 1990 and 2004 CH_4 emissions have decreased by 46% to 311 Gg. This decrease is due to the increase in recovered CH_4 – from about 5% in 1990 to 16% in 2004 – but also to the decrease in methane produced in solid waste disposal sites.

Wastewater Handling [6B]
N_2O emissions from waste water treatment (see *Table 8.1*) contributed about 2% to total N_2O emissions in 2004 (as well as in 1990) and 0.2% in total CO_2-equivalents. N_2O emissions from waste water handling decreased by 22% during the period 1990–2004. This decrease is mainly caused by improved nitrogen removal at Urban WWTPs, thereby resulting 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 in the national total of CH_4 emissions in 2004 was 1%. Since 1993, CH_4 emissions from wastewater treatment plants have decreased due to the introduction in 1990 of a new sludge stabilisation system in one of the largest wastewater treatment plants. As the operation of the plant took a few years to optimise, venting emissions were higher in the introductory period (1991–1993) than under normal operating conditions.

The amount of wastewater and sludge being treated does not change much over time. Therefore, the interannual changes in methane emissions can be explained by varying fractions of methane being flared instead of vented or used for energy purposes.

2.3.7 Other [7]
Not applicable, after the major recalculations and re-allocation of sources to other CRF sectors.

2.3.8 Uncertainty in emissions by sector
The uncertainty estimates in ***annual*** CO_2-equivalent emissions of IPCC sectors *Energy* [1], *Industry* [2], *Solvents and product use* [3], *Agriculture* [4], and *Waste* [6] are about ±2%, ±20%, ±30%, ±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 ±3%-points in the 14% increase, for sector 2 *Industry* at ±7%-points in the 34% decrease, for sector 4 *Agriculture* at ±14%-points in the 17% decrease and for sector 6 *Waste* at ±11%-points in the 43% the decrease.

2.4 Emission trends for indirect greenhouse gases and SO_2

Figure 2.18 shows the trends in total emissions of CO, NO_x, NMVOC and SO_2. 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. Between 1990 and 2004 CO and NMVOC emissions increased by 46% and 61%, respectively. SO_2 emissions increased by 67%, and the emissions of NO_x were 37% lower in 2004 than in 1990. We recall here that in contrast with the direct greenhouse gases, emissions of precursors from road transport are not corrected for fuel sales according to the national energy statistics but are directly related to transport statistics on a vehicle-kilometre basis. To some extent this is different from the IPCC approach (see *Section 3.5.4.*). Due to lack of data, the emissions for 1991–1994 are intrapolated for all sources. With the exception of NMVOC, most of the emissions stem from fuel combustion. Uncertainty in the emission factors for NO_x, 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 NO_x, 5% for SO_2, and approximately 25% for NMVOC (TNO, 2004; RIVM, 2005).

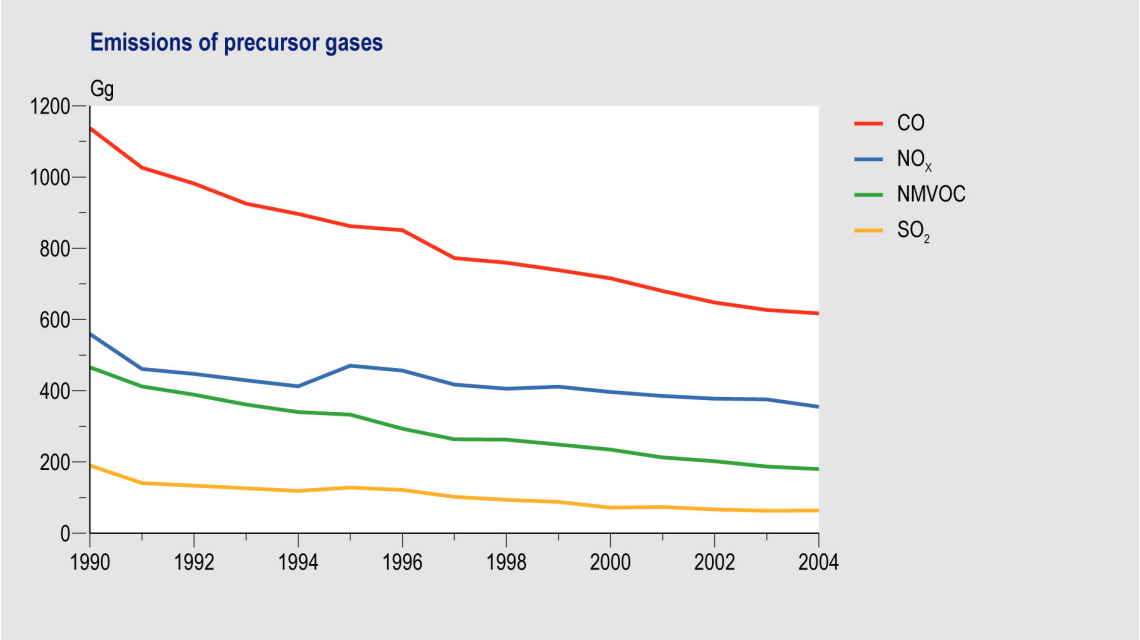


Figure 2.18 Emission trends of NO_x, CO, NMVOC and SO_2. (Units: Gg).

3. ENERGY [CRF sector 1]

Major changes in the *Energy* sector compared to the *National Inventory Report 2005*

Emissions: Compared to the previous submission, CO_2 emissions from the sector *Energy* (mainly source categories 1A1a and 1B2b) increased for the complete time series [+0.4% (+0.6 Tg) in 1990 and +0.1% (+0.1 Tg) in 2004]. The most important changes are due to a revision of the emission factor for natural gas from 56.1 to 56.8 kg/GJ and revised activity data for natural gas in the oil and gas production industry. Gas combustion emissions increased by 0.8 Tg in 1990 and 1.0 Tg in 2004.
Based on the new activity data it is possible to distinguish between emissions from combustion activities, venting and flaring. Minor changes are found in CO_2 emissions from agricultural machinery and in emissions from inland navigation (activity data for 2000 onwards and emission factors). CH_4 emissions from 'Fugitive Emissions from Fuels' decreased for the complete time series (-20% or -19 Gg in 1990 and -27% or -14 Gg in 2004). The main changes are in 1B2b 'Oil and natural gas' due to the use of revised emission factors to estimate gas distribution. Minor changes are caused by new activity data for the oil and gas production industry.
Due to data re-processing errors, some allocations have accidentally been changed, although totals were not affected. The main differences are found in CO_2 reported in 1A2f/2G and in 1A2c ('Liquid/Solid Allocation').
Key sources: Compared to the previous submission the key sources are disaggregated by fuel type, in line with the *IPCC Good Practice Guidance*. As a result, 14 key sources in the source categories 1A1, 1A2, 1A3 and 1A4 were added.
Methodologies: The CO_2 emission factor for natural gas was changed, thereby increasing all natural gas combustion emissions by 1.25%. Changed methodologies are applied to estimate: (1) CO_2 emissions from waste incineration in 1A1a 'Public Electricity and Heat Production' (error correction of the biogenic component of the total amount of waste incinerated, thus not affecting national totals); (2) emissions from the oil and gas production industry (mass balance calculation and allocation to either 1Ac or 1B2c).
To estimate emissions from 1B2b-iv 'Gas distribution', two country-specific emission factors for gas distribution were developed instead of the emission factors based on a German study that were applied previously.

3.1 Overview of sector

Emissions from this sector include all emissions from energy use in The Netherlands. Categories of the Energy *sector are 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 residual gases, which are comparable with refinery gas) (included in 1A1a and 1A2c). According to the *IPCC Guidelines* CO_2 emissions included in the total national inventory are only fossil-fuel related emissions, thereby 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 subcategory 1A1a 'Public Electricity and Heat Production'.

Trends in fossil fuel use and fuel mix
In 2004 natural gas was the most important of the fossil fuels, contributing 56% 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 has tripled since 1990, its share in total fossil fuel use is still only 1% at the present time. Nuclear energy and hydropower production provide very little of the total primary energy supply in The Netherlands. In the period 1990–2004 total fossil fuel combustion increased by 15%, of which two-thirds was due to a 20% increase in gas

consumption, while liquid fuel use increased by 15%. At the same time the combustion of solid fuels decreased by 6%.

Total fossil fuel consumption for combustion increased by 1% between 2003 and 2004, mainly due to a 2% increase in gas consumption. The 2% decrease in solid fuel combustion was partly compensated by increased combustion of liquid fuels. The increased use of gas for combustion is mainly to be seen in power-generating activities (+8%), where 4% less coal was used for electricity production. As the winter temperatures of 2003 and 2004 were similar, total gas consumption in the other sectors (residential, services, agriculture) did not differ to any great extent between these two years (–1% in 2003 relative to 2004).

Structure of energy production and consumption sectors

The Netherlands produces large amounts of natural gas, both onshore (e.g. Groningen gas) and offshore. About 50% 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 co-generation plants, with many of the latter being operated as joint-ventures with industries. The Rotterdam harbour 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. Rotterdam is 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 aluminium 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 5401: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels' (included in 1A);
- Protocol 5403: CO_2 , CH_4 and N_2O from 'Mobile Equipment' (1A2f_1A4c);
- Protocol 5405: CO_2 from 'Road Transport' (1A3b);
- Protocol 5407: CH_4 from 'Road Transport' (1A3b);
- Protocol 5406: N_2O from 'Road Transport' (1A3b);
- Protocol 5404: CO_2 , CH_4 and N_2O from 'Inland Aviation' (1A3a);
- Protocol 5410: CO_2 , CH_4 and N_2O from 'Fisheries' (1A4c);
- Protocol 5408: CO_2 , CH_4 and N_2O from 'Rail Transport' (1A3c);
- Protocol 5409: CO_2 , CH_4 and N_2O from 'Inland Navigation' (1A3d);
- Protocol 5411: CO_2 , CH_4 and N_2O from 'Defence' (1A5);
- Protocol 5412: CO_2 , CH_4 and N_2O from 'Oil and Gas Production' (1B2);
- Protocol 5413: CO_2 , CH_4 and N_2O from 'Oil and Gas Distribution/Transport' (1B2);
- Protocol 5402: CO_2 , CH_4 from 'Process Emissions: Fossil Fuels' (1B).

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 subcategories 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.

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 shows the contribution of the source categories in the sector *Energy* to the total national greenhouse gas inventory. In 2004 the *Energy* sector accounted for 81% of the total national emissions (excluding LULUCF), the predominant share of these being CO_2 emissions. Source category 1A1 'Energy Industries' contributes 39% to the national total CO_2 emissions; 1A4 'Other Sectors, 22%; 1A3 'Transport, 19% and 1A2 'Manufacturing Industries', 15%. Methane emissions accounted for only 0.8% of the emissions in the sector, with approximately 50% of these from fugitive emissions from 1B2 'Oil and Gas'. N_2O emissions accounted for 0.4% of the sector emissions, mostly from 1A3 'Transport'.

The emissions from the *Energy* sector have increased by 14% since 1990, primarily due to increasing CO_2 emissions from public power generation (included in 1A1a) and road transport (included in 1A3b) – with increases of 42% and 33%, respectively. In 2004 CO_2 emissions from the *Energy* sector increased by 1.3% compared to 2003, mainly as a result of an 8% increase in the emissions from gas combustion from the public electricity sector (included in 1A1a).

Table 3.1 also presents the key sources in the *Energy* sector specified by both level and trend (see also *Annex 1*). The key sources 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 domestic aviation and railways – almost all CO_2 sources are identified as key sources. The total CH_4 emissions from all combustion sources together are also identified as a key source.

Table 3.1 Contribution of main categories and key sources in CRF sector 1 Energy.

Sector/category Key source	**Gas**	**Key**[1)]	**Emissions in base year**		**Emissions in 2004**		**Contribution to total in 2004 (%)**		
		Level, Trend, Non Key	Gg	Tg CO_2-eq.	Gg	Tg CO_2-eq.	By sector	Of total gas	Of total CO2-eq.
1 Energy	CO_2			151.2		173.9	99	96	80
	CH_4		111.8	2.3	64.8	1.4	0.8	8	0.6
	N_2O		1.6	0.5	2.3	0.7	0.4	4	0.3
	All			**154.0**		**175.9**	**100**		**81**
1A Fuel combustion	CO_2	*		150.0		173.2	98	96	79
	CH_4		32.4	0.7	30.1	0.6	0.4	4	0.3
	N_2O		1.6	0.5	2.3	0.7	0.4	4	0.3
	All			**150.7**		**173.9**	**99**		**80**
1A CH4 stationary combustion (excl. 1A3)	CH_4	L2	24.9	0.5	26.9	0.6	0.3	3	0.3
1A1 Energy industries	CO_2	*		**52.5**		**70.6**	**40**	**39**	**32**
1A1a. Public electricity and heat production	CO_2	*		39.9		56.8	32	31	26
1A1a liquids	CO_2	L1,T		0.2		2.2	1	1	1
1A1a solids	CO_2	L,T1		25.8		26.9	15	15	12
1A1a gases	CO_2	L,T		13.3		25.6	15	14	12
1A1a other fuels: waste incineration	CO_2	L1,T		0.6		2.1	1	1	1.0
1A1b. Petroleum refining	CO_2	*		11.0		11.8	7	7	5
1A1b liquids	CO_2	L,T1		10.0		9.6	5	5	4
1A1b gases	CO_2	L1,T1		1.0		2.3	1	1	1
1A1c. Manufacture of solid fuels and other energy industries	CO_2	*		1.5		2.0	1	1	0.9
1A1c gases	CO_2	L,T1		1.5		2.0	1	1	0.9
1A2 Manufacturing industries and construction	**CO_2**	*		**33.0**		**27.2**	**15**	**15**	**12**
1A2 liquids	CO_2	L,T1		9.0		7.3	4	4	3
1A2 solids	CO_2	L,T1		5.0		4.5	3	2	2
1A2 gases	CO_2	L,T1		19.0		15.4	9	8	7
1A2a. Iron and steel	CO_2	*		4.0		4.7	3	3	2
1A2b. Non-ferrous metals	CO_2	*		0.2		0.2	0.1	0.1	0.1
1A2c. Chemicals	CO_2	*		17.2		11.8	7	7	5
1A2d. Pulp, paper and print	CO_2	*		1.7		1.5	0.8	0.8	0.7
1A2e. Food industry	CO_2	*		4.1		4.0	2	2	2
1A2f. Other	CO_2	*		5.8		5.0	3	3	2
1A3 Transport	CO_2			26.0		34.8	20	19	16
	N_2O		0.9	0.3	1.6	0.5	0.3	3	0.2
	All			**26.4**		**35.4**	**20**		**16**
1A3a. Civil aviation	CO_2	NK		0.0		0.0	0.0	0.0	0.0
1A3b. Road vehicles	CO_2	*		25.5		33.8	19	19	16
1A3b gasoline	CO_2	L,T1		10.9		13.2	8	7	6
1A3b diesel oil	CO_2	L,T		11.8		19.5	11	11	9
1A3b LPG	CO_2	L1,T		2.7		1.1	1	1	0.5
1A3b. Road vehicles	N_2O	L2	0.9	0.3	1.6	0.5	0.3	3	0.2
1A3c. Railways	CO_2	NK		0.1		0.1	0.1	0.1	0.0
1A3d. Navigation	CO_2	L1,T1		0.4		0.8	0.5	0.5	0.4
1A4 Other sectors	CO_2	*		37.9		40.2	23	22	18
	CH_4	*	18.7	0.4	18.4	0.4	0.2	2	0.2
	All			**38.3**		**40.6**	**23**		**19**
1A4 liquids (excl. from 1A4c)	CO_2	T		1.5		0.6	0.4	0.3	0.3
1A4a. Commercial/institutional	CO_2	*		7.5		11.5	7	6	5
1A4a gases	CO_2	L,T		6.6		11.0	6	6	5
1A4b. Residential	CO_2	*		19.5		19.1	11	11	9
	CH_4		16.9	0.4	16.3	0.3	0.2	2	0.2
1A4b gases	CO_2	L		18.7		18.8	11	10	9
1A4c. Agriculture/Forestry/Fisheries	CO_2	*		10.9		9.6	6	5	4
1A4c liquids	CO_2	L		2.5		2.6	1	1	1
1A4c gases	CO_2	L,T		8.3		7.0	4	4	3
1A5 Other	**CO_2**	NK		**0.6**		**0.4**	**0.3**	**0.2**	**0.2**
1B Fugitive emissions from fuels	CO_2	*		1.2		0.6	0.4	0.4	0.3
	CH_4	*	79.5	1.7	34.6	0.7	0.4	4	0.3
	All			**2.8**		**1.4**	**0.8**		**0.6**
1B1 Solid fuel transformation: coke production	CO_2	L2		0.4		0.5	0.3	0.3	0.2
1B2 venting/flaring	CO_2	T		0.8		0.1	0.1	0.1	0.1
1B2 venting/flaring	CH_4	T	59.6	1.3	14.8	0.3	0.2	2	0.1
Total National emissions	CO_2			159.4		180.9		100	
	CH_4		1211.5	25.4	824.0	17.3		100	
	N_2O		68.4	21.2	57.3	17.7		100	
National total GHG emissions (excluding LULUCF)	All			214.3		218.1			100

[1)] *Key sources in the 1A1, 1A2, and 1A4 categories (indicated by an asterisk) are based on aggregated emissions of CO_2 by fuel type.*

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, background documents or *Annex 2* of the *NIR 2006*. In some instances, activity data for the year are based on preliminary data. More detailed information on activity data 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, we refer the reader to the following sections and the website www.greenhousegases.nl.

The emissions from fuel combustion in the sector *Energy* emissions 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 judgements of CBS and MNP 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 factor, the degree of heterogeneity within the sources and within fuel types – this is particularly true for derived gases – and over time (see Olivier and Brandes, 2006).

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 data set. For the base year 1990, Statistics Netherlands (CBS) has re-assessed the original statistics and made them compatible with the 'new' 1993 classification system. 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).

Other – sometimes relatively large – discontinuities or omissions result from partial and annual changes in the monitoring of biomass fuel use in the manufacturing industries, as discussed above (1A2b–f) (see *Table 3.13*).

3.2.4 Source-specific QA/QC and verification

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

3.2.5 Source-specific re-calculations

Immediately prior to the submission to the UNFCCC in April 2006, one major re-calculation was made in 1A 'Fuel Combustion Activities': a revision of the emission factor for natural gas from 56.1 to 56.8 kg/GJ. Recent, new information provided by *Gasunie Transport Services* (GtS) on the results of routine measurements carried out in 2003 and 2004 on the emission factor of natural gas at the 35 distribution stations indicates that the average CO_2 emission factor for natural gas (56.1 kg/GJ) is underestimated. Further analyses showed that both qualities of natural gas delivered in The Netherlands – the so-called Groningen gas (a mixture of gas from the Slochteren reservoir and high calorific gas from other small gas fields) and high-calorific gas – have significantly higher average CO_2 emission factors than the factor for pure Slochteren gas (Vreuls, 2006). A very detailed analysis of the measurement data showed that for 2003/2004 the national average weighted emission factor is 56.8 kg CO_2/GJ. A second analysis of the data showed that the national average emission factor for 1990 has the same value. Therefore, the value of 56.8 was applied for the whole time series 1990–2004. The old emission factor was based on a study that had concluded that the average mix had an emission factor very close to that of pure Slochteren gas (Van Harmelen and Koch, 2002). As a result of this revision, the difference in gas combustion emissions increased by 0.8 Tg in 1990 and 1.0 Tg in 2004 (see *Table 3.2*).The results of the re-calculation are included in the key source analysis, with the exception of the new uncertainty estimate for the CO_2 emission factor of natural gas (see *Section 3.3.3.* and *Table 3.1*).

Table 3.2 Effect of the re-calculation of CO_2 emissions from natural gas combustion (Units:Tg).

Category		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1A-Gas	*NIR 2005*	67.7	75.6	73.5	76.1	72.8	75.0	83.4	77.7	77.2	75.0	75.7	78.6	78.5	79.5	81.0
	NIR 2006	68.6	76.5	74.4	77.0	73.7	76.0	84.5	78.7	78.2	76.0	76.7	79.7	79.6	80.2	82.0
	Difference	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**1.0**	**1.1**	**1.0**	**1.0**	**1.0**	**1.0**	**1.1**	**1.1**	**0.7**	**1.0**
of which:																
1A1-Gas	*NIR 2005*	15.6	18.3	19.1	20.2	19.7	20.1	22.5	24.1	24.5	24.9	24.6	26.4	27.3	27.2	29.4
	NIR 2006	15.9	18.6	19.4	20.5	19.9	20.4	22.9	24.5	24.9	25.3	25.0	26.8	27.8	27.6	29.8
	Difference	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.4**	**0.4**
1A2-Gas	*NIR 2005*	18.8	19.1	19.2	18.2	17.9	17.2	17.8	17.1	17.1	16.7	16.9	16.1	15.8	15.5	15.2
	NIR 2006	19.0	19.3	19.4	18.4	18.2	17.5	18.0	17.4	17.3	16.9	17.1	16.3	16.0	15.5	15.4
	Difference	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.2**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.0**	**0.2**
1A4-Gas	*NIR 2005*	33.3	38.2	35.2	37.6	35.2	37.6	43.1	36.5	35.6	33.4	34.1	36.2	35.4	36.8	36.4
	NIR 2006	33.7	38.6	35.6	38.1	35.7	38.1	43.7	36.9	36.0	33.8	34.6	36.7	35.8	37.1	36.8
	Difference	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**0.5**	**0.6**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**0.4**	**0.3**	**0.4**

Two other re-calculations were made for 1A1 'Energy Industries':

- In 'Public Electricity and Heat Production' (1A1a) an error made in the calculation of the biogenic component of the total amount of waste incinerated (amounts of the fossil waste were correct) is corrected. The result does not affect the total of national CO_2 emissions. Only the minor CH_4 and N_2O emissions and the Memo item 'CO_2 Emissions from Biomass' (see *Table 3.3*) changed.
- In subcategory 1A1c energy consumption data of 'Oil and Gas Production' for 'own' consumption (the difference between the amounts of fuel produced and sold, minus the amounts of associated gas either flared or vented) was re-assessed, since the former time series still had some inconsistencies.

See the following sections for more details on the latter two re-calculations.

3.2.6 Source-specific planned improvements

Other planned improvements are addressed in the *Sections 3.3-3.11*.

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 minor key source, since this source is only identified as a level key source when uncertainty information is added (Tier 2 key source analysis; see *Annex 1*). 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 3.1*), 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 subcategory also includes the co-generation (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 3.2*).

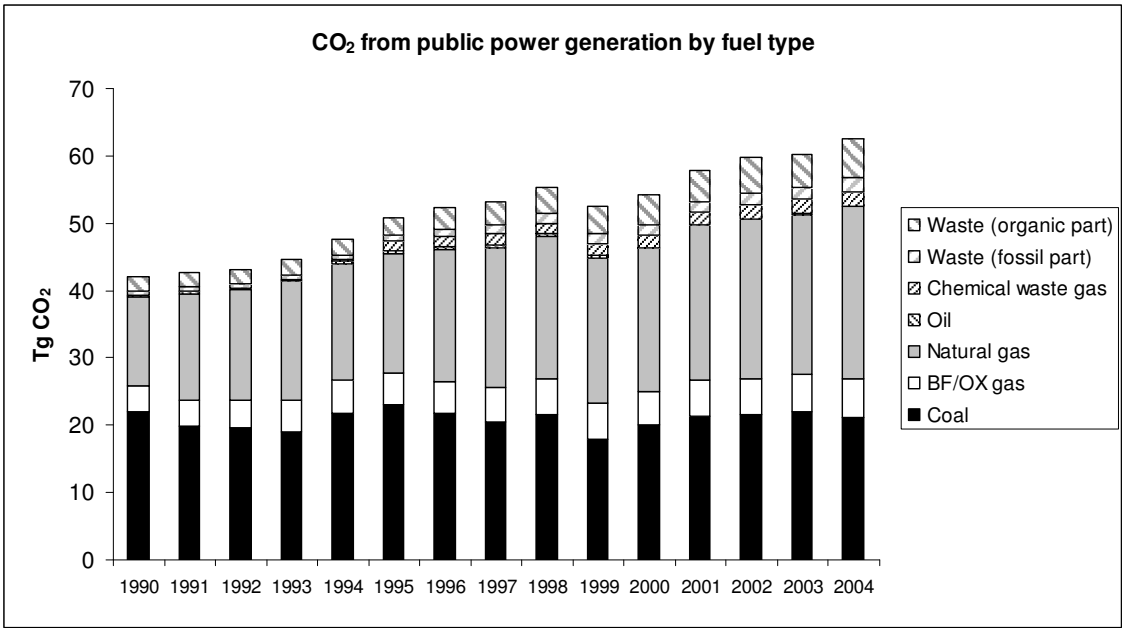


Figure 3.1 Trend in sources of CO_2 from fuel use in power plants (a small amount from coke oven gas, about 0.1 Tg, is included in coal). Note that CO_2 from organic waste (waste organic part) does not contribute to net CO_2 emissions.

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' 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, etc.);
- 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.

The share of CO_2 emissions from 1A1 'Energy Industries' in the total national CO_2 emissions (without LULUCF) increased from 33% in 1990 to 39% in 2004, mainly due to a change in ownership of CHP plants (joint-ventures, which are allocated to this source category). CO_2 emissions of this category have increased by 35% since 1990. In 2004 CO_2 emissions from gas combustion in the public electricity sector (1A1a) increased by 8% (almost 2 Tg), compared to 2003. CO_2 emissions from liquid fuel use in refineries (1A1b) increased by 5%, but solid fuel combustion decreased by 2% between 2003 and 2004.

Activity data and (implied) emission factors

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 is partly compensated for by a shift from coal to natural gas and the increased efficiency of power plants (*Figure 3.1*). One-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 co-generation plants and a few large residual-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 9.5 Tg in 2004 (see *Figure 3.3*).

After a period of increasing CO_2 emissions from power generation up to 1998, in 1999 the emissions suddenly dropped by 6% compared to 1998, even though the electricity consumption in The Netherlands in 1999 was 2% higher than in 1998 as a result of electricity and heat production. This apparent incongruity is explained by the increased amount of electricity imported in 1999 (almost double that imported in 1998). 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 3% as a direct result of an 8% increase in gas combustion, partially due to the start-up in June 2004 of a large new gas-fired 790 MW_e co-generation plant, and a 2% decrease in coal combustion.

Solid fuel combustion decreased by 14% in 1999 and increased by 7% in 2001. This trend is partly caused by the large increase in 1999 in imported electricity (see *Figure 3.2*) as the higher electricity import corresponds to approximately 4 Tg CO_2 emissions. In addition, significant amounts of blast furnace (BF) and oxygen furnace gas (OX) purchased from the steel plant (*Figure 3.1)* are used – included in solid fuels – thereby explaining the inter-annual variation in the implied emission factors (IEFs) for CO_2.

The strong increase in *liquid fuel* use in 1994 and 1995, with a sharp increase in 1995, is due to residual chemical gas being used, as shown in *Figure 3.1,* predominantly 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 a few percentage points. This also explains a large part of the increase found in both *biomass fuels*, but the co-combustion of biomass in coal-fired power stations (showing a marked increase in 2002, with an almost 25% share in 2004) and the combustion of biogas in CHP from landfill sites (15% share) is also part of this category and has increased significantly (see *Section 3.8*).

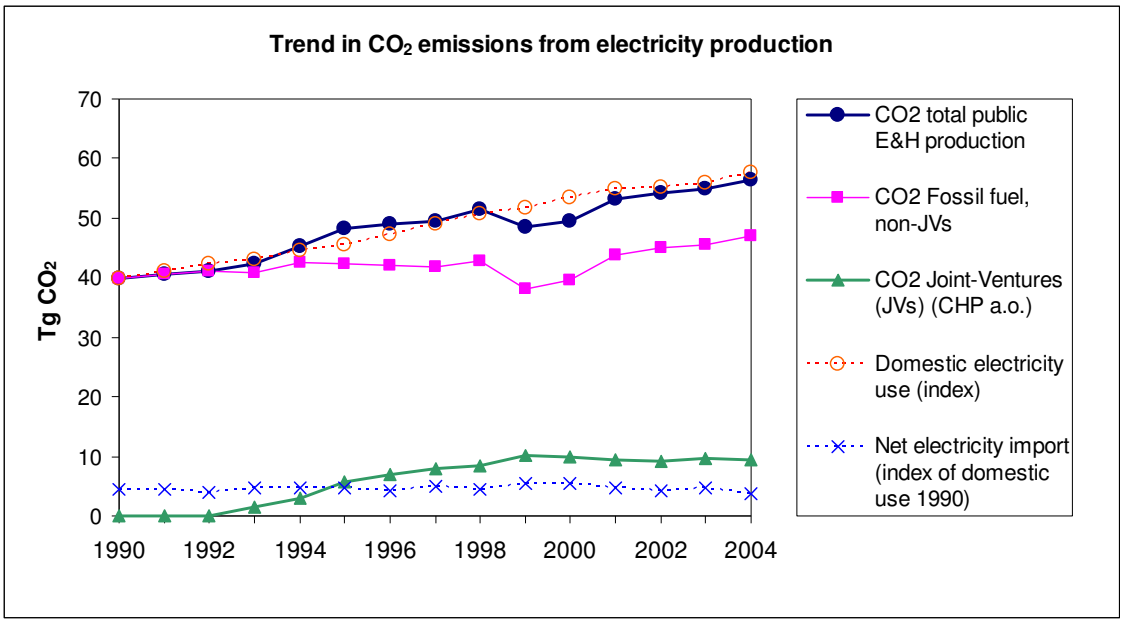


Figure 3.2 Trends in CO_2 emissions from public electric power generation (including public heat production).

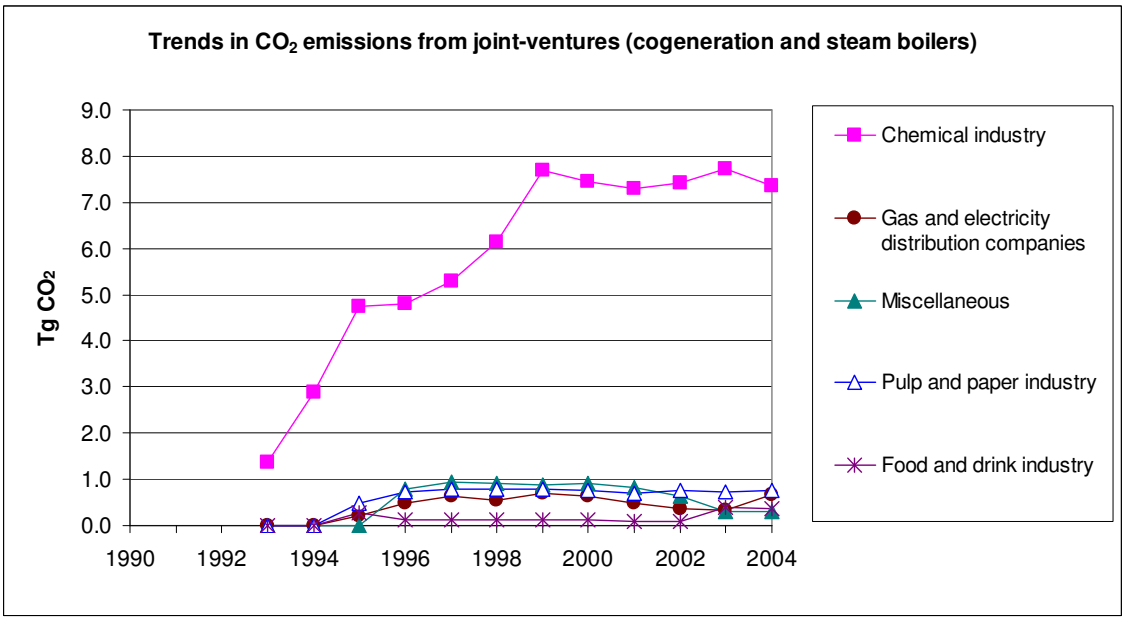


Figure 3.3 Trends in CO_2 emissions from joint-ventures of cogeneration plants and steam boilers.

Refineries [1A1b]

CO_2 emissions from 'Refineries' decreased by 14% in 2002 and by 7% in 1999. This corresponds with similar reductions in the activity data in terms of liquid fuel combustion and in terms of crude throughput. These liquid fuel combustion emissions constitute about 5% of the national total CO_2 emissions (see *Table 3.3*).

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 also has a relatively low emission factor compared to most other oil products, 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). 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 only, not for other emissions, and replaced a carbon balance method and the reporting of net carbon losses as CO_2 under 1B2 (see *Section 3.3.6* on planned improvements).

Table 3.3 Trends in CO_2 emissions from refineries by fuel type (Units:Tg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Liquid: total	10.0	9.9	9.3	10.2	10.0	10.4	10.1	10.0	10.4	9.7	10.2	10.8	8.8	9.1	9.6
o.w. oil products	*1.6*	*1.7*	*1.5*	*4.5*	*4.5*	*4.5*	*4.8*	*4.2*	*4.0*	*3.4*	*3.1*	*3.1*	*2.7*	*2.8*	*2.6*
o.w. refinery gas in refineries	*3.8*	*3.9*	*4.0*	*4.2*	*4.4*	*4.2*	*3.9*	*5.0*	*4.9*	*4.7*	*5.2*	*5.1*	*4.7*	*5.0*	*5.6*
o.w. unaccounted for liquid fuel	*4.6*	*4.3*	*3.8*	*1.4*	*1.1*	*1.0*	*0.6*	*0.0*	*0.9*	*0.9*	*1.3*	*2.0*	*1.4*	*1.3*	*1.4*
Gaseous fuels: total	1.0	1.2	1.1	1.3	1.3	1.2	1.5	2.0	1.8	1.9	1.9	1.8	2.1	2.1	2.3
Total CO_2 from refineries	**11.0**	**11.1**	**10.4**	**11.5**	**11.3**	**11.7**	**11.6**	**12.0**	**12.3**	**11.6**	**12.1**	**12.6**	**10.9**	**11.2**	**11.8**
Refinery act data: throughput	*2.2*	*2.5*	*2.6*	*2.8*	*2.8*	*2.7*	*2.7*	*2.7*	*2.8*	*2.4*	*2.5*	*2.5*	*2.2*	*2.3*	*2.3*
CO_2/PJ throughput	*5.0*	*4.4*	*4.0*	*4.1*	*4.0*	*4.3*	*4.3*	*4.4*	*4.4*	*4.8*	*4.8*	*5.0*	*5.0*	*4.9*	*5.1*

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 2.0 Tg CO_2 in 2004 due to the exploitation of less favourable 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, 27.0 and 25.5 Tg CO_2); 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 residual chemical 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, residual chemical 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*.

'Public Electricity and Heat Generation' (1A1a) includes co-generation (and some steam boilers) operated as joint-ventures of a utility and private industries. In the national energy statistics, fuel consumption of these sources is 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 3.2* and *3.3*) 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 amount of CO_2 from fuel combustion is based on the sectoral energy statistics, including the combustion of residual refinery gases. However, 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 residual refinery gases and other residual fuels that are all combusted but not monitored by the industry are the ones unaccounted for. This assumption is confirmed by the comparison of the calculated emission data to the data submitted by refineries in their MJVs. The CO_2 emissions from this varying fuel consumption are included in the fuel type: liquids. *Table 3.7* and *Figure 3.4* show that this represents approximately 10% (5 –20%) of the total fuel consumption accounted for in the statistics.

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 neighbouring countries. Greenhouse gas emissions from fossil fuel use 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 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, and the 'unaccounted for liquids' calculated for refineries (Olivier and Brandes, 2006). 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 we use a 10% uncertainty, 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 (2006) and further discussed in Olivier and Brandes (2006); 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 Corus). 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 residual chemical 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 we assumed a higher uncertainty of 10% 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) we assume uncertainties of 5% and 2%, 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), we assumed an uncertainty of 5%, which reflects the limited accuracy of the waste composition and of the carbon fraction per waste stream (Olivier and Brandes, 2006).

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 5401: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.3.5 Source-specific re-calculations

In addition to the re-calculation of emissions from gas combustion due to the revision of the emission factor for natural gas discussed in *Section 3.2.5*, two re-calculations were made for 'Energy Industries':

- In 1A1a 'Public Electricity and Heat Production' an error made in the calculation of the biogenic component of the total amount of waste incinerated (the amounts of the fossil waste part were correct) is corrected. The result does not affect the total of national CO_2 emissions; only the minor CH_4 and N_2O emissions and the Memo item 'CO_2 Emissions from Biomass" (see *Table 3.4a*) changed.
- In 1A1c 'Oil and Gas Production' energy consumption data for 'own' consumption (the difference between the amounts of fuel produced and sold, minus the amounts of associated gas either flared or vented) was re-assessed, since the former time series still showed some inconsistencies. A new time series is established, based on assessments of activities of the individual companies in the past made by the trade organisation NOGEPA. The resulting time series of emissions from combustion included in 1A1c (see *Table 3.4.b*) and the fugitive emissions included in 1B2c (see *Table 3.23* in *Section 3.14*) appear to be more consistent. CO_2 emissions increased by approximately 0.7 Tg CO_2 in 1990 and in 2003 by about 0.3 Tg CO_2, while CO_2 emissions included in 1B2 increased by 0.3 Tg in 1990 and 0.2 Tg in 2003 (*Table 3.23*).

Table 3.4a. Re-calculated CO_2 emissions of 1A1a 'Public Electricity and Heat Production' due to revised biomass fuel uses in waste incineration (Units: Tg CO_2).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NIR 2006	2.1	2.1	2.2	2.4	2.3	2.6	3.1	3.6	3.8	4.1	4.4	4.7	5.3	5.0
NIR 2005	2.8	2.8	2.8	3.0	2.8	3.0	3.6	4.3	4.4	4.7	5.0	5.1	5.8	5.8
Difference	**-0.7**	**-0.7**	**-0.6**	**-0.6**	**-0.5**	**-0.4**	**-0.5**	**-0.7**	**-0.6**	**-0.6**	**-0.6**	**-0.4**	**-0.5**	**-0.8**

Table 3.4. Re-calculated CO_2 emissions of 1A1c 'Oil and Gas Production' due to revised 'own' energy use of the oil and gas production industry (Units: Tg CO_2).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NIR 2006	1.5	1.6	1.7	1.5	1.4	1.7	1.8	1.8	1.9	1.8	1.8	1.9	1.9	1.9
NIR 2005	0.8	1.0	1.2	1.2	1.1	1.3	1.7	1.7	2.0	1.8	1.8	1.9	1.7	1.6
Difference	**0.7**	**0.6**	**0.5**	**0.3**	**0.3**	**0.4**	**0.1**	**0.1**	**-0.1**	**0.0**	**0.0**	**0.0**	**0.2**	**0.3**

3.3.6 Source-specific planned improvements

In the future The Netherlands intends to use more plant-specific CO_2 emission factors – for example, those provided in the MJVs of large companies – if these improve the accuracy of the emissions while maintaining consistency and transparency. For this source category this refers in particular to refinery fuels produced. In the next submission a re-calculation of CO_2 emissions from refineries for 2001–2004 is expected, which will probably result in an increase in emissions from 0.5 to 1 Tg. Moreover, a pure CO_2 stream generated and released by refineries, which is now reported as 'unaccounted for liquid fuel use' as part of 1A1b, will be separately reported and included in the CRF as process emissions under subcategory 1B2. In the future this CO_2 will be sold to external users (e.g. for crop fertilization in greenhouse horticulture) and monitored separately. In addition, preliminary new data on waste composition (component fractions and carbon fractions) suggest that the split of incinerated waste into the organic and fossil fractions may need to be updated for recent years (e.g. since 2000). This will be considered for the *NIR 2007*.

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' 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 (i.e. coal and coke-derived fuels such as blast furnace/oxygen furnace gas) are 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.

Subcategory 1A2b 'Non-ferrous Metals' consists mainly of two aluminium smelters. CO_2 emissions from anode consumption in the aluminium 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. 1A2f 'Other' includes all other industry branches, among which are mineral products (e.g. 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.

CO_2 emissions from this source category have decreased 18% since 1990. The share of CO_2 emissions from this source category in total national CO_2-equivalent emissions (excluding LULUCF) was 12% in 2004. In 2004 total CO_2 emissions from the manufacturing industries decreased 1% compared to 2003, while solid fuel combustion in the iron and steel industry (1A2a) increased by 10%.

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.

Another feature of industry in The Netherlands is that it operates a large number of 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).

Activity data and (implied) emission factors

Although total industrial production has *increased* about by 22% (in fixed monetary units) since 1990, the combustion emissions of CO_2 have *decreased* by 18% – or by about 5.9 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 31%, or 5.4 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 3.4.* 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).

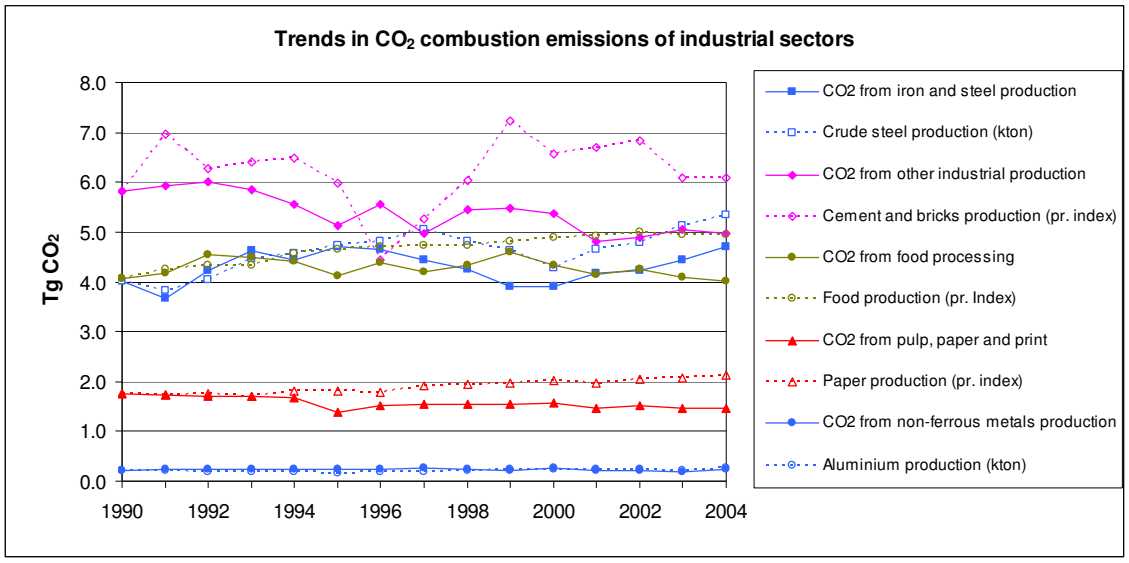


Figure 3.4.a. Trends in CO_2 emissions from combustion in industrial sectors.

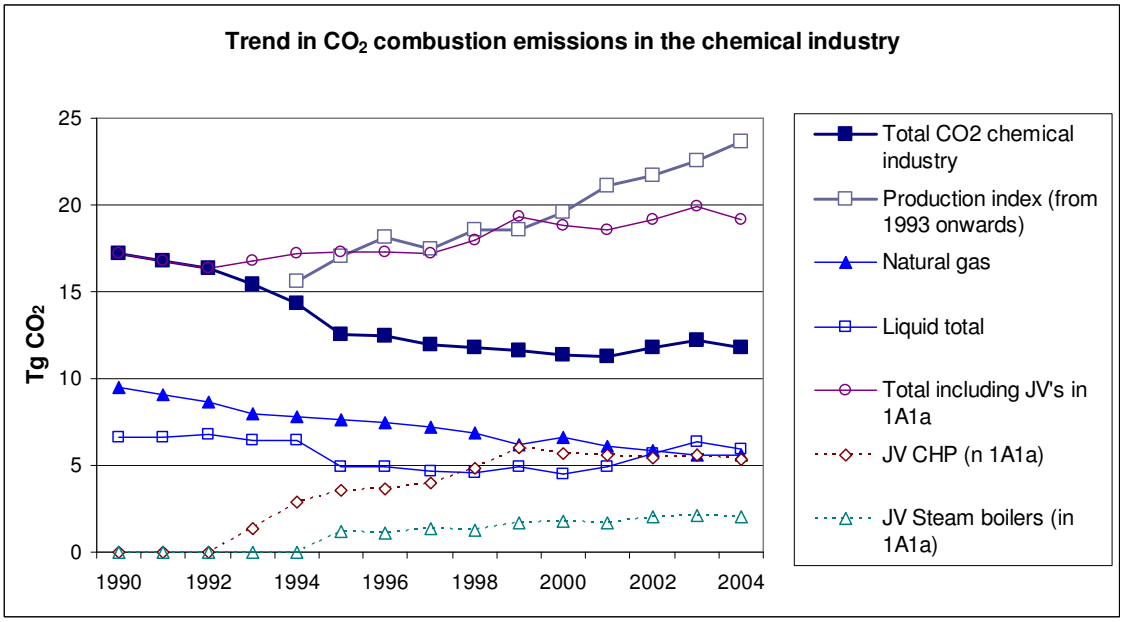


Figure 3.4.b. Trends in CO_2 emissions from combustion in the chemical industry.

Iron and steel [1A2a]

The share of 1A2a in the CO_2 emissions from 1A2 'Manufacturing Industries and Construction' was about 12% in 1990 and 17% 2004. In 2004 solid fuel combustion increased by 10% (+0.4 Tg CO_2) compared to 2003, which is not solely explained by the 4% trend in activity data but rather reflects a higher fraction of derived gases (blast furnace gas, oxygen furnace gas) included in solid fuel combustion, mainly in the coke plants. In addition to this development, a 2% higher fraction of blast furnace gas and oxygen gas was captured in 2004, which reduced conversion losses in blast furnaces in the industrial processes sector (-0.5 Tg CO_2 in 2C1).

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 3.5)*. Total CO_2 emissions have remained rather constant in the period 1990–2004 even though production has increased by more than 25%. 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 25% in 1990 to 12% at the present time and the corresponding increase (about 40%) in the capture and energetic use blast furnace gas (and oxygen furnace gas).

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 (see *Table 3.5*). 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.

Table 3.5 CO_2 emissions from the iron and steel industry by fuel type (excluding CO_2 losses in coke ovens) (Units:Tg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Solid: total	3.3	2.9	3.5	3.9	3.7	3.9	3.9	3.7	3.5	3.1	3.1	3.4	3.4	3.7	4.0
o.w. BF/OX gas in steel	2.4	2.1	2.7	3.1	2.8	3.1	3.0	2.8	2.7	2.5	2.5	2.7	2.8	3.0	3.4
N.B. BF/OX gas in power generation.	3.8	3.9	4.0	4.6	4.8	4.8	4.7	5.1	5.4	5.4	4.9	5.3	5.3	5.5	5.9
Total BF/OX gas	6.2	6.0	6.7	7.7	7.6	7.9	7.7	7.9	8.0	7.8	7.4	8.1	8.1	8.6	9.3
o.w. CO gas in steel	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.6	0.6	0.7
o.w. other than BF/OF or CO gas	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0
Gaseous fuels	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7
Liquid: total	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	0.0
Net CO_2 from C inputs in BF (2C1)	2.5	2.1	1.6	1.5	1.8	1.8	1.8	2.1	1.7	1.5	1.3	1.3	1.3	1.5	1.3
o.w. carbon from iron ore	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
o.w. coke inputs in blast furnaces 2)	2.2	1.9	1.3	1.2	1.5	1.5	1.5	1.8	1.4	1.3	1.0	1.0	1.1	1.2	0.7
o.w. limestone use	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3
Total CO_2 from steel production	6.5	5.8	5.8	6.1	6.3	6.5	6.4	6.5	5.9	5.4	5.2	5.4	5.6	5.9	6.0
Activity data: crude steel prod. [Gg]	5.2	4.9	5.2	5.8	5.9	6.1	6.2	6.5	6.2	6.0	5.5	6.0	6.2	6.6	6.9
CO_2/ton crude steel	1.3	1.2	1.1	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9

Non-ferrous metals [1A2b]

This is a small category that accounts for about 0.2 Tg CO_2, almost all of which originates from natural gas combustion. 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 aluminium 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'. It should be noted that CO_2 from anode consumption, which was about 0.5 Tg in 2004, is reported under 2C.

Chemicals [1A2c]

The share of this category in the CO_2 emissions from category 1A2 was 52% in 1990 and 43% in 2004. CO_2 emissions from this source category have decreased by about 31% since 1990, mainly due to a 41% decrease in natural gas combustion. In 2004 gas combustion remained almost constant compared to 2003. At present, natural gas and liquid fuels together account for about 50% of the CO_2 emissions of this sector.

The steady decreasing CO_2 emissions from the combustion of natural gas can be largely explained by the decreasing use or ownership of co-generation facilities by the industry. CO_2 emissions from liquid fuel combustion stem predominantly from the combustion of chemical residual gas. The marked decrease in liquid fuel consumption since 1995 (see *Table 3.6*) is not due to a decrease in chemical production or data errors, but mainly to a large shift of ownership of a large co-generation plant – one

using residual chemical gas – into a joint-venture, thus re-allocating it to energy industries. 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' sector. 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 1990–2004 period (see *Table 3.6*). 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.

Table 3.6 CO_2 emissions from the chemical industry specified by fuel type (Units: Tg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Natural gas	9.5	9.1	8.6	8.0	7.8	7.7	7.5	7.2	6.9	6.2	6.6	6.1	5.8	5.6	5.6
Liquid: total used in chem. ind.	6.6	6.6	6.7	6.4	6.5	4.9	4.9	4.7	4.6	5.0	4.5	4.9	5.7	6.3	5.9
o.w. chem.residual gas	*5.3*	*4.8*	*4.9*	*4.9*	*4.8*	*3.8*	*4.0*	*3.8*	*4.0*	*4.3*	*4.1*	*4.5*	*5.3*	*5.7*	*5.7*
N.B. chem. residual gas in power gen.	*0.0*	*0.0*	*0.0*	*0.0*	*0.3*	*1.5*	*1.4*	*1.7*	*1.7*	*1.8*	*1.9*	*1.9*	*2.2*	*2.0*	*2.1*
Total chem. residual gas	*5.3*	*4.8*	*4.9*	*4.9*	*5.1*	*5.3*	*5.5*	*5.5*	*5.7*	*6.1*	*6.0*	*6.4*	*7.5*	*7.8*	*7.8*
o.w. other fuels	*1.3*	*1.8*	*1.9*	*1.6*	*1.7*	*1.1*	*0.9*	*0.8*	*0.6*	*0.7*	*0.3*	*0.3*	*0.3*	*0.6*	*0.3*
Natural gas	9.5	9.1	8.6	8.0	7.8	7.7	7.5	7.2	6.9	6.2	6.6	6.1	5.8	5.6	5.6
Solid fuels	1.1	1.0	1.0	1.0	0.1	0.0	0.1	0.1	0.3	0.4	0.3	0.0	0.0	0.0	0.0
Ammonia production (a.o.) (2B)	3.1	3.5	3.5	3.4	3.6	3.6	3.4	3.6	3.6	3.6	3.6	3.0	2.9	2.9	3.1
Total CO_2 chemical industry	17.2	16.8	16.4	15.4	14.4	12.6	12.5	11.9	11.8	11.6	11.3	11.3	11.7	12.2	11.8
Joint-Ventures (JV)	0.0	0.0	0.0	1.4	2.9	4.8	4.8	5.3	6.2	7.7	7.5	7.3	7.4	7.7	7.4
Total including JVs	17.2	16.8	16.4	16.8	17.2	17.3	17.3	17.2	17.9	19.3	18.8	18.6	19.2	19.9	19.1

Pulp, Paper and Print [1A2d]

The share of this category in the CO_2 emissions from 1A2 'Manufacturing Industries and Construction' was about 5% in 1990 and 2004. CO_2 emissions from this source category have decreased 16% since 1990 following the trend in the consumption of natural gas, which is the single most used fuel for this category. A very large fraction, almost 1 Tg from a total of about 1.5 Tg CO_2, results from co-generation (*Figure 3.4.a*). The CO_2 emission level in 1995 is relatively low, due to the shift of joint-venture co-generation to the energy sector (approximately 1 Tg CO_2).

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*).

Food Processing, Beverages and Tobacco [1A2e]

The share of this category in the 1A2 CO_2 emissions was 12% in 1990 and 15% in 2004. The CO_2 emissions of the 'Food, Beverages and Tobacco Industry' (1A2e), almost all of which stem from natural gas combustion, have remained almost constant over time: the 10% increase in gas consumption since 1990 is compensated by decreases in the small uses of other fuels. In 2004 fossil fuel CO_2 emissions decreased 1% compared to 2003. About 1.5 Tg of a total of about 4 Tg CO_2 is currently emitted by co-generation plants owned by the food industry.

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*).

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

Although the CO_2 emissions of this category have decreased by 15% since 1990, its share in total CO_2 emissions from 1A2 'Manufacturing Industries and Construction' remained at 18% in 1990 and 2004. Most of the present 5 Tg CO_2 emissions from this source category stem from gas combustion (about

3.5 Tg). Almost all of the remaining CO_2 emissions relate to the combustion of liquid fuels (1–2 Tg CO_2), of which off-road machinery accounts for 0.7–1.2 Tg CO_2. A very small portion of the CO_2 emissions (0.2 Tg) originates from co-generation plants. The varying amounts from liquid fuel are mainly due to the relatively large inaccuracy of the fuel consumption data in the energy statistics for off-road machinery. The much higher levels of biofuel combustion during the period 1991–1994 include the amounts not reported under the previous categories 1A2b to 1A2e and, by accident, the amount originally allocated to category 1A1a.

The small amounts and varying shares of derived gases explain the large inter-annual variation that can be observed in the IEFs for solid and liquid fuels. For 1991–1994, in particular, the detailed fuel mix assumed was often different from that of the adjoining years 1990 and 1995 due to the revision of the energy statistics at a high aggregation level (for more details on this, see *NIR 2005*).

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). 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 residual chemical 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 residual chemical 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' industry. 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 subcategory 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 liquids (Olivier and Brandes, 2006). 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 residual chemical 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 (2006) and further discussed in Olivier and Brandes (2006), 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 residual chemical 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 the 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 aluminium 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 (residual chemical 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: Protocol 5401: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.4.5 Source-specific re-calculations

See *Section 3.2.5* for the explanation of the re-calculation of emissions from gas combustion due to the revision of the emission factor for natural gas.

The present data set for biomass combustion in this source category is be replaced by a new consistent time series of activity data and emissions based on new monitoring data recently incorporated in the national energy statistics. The data are compiled in a new project for collecting annually national statistics on renewable energy use specified by sector as set down in the *Protocol for Monitoring of Renewable Energy* (Abeelen and Bosselaar, 2004). Data for 1990 onwards are reported in *CBS, 2004*. The consistency of the time series is improved and the very large inter-annual variations reported in the previous NIR 2005 in this source category 1A2 are reduced. However, this improvement has only a very small impact on the total national greenhouse gas emissions.

3.4.6 Source-specific planned improvements

The Netherlands intends to use more plant-specific CO_2 emission factors in the future such as those reported in the MJVs of large companies. This might improve the accuracy of the emissions, while maintaining consistency and transparency. This will particularly affect the emissions from the combustion of residual chemical gas, blast furnace gas and coke oven gas for this source category.

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 (inland) transport. Domestic aviation consists of the domestic civil aviation traffic between Dutch airports, while 'Civil Aviation' is the aviation traffic from and to

the same airport. Emissions from international transport (aviation bunkers) are reported separately; see *Section 3.8.* 1A3d 'Navigation' includes emissions from domestic navigation (inland shipping). Emissions from fuel used in international navigation are not included in 1A but in the inventory in 'Marine Bunkers'; see also *Section 3.7*. Emissions from national fisheries are included in 1A4c 'Agriculture, Forestry and Fisheries'; see *Section 3.6*. Greenhouse gas emissions from mobile combustion by military aircraft and shipping activities (Hulskotte, 2004a, b) are included in 1A5 (see *Section 3.7*), while emissions from off-road machinery, such as tractors in agriculture, are included in 1A4c 'Agriculture'. Emissions from road and building construction equipment and other areas 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.

Key sources

CO_2 emissions from 1A3b 'Road Transport', all fuel types, CO_2 emissions from 1A3d 'Navigation' and N_2O emissions from 1A3 'Road transport' are identified as key sources (*Table 3.1*).

Activity data and (implied) emission factors

Civil Aviation [1A3a]

The share of 1A3a 'Civil Aviation' in national CO_2 emissions was less than 1% in both 1990 and 2004. Domestic aviation in The Netherlands released 0.04 Tg CO_2 in 1990 and in 2004, based on a rough estimate of fuel consumption in 2000 by domestic aviation, which is applied to the whole time series (see *Section 3.5.2*).

Road Transport [1A3b]

While the share of petrol in fuel sales to road vehicles has remained rather constant over the whole period, there has been a shift from LPG to diesel fuel. This shift has effectively increased the share of diesel in road transport fuel sales from 46% in 1990 to 58% in 2004 (*see Figure 3.5).*

The share of 1A3b 'Road Transport' in national CO_2 emissions was 16% in 1990 and 19% in 2004. Passenger cars are by far the largest contributor to this source category, accounting for 64% in 1990 and 59% in 2004 (see *Table 3.7*). The share of CO_2 emissions of freight transport in total road transport increased from 36% in 1990 to 41% in 2004.

CO_2 emissions from 1A3b 'Road Transport' increased by 8.4 Tg or 33% during the period 1990–2004, primarily due to the increased use in passenger cars (+21%) and vans (+130%). In addition, the energy efficiency of both passenger cars and vans did not improve significantly between 1990 and 1999. The European, Korean and Japanese car manufacturers are committed to selling new cars in the European Union in 2008 that release, on average, 25% less CO_2 per kilometre than in 1995. While this has probably led to a slight decrease in average fuel use per kilometre driven during the last years, this supposition cannot be proven because data on car use has become more and more uncertain since 1999. In 1999 Statistics Netherlands cancelled the annual passenger car use survey that supplied data on car use and fuel efficiency per fuel type.

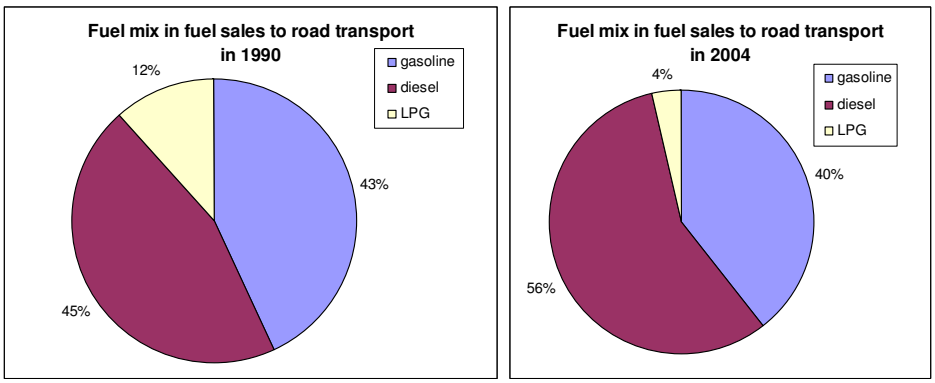


Figure 3.5 Shares of petrol, diesel and LPG in fuel sales to 'Road Transport' 1990 and 2004.

Table 3.7 CO_2 emissions from road transport specified by type of vehicle (Units: Tg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Passenger transport	16.4	16.5	16.9	17.4	17.8	18.2	18.5	18.6	18.9	19.1	19.0	19.3	19.7	19.8	19.9
Freight transport	9.1	9.3	10.1	10.2	10.2	10.4	10.9	11.1	11.6	12.2	12.7	12.9	13.2	13.6	14.0
o.w. Freight vans	*2.4*	*2.4*	*2.7*	*3.0*	*3.0*	*3.1*	*3.3*	*3.6*	*4.0*	*4.4*	*4.8*	*5.0*	*5.2*	*5.5*	*5.8*
o.w. Freight trucks	*6.7*	*6.9*	*7.4*	*7.2*	*7.2*	*7.3*	*7.5*	*7.5*	*7.6*	*7.8*	*7.8*	*7.9*	*7.9*	*8.1*	*8.2*
Total road transport	**25.5**	**25.8**	**27.0**	**27.6**	**28.0**	**28.6**	**29.4**	**29.7**	**30.5**	**31.3**	**31.7**	**32.2**	**32.9**	**33.4**	**33.8**

CH_4 emissions by 1A3b 'Road Transport' dropped almost 57% between 1990 and 2004, from 7.5 to 3.2 Gg CH_4 (0.07 Tg CO_2-eq.). In 2004 passenger cars were accountable for 66% of these CH_4 emissions. This reduction is related to the reduction in total VOC emissions that followed the implementation of European emission legislation for new road vehicles: total combustion and fugitive VOC emissions by road transport decreased approximately 50% during the period 1990–2004. This reduction is mainly the result of the penetration of catalyst-equipped cars into the passenger car fleet.

N_2O emissions from 1A3b 'Road Transport' increased from 0.9 Gg in 1990 to 1.6 Gg N_2O (0.5 Tg CO_2-eq.) in 1999 and remained more or less stable between 1999 and 2004. The increasing trend up to 1999 can be explained by the increased vehicle kilometres and the increasing share of petrol cars equipped with a catalytic converter, as the latter have a higher emission factor than cars without this emission control technology. The fact that N_2O emissions from transport are constant between 1999 and 2004, despite the increase in vehicle-kilometres, is explained by a mix of developments (see *Figures 3.6 and 3.7*):

- Subsequent generations of catalytic converters (the second was introduced in 1996) appear to have lower N_2O emission factors (Gense and Vermeulen, 2002).
- The share of diesel cars in road passenger transport, which are assumed to have a lower emission factor than catalyst-equipped petrol cars, has increased during the last few years.

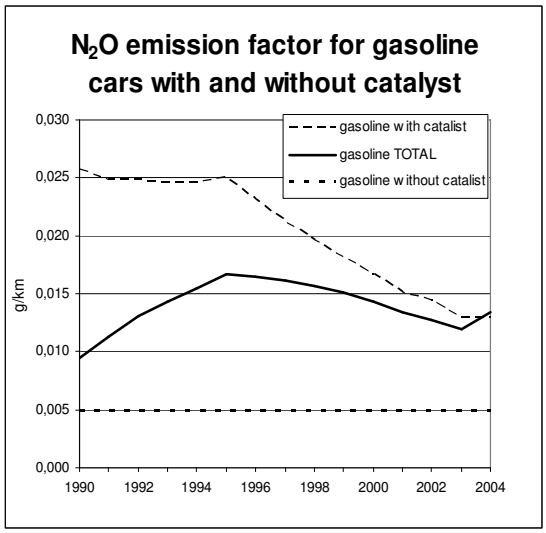


Figure 3.6 Trends in emission factors for N_2O from petrol passenger cars in The Netherlands due to the increase in the numbers of cars equipped with a catalytic converter.

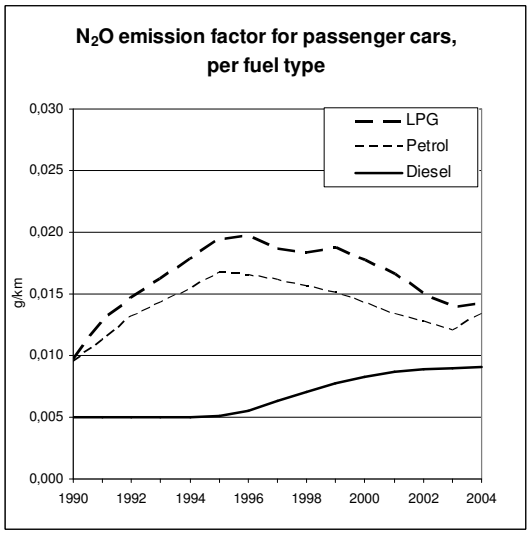


Figure 3.7 Trends in emission factors for N_2O from passenger cars in The Netherlands specified by fuel type

Rail transport [1A3c]

The share of 1A3c *Rail transport* in national CO_2 emissions was less than 1% in 1990 and 2004; consequently, rail transport is not a key source.

Navigation [1A3d]

The share of domestic waterborne navigation (1A3d) in national CO_2 emissions was small (about 0.5%) in both 1990 and 2004. Emissions were about 0.4 Tg in 1990 and 0.8 Tg in 2004. The results of the key source analysis show that 'Navigation' is a key source (see *Section 3.5.3*).

3.5.2 Methodological issues

A detailed description of the methodology and data sources used to calculate transport emissions are 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 gasoline 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 gasoline and 230 TJ jet kerosene), these figures are used for the whole time series. CO_2 emissions are calculated based on fuel consumption by aircraft for domestic flights in The Netherlands (Pulles, 2000). Default IPCC emission factors for kerosene and aviation gasoline (avgas) are used to calculate greenhouse gas emissions. Deliveries of bunkers to international aviation are not included in this source category.

Non-greenhouse gas emissions reported in the NIR under domestic air traffic are the uncorrected emissions 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; emissions from other airports are ignored. No attempt has been made to estimate non-greenhouse gas emissions related to only *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-kilometres. However, the fuel consumption figure that is based on vehicle-kilometres is lower than the fuel consumption included in the statistics on energy sales in The Netherlands. The *Revised IPCC Guidelines* (IPCC, 1997) asks countries to report greenhouse gas emissions from combustion on the basis of fuel consumption within the national territory. Thus, 'Road Transport' emissions of the direct greenhouse gases CO_2, CH_4 and N_2O are calculated based using IPCC methodologies.

An IPCC Tier 2 methodology is used for CO_2 emissions from 'Road Transport' using The Netherlands' data on fuel sales to 'Road Transport' from Statistics Netherlands (CBS) and country-specific emission factors, as reported in Klein *et al.* (2004), see *Annex 2*.

An IPCC Tier 3 methodology is used for CH_4 emissions from 'Road Transport'. CH_4 emissions from 'Road Transport' were calculated based on data on the mass fractions of different compounds in total VOC (Veldt and Van der Most, 1993). In turn, VOC emissions from 'Road Transport' are calculated using data on vehicle-kilometres from Statistics Netherlands (CBS), and VOC emission factors are obtained from The Netherlands Organization for Applied Scientific Research (TNO). The mass fraction is dependent on the fuel type and whether a petrol-fuelled vehicle is equipped with a catalyst or not. 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, while 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 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 vehicles using petrol or LPG are based on country-specific data (Gense and Vermeulen, 2002). Emission factors for diesel light-duty vehicles, heavy-duty vehicles, motorcycles and mopeds are based on Riemersma *et al*. (2003). From 2005 onwards, new heavy-duty diesel engines will require exhaust after-treatment systems such as SCR-deNO_x (selective catalytic converters) or EGR

(exhaust gas re-circulation) combined with a CRT (continuous regeneration trap) to be able to meet the Euro4 emission limits. Euro4 and Euro5 heavy-duty diesel vehicles will probably emit about 50 mg N_2O per kilometre (Riemersma *et al*., 2003).

Since the CO_2 and N_2O emissions from 'Road Transport' are considered to be key sources (see *Table 3.1*), the present Tier 2 and Tier 3 methodologies comply with the *IPCC Good Practice Guidance* (IPCC, 2001). CH_4 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 therefore calculated bottom-up using vehicle-kilometre data (i.e. with fuel consumption figures that are somewhat different from the energy supply statistics; see *Section 3.5.4* for more details).

Rail Transport [1A3c]
Information on fuel use by diesel trains is obtained from the Dutch Railways (NS). For CO_2 emissions, country-specific emission factors are used (Olivier, 2004), see *Annex 2*. For CH_4 and N_2O emissions, IPCC default emission factors have been 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 (i.e. sold without VAT). Although the national energy statistics (NEH) makes a distinction between trips on the Rhine river and 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) method, however, it is possible to distinguish between national and international navigation based on ton-kilometres travelled 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 does comply with the *IPCC Good Practice Guidance* (IPCC, 2001). Emissions from fisheries are allocated under 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). 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). 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 jet kerosene and diesel used in non-road categories, the uncertainty 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 (Van der Sluijs, 2006 in preparation). The uncertainty in fuel use by road vehicles is 2% for gasoline, 5% for diesel oil and 10% for LPG.

The uncertainty in CH_4 emissions from 'Road Transport' is estimated to be approximately 60% 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 very possible that the mass fraction of CH_4 has changed due, for example, to recent changes in the aromatic content of road transport fuels or to improved exhaust after-treatment technology. The uncertainty in N_2O emissions from 'Road Transport' is estimated to be 50% in annual emissions. Although current emissions from heavy-duty diesel vehicles are probably overestimated, when the whole time series (since 1990) is taken into consideration, the overestimation only slightly affects the emission trend.

The uncertainty in fuel used by 'Civil Aviation' is presently estimated to be about 50%, while that in *'Navigation'* is estimated to be 20%. The uncertainty in CH_4 and N_2O emissions from other non-road transport sources is estimated to be about 100% in annual emissions (50% uncertainty in activity data and 100% in emission factors). As for 'Road Transport', data on the share of CH_4 in total VOC from these sources are based on Veldt and Van der Most (1993) and has not been validated since.

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-kilometre approach versus IPCC approach
The Netherlands applies two methodologies to calculate the CO_2 emissions from fuel consumption by 'Road Transport': (1) the IPCC approach (based on fuel deliveries); (2) the national approach, which is based on transport statistics in terms of vehicle-kilometres travelled.
The difference in fuel consumption inferred from transport statistics compared with that inferred from supply statistics on deliveries to fuelling stations is in the range of about 4–9%. This difference is not so much caused by petrol, which shows only differences up to +7%, with an average of around 2%, but rather by diesel and LPG figures, which differ annually by up to –23%, with an average of about –12% and –14%, respectively (see *Figure 3.8*). These differences can be explained to some extent, but not completely; for example, by fuel bought on both sides of the Dutch borders but consumed on the other side (Van Amstel *et al*., 2000a). Another explanation is the bad representation of company cars – which drive the most kilometres per year (usually using diesel or LPG) – in the passenger car questionnaire, which results in an underestimation of kilometres travelled by passenger cars. As illustrated in *Figure 3.8*, the annual differences per fuel type have more or less the same sign for the whole period. The discrepancy between total road fuel consumption and fuel deliveries has tended to decrease during the last 5 years. It can be concluded that roughly both methods show similar trends in fuel consumption by fuel type over the last 10 years.

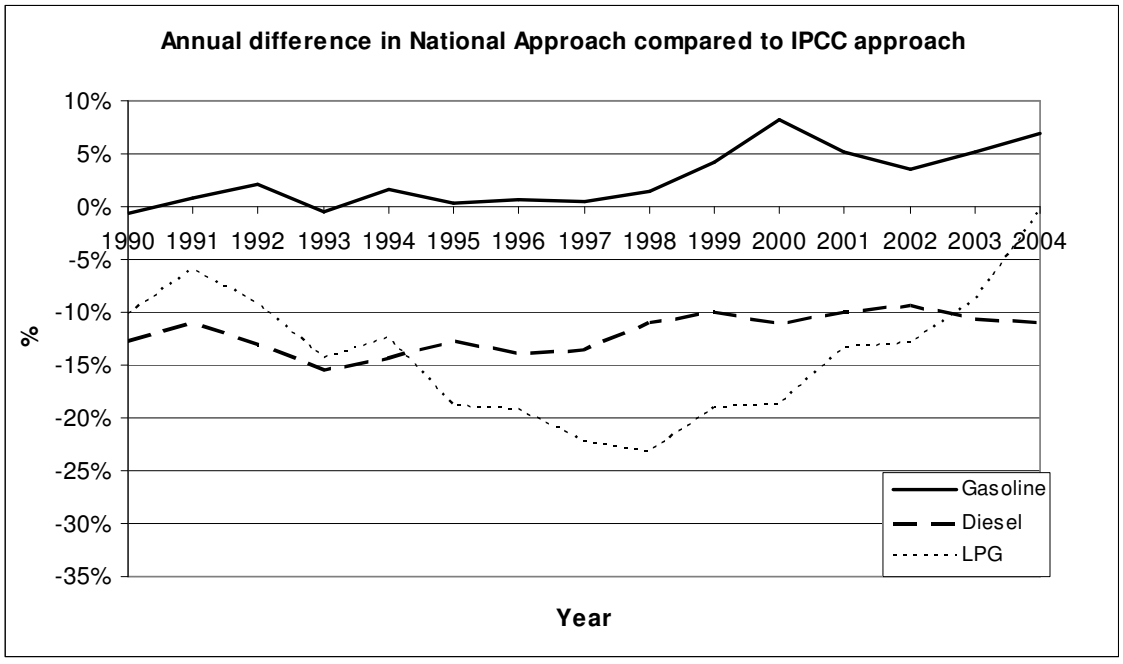


Figure 3.8 Annual differences per fuel type between fuel consumption (Units: PJ) according to the national approach (based on vehicle-kilometre statistics) and the IPCC approach (based on fuel deliveries to fuelling stations).

3.5.5 Source-specific re-calculations

IPCC default emission factors for CO_2, CH_4 and N_2O were used to re-calculate the emissions from 1A3d 'Navigation' for the whole time series, resulting in minor changes in the emissions compared to those reported in the *NIR 2005*. In addition, the activity data for 1A3d 'Navigation' have also been updated for the years 2000–2003, which has also affected the emissions.

3.5.6 Source-specific planned improvements

New emission factors for passenger cars ("cold start") became available in 2006 from research by TNO. NMVOC emissions for passenger cars are significantly higher due to the inclusion of the cold-start effect on emissions. Since CH_4 is calculated as a fixed share of NMVOC, the CH_4 emissions are also higher, but they still remain very small.

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'.

Within this source category, the combustion of gases and liquids form a key source for CO_2 emissions, this is particularly true for gases (37 Tg CO_2). Within the categories, gases in 1A4a and 1A4b, and gases and liquids in 1A4c are key sources. About 50% of the total CH_4 emissions in the *Energy* sector stems from the 'Residential' sector (0.3 Tg CO_2-eq., see *Table 3.1*). With the exception of liquid fuels used in category 1A4c for fisheries and agricultural machinery, almost all of the fossil fuel used in this source category is natural gas.

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.

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.

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 2004, respectively. 1A4b 'Residential' is the main contributor, contributing approximately 9% to the total national CO_2-equivalent emissions. Since 1990, CO_2 emissions from 1A4 'Other Sectors' have increased by 6%. CO_2 emissions from 1A4a 'Commercial/Institutional Services' have increased by 53% since 1990, whereas those from 1A4c 'Agriculture' have decreased by 11%. CO_2 emissions from 1A4b 'Residential' have remained almost constant in this period as have the CH_4 and N_2O emissions of the total 1A4 source category (see *Table 3.1*). In 2004, CO_2 emissions from 1A4 'Other Sectors' decreased by 1% compared to 2003 due to decreased gas combustion (1%) in the 'Residential' and 'Service' sectors.

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. The 'Residential' sector is by far the largest category (see *Table 3.1*), accounting for approximately 90% of the CH_4 emissions. Within this category, over 70% of the CH_4 emissions stem from residential gas combustion, in particular from cooking losses; the remainder is from biofuel combustion.

Since most of the fuel consumption in this source category is used for space heating, the gas consumption and related CO_2 emissions from 1A4 'Other Sectors' tend to vary considerably across years in response to variations in winter temperatures over time, thereby resulting in more or less space heating as the need arises. In the 'Residential' sector, space heating requires about three-quarters of the total consumption of natural gas. For trend analysis, a method is used to correct the CO_2 emissions from gas combustion for the varying winter temperatures (Peek, 2006, in preparation). For more details see *Section 3.6.3*.

Activity data and (implied) emission factors

Commercial and Institutional Services [1A4a]
In the 'Commercial/Institutional Services' sector, CO_2 emissions have increased about 50% since 1990. However, when a temperature correction is taken into account, the structural, anthropogenic trend shows a somewhat lower increase of 36% in this period (see Peek, 2006, in preparation). The 'Commercial/Institutional Services' sector has grown strongly during this period: the amount of manpower (in man-years) increased 32% in the period 1990–2000, while energy consumption increased 28%. This increase is roughly compatible with the approximately 45% structural increase in the emissions. It should be noted that of the CO_2 emissions from the service sectors, about 0.4 Tg in 1990, increasing to about 0.8 Tg in 2004, are emissions from co-generation 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.

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 re-calculation 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(see *Section 3.9*).

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 3.9*). The variations are much larger for liquid and solid fuels because of the much smaller figures. The biomass consumption is almost all wood (fuelwood, 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 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 not 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 12% in this period (see Peek, 2006, in preparation). Although the number of households and residential dwellings increased about 15% since 1990, the average fuel consumption per household decreased by 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 by about 11% since 1990, mainly due to a 15% 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 18% in this period (see Peek, 2006). This is mainly due to energy conservation measures in greenhouse horticulture, which 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 8% in the period after 1990 and now occupies over 95% of the total area of greenhouses. In particular, the cultivation of flowers and plants showed a large aerial increase of 15%. Thus, we may conclude that heated greenhouses have reduced their energy consumption, although their surface area has increased by 8% and 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 co-generation facilities, which may also provide electricity to the public grid.

Agricultural Machinery and Fisheries [1A4c] (mobile combustion)
In *Table 3.8* the CO_2 emissions from off-road machinery in agriculture and from fisheries are presented. Both sources emit a little over 1 Tg of CO_2.The CO_2 emissions from agricultural machinery have increased by 9% since 1990, whereas the emissions from fisheries have decreased 24%. Emission factors used for fisheries are presented in *Table 3 9.*

Table 3.8 Trend in CO_2 emissions from 'Agricultural Machinery and Fisheries'.

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Agricultural machinery	1.5	1.5	1.5	1.4	1.5	1.6	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6
Fisheries	1.2	1.3	1.2	1.3	1.4	1.4	1.3	1.3	1.2	1.3	1.3	1.2	1.1	1.1	1.1
Total mobile in 1A4c	2.7	2.7	2.7	2.7	2.8	3.0	2.7	2.7	2.7	2.8	2.8	2.8	2.7	2.7	2.7

Table 3.9 Emission factors[1)] used for fisheries.

Category	Fuel type	CO_2	CH_4	N_2O
Fisheries	Diesel	74.3 kg/GJ	5 g/GJ	0.6 g/GJ
	Heating oil	77.4 kg/GJ	5 g/GJ	0.6 g/GJ

[1)]Source: Monitoring Protocol 5410: CO_2 , CH_4 and N_2O from fisheries on www.greenhousegases.nl.

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. 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.

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 subcategory 1A4c and subtracted from the amount of bunker fuel consumption in the NEH. The modified bunker figures are reported as a

Memo item. *Table 3.23* shows the emission factors from this source. For more details, see the monitoring protocol for in-land navigation.

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 subcategories of 1A4. In particular, energy consumption by the commercial/institutional and – to some extent – agricultural categories 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. 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 (2006) and further discussed in Olivier and Brandes (2006), 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 ('HDD: running normal' in *Table 3.10*), as explained in Visser (2005). *Table 3.10* presents the calculated temperature correction factors for space heating; for more details, see Peek (2006, in preparation).

Table 3.10 Heating degree-days and temperature correction factors used for trend analysis.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Heating: degree-days (H)	2677	3163	2829	3076	2835	2917	3504	2929	2821	2676	2659	2880	2720	2913	2877
HDD:running normal (N)	3211	3198	3203	3177	3156	3140	3124	3135	3133	3118	3098	3076	3068	3046	3035
T-correction factor (= N/H)	**1.20**	**1.01**	**1.13**	**1.03**	**1.11**	**1.08**	**0.89**	**1.07**	**1.11**	**1.17**	**1.17**	**1.07**	**1.13**	**1.05**	**1.06**

Figure 3.9 compares the actual emission trend data for CO_2 of the three subcategories 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.

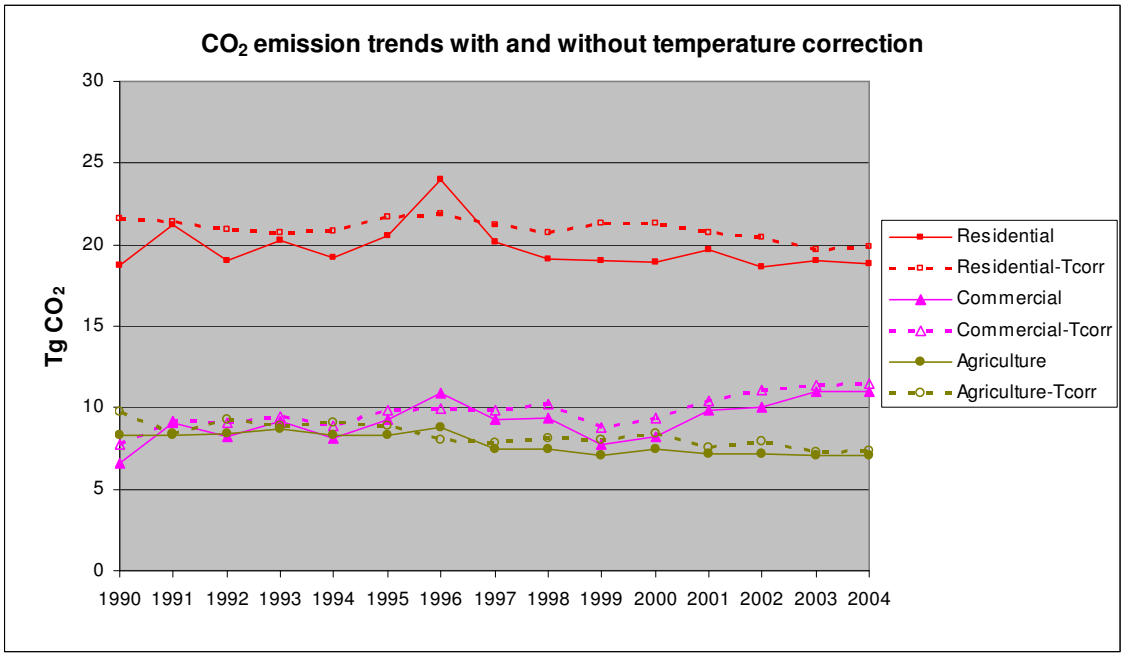


Figure 3.9 CO_2 emissions of 1A4 'Other Sectors': actual versus temperature-corrected trends, based on a 'normal' determined by the long-term trend.

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 (e.g. 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 5401: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels.

3.6.5 Source-specific re-calculations

See *Section 3.2.5* for the explanation of the re-calculation of emissions from gas combustion due to the revision of the emission factor for natural gas.

The present data set for biomass combustion in this source category is be replaced by a new consistent time series of activity data and emissions based on new monitoring data recently incorporated in the national energy statistics. The data are compiled in a new project for collecting annually national statistics on renewable energy use specified by sector as set down in the *Protocol for Monitoring of Renewable Energy* (Abeelen and Bosselaar, 2004). Data for 1990 onwards are reported in *CBS, 2004*. The consistency of the time series is improved and the very large inter-annual variations reported in the previous NIR 2005 in this source category 1A2 are reduced. However, this improvement has only a very small impact on the total national greenhouse gas emissions.

3.6.6 Source-specific planned improvements

An improvement may be a revision of aggregated emission factors for the years 1991–1994 to bring them in line with the fuel mixes in 1990 and 1995.

3.7 Others [1A5]

3.7.1 Source category description

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

Activity data and (implied) emission factors

The CO_2 emissions from this source category have been stable since 1990 (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 (*Table 3.11.a*). The emission factors used are presented in *Table 3.11.b.* The emissions of CH_4 and N_2O are negligible.

Table 3.1.1a Trend in CO_2 emissions from military ships and aviation.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Military ships	0.25	0.23	0.24	0.23	0.21	0.23	0.20	0.20	0.22	0.23	0.21	0.18	0.22	0.17	0.17
Military aviation	0.32	0.31	0.32	0.31	0.28	0.28	0.30	0.30	0.30	0.42	0.37	0.29	0.28	0.27	0.27
Total	**0.57**	**0.54**	**0.55**	**0.54**	**0.49**	**0.51**	**0.51**	**0.49**	**0.52**	**0.65**	**0.58**	**0.47**	**0.50**	**0.44**	**0.44**

Table 3.11.b Emission factors[1)] used for military marine and aviation activities.

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 2003 (Gg)	0.44	0.03	0.04

[1)]Source: Hulskotte (2004b).

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 Defence 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 Defence (see *Table 3.28*). 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*.

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 re-calculations

There have been no source-specific re-calculations.

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

'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.

Activity data and (implied) emission factors

The energy consumption of Marine bunkers and Aviation bunkers has grown substantially in the period 1990–2004 (see *Table 3.12*) with CO_2 emissions from Marine bunkers showing a 36% increase during this period (up to about 47 Tg in 2004). CO_2 emissions from Aviation bunkers increased by 131% in the same period to reach 10.5 Gg in 2004.

Table 3.12 Energy consumption[1)] (Units:PJ) and greenhouse gas emissions from bunker fuel[1)] (Units: CO_2 in Tg; CH_4 and N_2O in Gg) in the period 1990–2004.

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Energy consumption															
Marine bunkers[2)]	**445**	**460**	**464**	**480**	**455**	**461**	**471**	**499**	**505**	**522**	**555**	**611**	**604**	**564**	**608**
Residual fuel oil	368	378	382	410	384	375	391	427	427	446	473	522	521	491	541
Gas/diesel oil	73	78	78	66	66	82	75	68	73	71	76	82	77	68	63
Lubricants	4	4	4	4	5	4	5	5	5	5	6	7	5	5	4
Aviation bunkers[3)]	**64**	**68**	**79**	**87**	**91**	**106**	**113**	**122**	**134**	**138**	**136**	**133**	**140**	**137**	**147**
- jet fuel (kerosene)	64	68	79	87	91	106	113	122	134	138	136	133	140	137	147
Total bunkers	**509**	**528**	**543**	**567**	**546**	**567**	**584**	**622**	**639**	**660**	**692**	**745**	**743**	**702**	**755**
CO_2 emissions															
Marine bunkers[2)]	**34.4**	**35.3**	**35.6**	**36.9**	**35.0**	**35.4**	**36.2**	**38.4**	**38.9**	**40.2**	**42.7**	**47.0**	**46.5**	**43.4**	**46.8**
Residual fuel oil	28.6	29.2	29.5	31.7	29.7	29.0	30.3	33.0	33.0	34.5	36.6	40.4	40.3	38.0	41.8
Gas/diesel oil	5.4	5.8	5.8	4.9	4.9	6.1	5.6	5.0	5.4	5.3	5.6	6.1	5.8	5.1	4.7
Lubricants	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.4	0.3	0.3
Aviation bunkers[3)]	**4.5**	**4.8**	**5.6**	**6.2**	**6.5**	**7.6**	**8.1**	**8.7**	**9.6**	**9.8**	**9.7**	**9.5**	**10.0**	**9.8**	**10.5**
- jet fuel (kerosene)	4.5	4.8	5.6	6.2	6.5	7.6	8.1	8.7	9.6	9.8	9.7	9.5	10.0	9.8	10.5
Total bunkers	**38.9**	**40.2**	**41.3**	**43.1**	**41.5**	**43.0**	**44.3**	**47.2**	**48.4**	**50.0**	**52.5**	**56.6**	**56.4**	**53.3**	**57.3**
CH_4 emissions															
Marine bunkers[2)]	**0.84**	**0.87**	**0.88**	**0.88**	**0.84**	**0.88**	**0.89**	**0.92**	**0.94**	**0.96**	**1.02**	**1.12**	**1.10**	**1.02**	**1.08**
Aviation bunkers[3)]	**0.22**	**0.23**	**0.27**	**0.30**	**0.31**	**0.36**	**0.38**	**0.42**	**0.45**	**0.47**	**0.46**	**0.45**	**0.47**	**0.47**	**0.50**
Total bunkers	**1.06**	**1.11**	**1.15**	**1.18**	**1.16**	**1.24**	**1.27**	**1.33**	**1.39**	**1.43**	**1.49**	**1.58**	**1.58**	**1.49**	**1.58**
N_2O emissions															
Marine bunkers[2)]	**0.27**	**0.28**	**0.28**	**0.29**	**0.27**	**0.28**	**0.28**	**0.30**	**0.30**	**0.31**	**0.33**	**0.37**	**0.36**	**0.34**	**0.36**
Aviation bunkers[3)]	**0.04**	**0.04**	**0.05**	**0.05**	**0.05**	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.09**
Total bunkers	**0.31**	**0.32**	**0.33**	**0.34**	**0.33**	**0.34**	**0.35**	**0.37**	**0.38**	**0.40**	**0.42**	**0.45**	**0.45**	**0.42**	**0.45**

[1)] Source: CBS, 1990-2004 (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). Residual fuel oil, heavy fuel oil; gas/diesel oil, petrol.
[3)]Aviation petrol is included under jet fuel.

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 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 re-calculations

There have been no significant source-specific re-calculations. A small error correction was made for lubricant consumption in 1991–1994.

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;
- 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 –fuelwood only.

- 1A4c 'Agriculture/Forestry/Fisheries' – biogas from composting of manure, and composting of kitchen and garden waste.

Table 3.13 Biomass fuel consumption specified per source category and fuel type 1990–2004 (Units: in PJ).

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total 1A1	15.2	15.9	16.7	19.2	19.1	21.6	25.9	28.7	30.4	33.1	36.0	39.1	44.4	41.3	48.3
Total 1A2	2.6	2.4	2.5	2.6	2.8	3.2	3.3	3.4	3.3	3.2	3.2	3.1	3.3	3.7	4.5
Total 1A4	13.9	13.9	14.0	14.0	13.7	13.4	13.5	13.5	13.3	12.9	13.9	14.2	14.1	13.4	13.3
National total	31.8	32.3	33.3	35.9	35.7	38.2	42.8	45.6	47.0	49.2	53.1	56.4	61.8	58.4	66.1

Table 3.14 Organic CO_2 emissions (Units: Gg) reported as CO_2 from biomass combustion (included in 1A).

Category	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1A	Fuel combustion	3.9	3.8	3.9	4.1	4.0	4.3	4.9	5.3	5.5	5.7	6.2	6.5	7.1	6.8	7.6
1A1	Energy industries	2.1	2.1	2.2	2.4	2.3	2.6	3.1	3.6	3.8	4.1	4.4	4.7	5.3	5.0	5.8
1A2	Manufacturing industries	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4
1A3	Transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1A4	Other sectors	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.4	1.5	1.5	1.4	1.4
1A4a	Commercial/Institutional	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.3
1A4b	Residential	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.0	1.0
1A4c	Agriculture/Forestry/Fisheries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total memo CO2 from biomass		3.9	3.8	3.9	4.1	4.0	4.3	4.9	5.3	5.5	5.7	6.2	6.5	7.1	6.8	7.6

[1)]NO, Not occurring

Activity data and implied emission factors

Table 3.13 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 66 PJ. This increase is the result of increased waste incineration with energy recovery since the early 1990s 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. On the other hand, fuelwood use in the 'Residential' sector has decreased since 1990 by more than 10%. In addition, the use of biogas produced from landfills and WWTPs has increased significantly and now has about a 7% share in total biofuel combustion. Through these developments, the share of residential biofuels decreased from 36% in 1990 to 14% in 2004. Please 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

In this report, all data is replaced by a new data set compiled within a special annual project with the aim of monitoring the use of renewable energy sources in The Netherlands (CBS, 2005; Segers, 2005) since it also includes the compilation of a time series back to 1990. For residential biofuel use, the present PER monitoring data include fuelwood and organic waste combustion in residential multi-burners even though this is not included in the data collection method of the DE project. Charcoal consumption is included in CBS (2005), while the PER 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 included in the PER data set for greenhouse gas emissions.

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 judgements, the uncertainty in fuelwood and biogas consumption is estimated to be approximately 25% and 10%, respectively (Olivier and Brandes, 2006).

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, +50–100% and –25%. However, the amounts of biomass fuels are now also annually accounted for – in energy units – in a separate monitoring of renewable energy use in The Netherlands (see, for example, CBS, 2004). Consequently, the present inconsistent data may be replaced in the future by more reliable figures. The uncertainty in the emission factors is rather high (e.g. 5% 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 biogas. The uncertainty in CH_4 and N_2O emission factors is estimated to be much higher (e.g. 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 on the Memo item: 'CO_2 from Biomass'.

3.9.5 Source-specific re-calculations
In 2004, The Netherlands compiled annually national statistics on renewable energy use by sector according to the *Protocol for Monitoring of Renewable Energy* (Abeelen and Bosselaar, 2004). As part of the first step in undertaking this activity, consistent time series for consumption of renewable energy since 1990 were also established (CBS, 2005). The new data set for estimating emissions from biomass is now implemented in the *NIR 2006*. The revision affects all activity data. In addition, dividing incinerated waste into organic and fossil fractions is re-assessed for recent years (for example, since 2000).

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 re-calculation differences can be found in *Annex 4*.
There are three 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.

In addition, 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 3.15* the results of the *IPCC Reference Approach* calculation are presented for 1990–2004 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 –0.3% for 2004 and -4.3% for 1991 and 1992. The largest differences are seen for the 1990s.

However, if we correct for the fossil waste included in the NA and the 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 all below 2% (see *Table 3.16*): between –0.5% in 1992 and +1.6% in 2004, with an (direct) average of 0.7%. Also, the largest differences do not concentrate in a particular time span of the period in question. The corrected 1990–2004 trends also differ only slightly: 13.1% for the NA (= sum of sectoral emissions in source category 1A plus selected 1B and 2 minus fossil waste) and 11.9% for the RA. The corrected comparison with the RA (based on national energy balance data) shows differences in emissions from liquid fuels of up to 4% for a single year (except for 2004, when it was 6%) compared to 3% for several of the years when uncorrected comparisons were made; differences of up to 3% compared to 10% for solid fuels and 1% compared to 5% for gaseous fuels are calculated if corrections are made for 2G ('Non-energy Uses') in NA-liquids, 1B1 ('Coke Production'), 2A ('Soda Ash'), 2B4, 2C1 ('Blast Furnaces) and 2D in NA-solids, and 1B1 ('Gas Flaring') and 2B1 (Ammonia') in NA-gases (*Table 3.16*).

Table 3.15 Comparison of CO_2 emissions: Reference Approach (RA) versus National Approach (in percentage).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004[1)]
Liquid fuels	0.2	-1.5	-2.1	0.6	-0.2	1.7	0.7	1.1	2.9	2.6	1.0	1.7	3.0	2.9	4.7
Solid fuels	-8.9	-9.9	-8.5	-7.5	-8.1	-6.7	-7.4	-8.0	-6.2	-6.5	-5.7	-4.3	-5.5	-6.6	-5.6
Gaseous fuels	-4.6	-4.7	-4.8	-4.6	-5.1	-4.9	-4.4	-5.0	-5.0	-5.0	-5.2	-4.4	-4.2	-4.1	-3.8
Other	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Total (NA-RA)/RA	**-3.6**	**-4.3**	**-4.3**	**-3.1**	**-3.7**	**-2.7**	**-2.8**	**-2.9**	**-1.9**	**-1.9**	**-2.4**	**-1.6**	**-1.2**	**-1.4**	**-0.3**

Table 3.16 Comparison of CO_2 emissions: differences between corrected Reference Approach (RA) versus corrected National Approach [(NA-RA)/RA)] (in percentage).

Fuel type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Liquids [incl. 2G]	0.3	-1.1	-1.5	1.0	0.2	2.1	1.1	1.9	3.5	3.7	2.4	2.8	4.1	2.9	5.7
Solids [incl. 1B1,2A,2B4,2C1,2D]	1.9	-0.3	-0.7	-0.1	0.2	2.7	2.4	2.6	1.3	1.6	1.3	1.6	0.6	0.0	-0.7
Gas [incl. 1B2, 2B1]	0.2	0.2	0.2	0.2	0.0	-0.2	-0.4	-0.4	-0.5	-0.5	-0.7	-0.8	-0.7	-0.4	-0.1
Total corrected (excl. waste)	**0.6**	-0.3	-0.5	**0.4**	**0.1**	**1.1**	**0.6**	**0.9**	**1.1**	**1.3**	**0.7**	**0.8**	**1.1**	**0.8**	**1.6**

Note: Shown in reduction and blue are the largest annual differences, respectively.

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 residual 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 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, residual chemical 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). However, it should be noted that The Netherlands accounts for most of the use of chemical residual gas and of blast furnace gas separately as combustion in the source categories 1A1a, 1A2a and 1A2c. As the former may be included in feedstock emissions by other countries, with significant levels of CO_2 emissions, they would then become key sources when assessed separately.

Activity data and implied emission factors

The share of total feedstock-related emissions, including the combustion of residual chemical gas and waste combustion, in national total CO_2 emissions (without LULUCF) is about 12%. The largest part of these emissions, 64% in 1990 and about 80% in 2004, is reported under 'Fuel Combustion' (1A). About 50% of these emissions are from blast furnace gas, which is largely used for power generation, and the other 50% stems from residual chemical gas, which is predominantly used in the chemical industry. These two sources together accounted for a 60% share in 1990 and an almost 75% share in 2004. The share of emissions from 'Waste Incineration' (sector 6, but allocated under 1A1a) was 3% in 1990 and 9% in 2004. The share of emissions from industrial processes (sector 2) decreased from 33% in 1990 to 20% in 2004 *(Table 3.17*). 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%.

The share of total feedstock-related emissions, including the combustion of residual chemical gas and waste combustion, in national total CO_2 emissions (excluding LULUCF) is about 12%: the share of combustion of the by-product gases and waste incineration reported under sector 1A has increased from 8% to 10% since 1990, while the share of industrial process emissions in sector 2 has remained about 3%.

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

IPCC no. /category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1A1a Public power & heat															
BF/OF gas	3.8	3.9	4.0	4.6	4.8	4.8	4.7	5.1	5.4	5.4	4.9	5.3	5.3	5.5	5.9
Chemical residual gas	0.0	0.0	0.0	0.0	0.3	1.5	1.4	1.7	1.7	1.8	1.9	1.9	2.2	2.0	2.1
Waste (fossil part)	0.6	0.6	0.6	0.7	0.7	0.8	1.1	1.3	1.4	1.5	1.5	1.5	1.6	1.7	2.1
1A2a Iron and steel															
BF/OF gas	2.4	2.1	2.7	3.1	2.8	3.1	3.0	2.8	2.7	2.5	2.5	2.7	2.8	3.0	3.4
1A2c Chemicals															
Chemical residual gas	5.3	4.8	4.9	4.9	4.8	3.8	4.0	3.8	4.0	4.3	4.1	4.5	5.3	5.7	5.7
TOTAL ENERGY1[1)]	12.1	11.4	12.1	13.3	13.4	14.0	14.3	14.8	15.1	15.4	14.9	16.0	17.2	18.1	19.2
2A Mineral products															
Soda Ash Production	0.1	0.4	0.4	0.4	0.3	0.4	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2
2B Chemical industry															
2B1 Ammonia production	3.1	3.5	3.5	3.4	3.6	3.6	3.4	3.6	3.6	3.6	3.6	3.0	2.9	2.9	3.1
2B5 Production of other chemicals	0.4		0.0	0.0	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
2B5 Carbon electrodes	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2B5 Production of activated carbon[2)]	0.0[2)]	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
2C Metal production															
2C1 Coke inputs blast furnace	2.2	1.9	1.3	1.2	1.5	1.5	1.5	1.8	1.4	1.3	1.0	1.0	1.1	1.2	0.9
2D Other production															
Food and drink	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2G Other															
2G4 Other economic sectors	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	NA
TOTAL INDIVIDUAL PROCESSES[1)]	6.2	6.2	5.7	5.4	5.9	6.0	5.4	5.9	5.6	5.6	5.3	4.7	4.7	4.8	4.6
Solvents/product use[3)]															
TOTAL PRODUCT USE[3)]	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Total Feedstock/NEU CO_2	18.6	17.8	18.0	18.9	19.5	20.2	19.9	20.9	21.0	21.2	20.4	20.9	22.0	23.1	23.9

[1)]0.0 means a non-zero emission, less than 0.05. [3)]NA, Not yet available.
[2)]Peat consumption is not included in The Netherlands Energy Statistics (NEH) but is taken from other sources.

Table 3.18 shows that the increase of oil feedstocks of about 60% since 1990 originates from a variety of inputs: naphtha use increased by one third, whereas the feedstock use of natural gas liquids (NGL) increased by one half. On average, it has been calculated for the CO_2 RA that about 22% of the carbon in the oil feedstocks and about 61% 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.*

Table 3.18 Chemical industry: feedstock uses of fuels (Units: PJ).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Oil products[1)]	303	*337*[2)]	*346*	*314*	*329*	321	299	318	313	349	386	411	430	489	496
o.w. Naphtha	136	*141*	*145*	*150*	*154*	159	176	171	117	111	74	77	94	181	159
o.w. Natural gas liquids	143	*151*	*159*	*167*	*174*	182	168	169	164	181	201	210	253	217	227
o.w. LPG	63	*62*	*60*	*58*	*56*	55	20	38	39	28	39	35	3	4	20
o.w. Gas/diesel oil	34	*29*	*24*	*20*	*15*	10	12	18	15	19	6	4	6	4	3
Natural gas	101	109	107	102	109	110	105	113	107	107	113	100	97	91	97

Note: Values represent net consumption (i.e. after subtraction of the amounts produced; this application may sometimes result in negative values).
[1)]Excluding lubricants, bitumen, coals, coal-derived fuels, which are mainly or fully used elsewhere.
[2)]Figures in italics are interpolated data.

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 residual chemical gas produced in the industry sector into the energy sector. In addition, significant parts of residual chemical 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 residual chemical 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 protocols 5401 and 5402, which describe CO_2 , CH_4 and N_2O emissions, respectively, from the stationary combustion of fossil fuels and 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, including chemical residual 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.

The analysis of all feedstock and other non-energy uses in the energy statistics ensures that all relevant sources are taken into account. Also, by coupling each of these uses – when applicable – to industrial process sources identified by the IPCC, double counting has been avoided. *Table 3.33* in the *NIR 2005* lists – per source category – the fuels used as feedstock and for other non-energy product uses (including the allocation of corresponding CO_2 emissions, either in sectors 2, 3 and 6, or in sector 1).

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 residual chemical 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 and Brandes (2006).

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 residual chemical 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 residual chemical gas, however, the question of whether the accounting is complete or not 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 3.19* 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 2.8 Tg CO_2), mostly due to changes in emissions from liquid fuels (*Table 3.19*).

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. For the comparison, the most relevant sources from *Table 3.19* are summarized in *Table 3.20*; no attempt has been made to be completely accurate and complete. However, we see similar trends for the three fuel types. This is particularly true for natural gas, which is essentially the sum of emissions from ammonia production and other chemicals: totals and trends are almost equal. Other differences are due to the use of one average oxidation factor for all years, whereas in the derivation of the annual oxidation figures differences up to a few percentage points can be observed.

Table 3.19 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).

Fuel type	Oxidation Factors[3)]	1990	…	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [1)]	Trend
Liquids[1)]	22.3%	5.0		5.2	4.9	5.1	5.1	5.7	6.1	6.6	6.8	7.8	7.9	3.0
Solids[2)]	42.5%	0.4		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.0
Gaseous	61.2%	3.5		3.8	3.7	3.9	3.7	3.7	3.9	3.5	3.4	3.2	3.2	-0.3
Total		**8.9**		**9.4**	**9.0**	**9.5**	**9.2**	**9.8**	**10.4**	**10.5**	**10.6**	**11.4**	**11.7**	**2.8**

[1)]Excluding refinery gas.
[2]Coal oils and tars (from coking coal), coke and other bituminous coal only; no coal derived gases.
[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.

Table 3.20 Trends in CO_2 emitted by feedstock use of energy carriers by fuel type (Units: Tg).

Fuel type	Sources	1990	…	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Trend
Liquids	Chemical residual gas in 1A + 2G4 lubr./wax	5.5		5.5	5.7	5.7	5.9	6.3	6.2	6.6	7.7	7.9	8.2	2.6
Solids[1)]	2A4 soda ash + 2D2 food	0.2		0.4	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.0
Gaseous	2B1 ammonia + 2B5 other chemicals[2)]	3.3		3.8	3.7	3.8	3.9	3.9	3.9	3.3	3.2	3.2	3.4	0.1
Total		**9.1**		**9.8**	**9.5**	**9.7**	**9.9**	**10.4**	**10.3**	**10.2**	**11.1**	**11.3**	**11.8**	**2.7**

[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.
[2)]Including some emissions from coke use (or combustion of phosphorus oven gas). Not included is 2B5 electrode production since this very small and refers to a mixture of liquid and solids used as input.

3.12 Fugitive emissions from fuels [1B]

3.12.1 Source category description

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 following sections discuss the inventory of fugitive emissions from fuels.

Activity data and (Implied) Emission factors

More detailed information on activity data and (implied) emission factors is provided in *Sections 3.13 and 3.14.*

3.12.2 Methodological issues

Different methods are used to estimate 'Fugitive Emissions from Fuels'. An energy balance calculation is made for fuel use in the 'Oil and Gas Production' industry in order to prevent double counting or omissions. For more details see *Sections 3.1, 3.13 and 3.14* and www.greenhousegases.nl.

3.12.3 Uncertainty and time-series consistency

Uncertainty

Most uncertainty estimates for activity data are based on the judgements of CBS and MNP experts, who in turn base them on the assumed accuracy of the underlying statistics, annual variability and the monitoring method involved. The uncertainty estimates for the emission factors are also based on expert judgements.

Time-series consistency

The methodologies used to estimate 'Fugitive Emissions from Fuels' are consistent throughout the time series.

3.12.4 Source-specific QA/QC and verification

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

3.12.5 Source-specific re-calculations

The re-calculation of emissions from gas combustion due to the revision of the emission factor for natural gas as discussed in *Section 3.2.5*, also affects the emission factor for 'Gas Venting and Flaring' (1B2).

In addition, there are two major re-calculations source category 1B2 'Oil and Natural Gas':

- Based on an assessment by the industry association NOGEPA and by an assessment of the Dutch PER of past activities of the individual companies, the emissions of the oil and gas production industry from venting and flaring (1B2c) and from own fuel use (1A1c) were re-analysed based on new background data from the industry.
- For gas distribution (1B2b-iv), new measurement data on the amounts of gas leakage per leak per type of material were available (Gastec/KIWA, 2005). Based on these new data, two country-specific emission factors were derived that were applied instead of the previously used emission factors based on data from a German study.

For more details see *Section 3.14.5*.

3.12.6 Source-specific planned improvements

Fugitive emissions from 'Charcoal Production', notably CH_4, may be included when a new data set for estimating biomass burning emissions (CBS, 2004) is used for the next inventory (see *Section 3.9.6*).

3.13 Solid fuels [CRF category 1B1]

3.13.1 Category description

Fugitive emissions from this category refer mainly to CO_2 from the key source 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.

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 3.21* shows the trend in CO_2 emissions from coke production during the period 1990–2004.

Table 3.21 Trend in CO_2 emissions from coke production (transformation losses reported in 1B1b.

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CO_2 emissions (Gg)	403	430	431	446	559	517	651	505	492	446	422	412	430	464	509
Coke production (PJ)	78.0	83.6	83.2	82.0	82.3	82.3	83.1	82.5	80.6	66.1	60.3	62.8	60.3	61.1	62.8
CO_2 losses/coke prod. (kg/GJ)	5.2	5.1	5.2	5.4	6.8	6.3	7.8	6.1	6.1	6.7	7.0	6.6	7.1	7.6	8.1

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. Fugitive emissions from 'Charcoal Production' – The Netherlands has one large production location that serves most of The Netherlands and also a large share of the market of our neighbouring countries – are presently not accounted for.

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 and Brandes, 2006).

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 re-calculations

No source-specific re-calculations.

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.

With respect to fugitive emissions from 'Charcoal Production', The Netherlands has one large 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.

CO_2 from gas flaring (including the venting of gas with a 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 (details are discussed in Peek, 2006, in preparation). The length of the gas distribution network is still gradually expanding as new neighbourhoods 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.

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%.

Table 3.22 Trend in CH_4 emissions from gas distribution and emission factors per type of pipeline material(Unit:Gg).

Material	CH_4 (mm^3)/ Mm/year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Grey cast iron	610	4.6	3.3	4.2	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.3	3.2	3.1	3.0
Other material	120	7.5	8.8	7.9	8.0	8.1	8.2	8.3	8.4	8.6	8.8	8.9	9.1	9.2	9.5	9.7
Total CH_4		12.1	12.1	12.1	12.0	12.0	12.0	12.0	12.0	12.1	12.2	12.3	12.4	12.4	12.6	12.6

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 m^3 (437 Gg) methane for grey cast iron and 120 m^3 (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

No source-specific QA/QC and verification

3.14.5 Source-specific re-calculations

The re-calculation of emissions from gas combustion due to the revision in the emission factor for natural gas, as discussed in *Section 3.2.5*, also affects the emission factor for gas venting and flaring.

Based on an assessment by the industry organization NOGEPA and an assessment by the Dutch PER on past activities of the individual companies, the emissions of the oil and gas production industry from venting and flaring (1B2c) and from own fuel use (1A1c) were re-analysed using new background data from the industry (FO-Industrie, 2005) in order to check the split of gas use – and related emissions – into figures for combustion, venting and flaring. This led to a revision and a re-allocation of greenhouse gas emissions from oil and gas production, resulting in a new more consistent time series. The small fugitive emissions from exploration activities are not reported separately, but these are now included in 1A1c, whereas last year they were included in Oil and gas production emissions (1B2b-i). The changes are mainly found in CO_2 emissions from flaring (up to 0.1 Tg CO_2 higher than previously reported) and in the CO_2 emissions from combustion included in 1A1c (up to 0.5 Tg CO_2 higher than previously reported) (see *Section 3.3.5*). In addition, CH_4 emissions from venting have decreased a few gigagrams in recent years, whereas for the period 1990–2000 a few gigagrams of methane emissions previously included in venting has been re-allocated to gas flaring. For gas distribution (1B2b-iv), new measurement data on the amounts of gas leakage per leak per type of material were available (Gastec/KIWA, 2005). Based on this new data, two country-specific emission factors were derived subsequently applied instead of the previously used emission factors based on data from a German study. This changed the CH_4 emissions from gas distribution

substantially (see *Table 3.24*). Compared to the emissions from this source reported in the previous submission, the emission levels are halved. Since energy consumption for pipeline transport is not recorded separately in the national energy statistics, the combustion emissions from gas transmission pipelines are included elsewhere; for example, for gas compressor stations this is included in 1A1c.

Table 3.23 Effect of re-calculation on CO_2 emissions from fugitive oil and gas sources (Units:Tg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NIR 2006														
1. B. 2. b. Natural Gas	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
o.w. ii. Prod./Processing	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
o.w. iii. Transmission	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
o.w. iv. Distribution	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. B. 2. c. Venting+flaring	**0.77**	**0.71**	**0.64**	**0.58**	**0.51**	**0.44**	**0.38**	**0.49**	**0.31**	**0.22**	**0.27**	**0.17**	**0.18**	**0.15**
o.w. Venting	0.35	0.31	0.26	0.21	0.17	0.18	0.15	0.18	0.17	0.13	0.11	0.08	0.07	0.06
o.w. Flaring	0.42	0.40	0.38	0.36	0.33	0.26	0.23	0.31	0.14	0.09	0.16	0.09	0.11	0.09
1B2 Total	**1.18**	**1.14**	**1.07**	**1.02**	**1.07**	**0.96**	**1.03**	**1.00**	**0.80**	**0.66**	**0.69**	**0.58**	**0.61**	**0.61**
NIR 2005														
1. B. 2. b. Natural gas	**0.18**	**0.21**	**0.20**	**0.15**	**0.13**	**0.18**	**0.17**	**0.00**	**0.00**	**0.14**	**0.14**	**0.14**	**0.14**	**0.14**
o.w. ii. Prod/Processing	0.18	0.20	0.20	0.15	0.13	0.18	0.16	0.00	0.00	0.14	0.14	0.14	0.14	0.14
o.w. iii. Transmission	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
o.w. iv. Distribution	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. B. 2. c. Venting+flaring	**0.66**	**0.61**	**0.53**	**0.41**	**0.43**	**0.27**	**0.31**	**0.27**	**0.29**	**0.27**	**0.27**	**0.27**	**0.27**	**0.27**
o.w. Venting	0.33	0.30	0.26	0.22	0.19	0.15	0.17	0.14	0.17	0.18	0.18	0.18	0.18	0.18
o.w. Flaring	0.33	0.31	0.27	0.19	0.24	0.12	0.15	0.13	0.11	0.09	0.09	0.1	0.09	0.09
1B2 Total	**0.84**	**0.81**	**0.73**	**0.56**	**0.56**	**0.45**	**0.48**	**0.27**	**0.29**	**0.40**	**0.40**	**0.41**	**0.41**	**0.41**
Difference														
1. B. 2. b. Natural gas	**-0.18**	**-0.21**	**-0.20**	**-0.15**	**-0.13**	**-0.18**	**-0.17**	**0.00**	**0.00**	**-0.14**	**-0.14**	**-0.14**	**-0.14**	**-0.14**
o.w. ii. Prod/Processing														
o.w. iii. Transmission														
o.w. iv. Distribution	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. B. 2. c. Venting+flaring	**0.11**	**0.10**	**0.11**	**0.17**	**0.08**	**0.17**	**0.07**	**0.22**	**0.02**	**-0.05**	**0.00**	**-0.10**	**-0.09**	**-0.12**
o.w. Venting	0.02	0.01	0.00	-0.01	-0.02	0.03	-0.02	0.04	0.00	-0.05	-0.07	-0.10	-0.11	-0.12
o.w. Flaring	0.09	0.09	0.11	0.17	0.09	0.14	0.08	0.18	0.03	0.00	0.07	-0.01	0.02	0.00
1B2 Total	**0.34**	**0.33**	**0.34**	**0.46**	**0.51**	**0.51**	**0.55**	**0.73**	**0.51**	**0.26**	**0.29**	**0.17**	**0.20**	**0.20**

Table 3.24 Effect of r-ecalculation on CH_4 emissions from fugitive oil and gas sources (Units: Gg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NIR 2006														
1. B. 2. a. Oil	0.6	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3
1. B. 2. b. Natural gas	17.8	17.8	17.6	17.4	17.5	17.4	17.2	16.6	18.0	17.2	16.7	16.7	18.3	18.4
o.w. iii. Transmission	5.7	5.7	5.6	5.4	5.4	5.4	5.1	4.5	5.9	5.0	4.4	4.3	5.9	5.8
o.w. iv. Distribution	12.1	12.1	12.1	12.0	12.0	12.0	12.0	12.0	12.1	12.2	12.3	12.4	12.4	12.6
1. B. 2. c. Venting/flaring	59.6	59.7	59.7	59.7	59.8	59.8	54.3	30.5	29.6	23.6	21.2	20.6	17.3	17.1
o.w. Venting	56.0	56.1	56.1	56.1	56.2	56.2	51.0	28.7	27.8	22.2	19.9	19.4	16.3	16.0
o.w. Flaring	3.6	3.6	3.6	3.6	3.6	3.6	3.3	1.8	1.8	1.4	1.3	1.2	1.0	1.0
1B2 Total	78.0	78.1	78.0	77.8	77.8	77.7	71.9	47.5	48.0	41.2	38.2	37.7	35.9	35.7
NIR 2005														
1. B. 2. a. Oil	**0.6**	**0.6**	**0.6**	**0.6**	**0.5**	**0.5**	**0.4**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
1. B. 2. b. Natural Gas	**37.1**	**37.0**	**36.0**	**35.2**	**34.1**	**33.5**	**33.5**	**31.4**	**29.7**	**29.3**	**28.9**	**29.0**	**28.7**	**28.4**
o.w. iii. Transmission	6.3	7.0	6.8	6.8	6.2	6.1	6.6	4.9	3.7	3.5	3.4	3.8	3.7	3.6
o.w. iv. Distribution	30.8	30.0	29.2	28.4	27.9	27.4	26.9	26.5	26.0	25.8	25.5	25.3	25.0	24.8
1. B. 2. c. Venting/Flaring	**59.6**	**59.7**	**59.7**	**59.7**	**59.8**	**59.8**	**54.3**	**30.5**	**29.6**	**23.6**	**21.2**	**20.8**	**20.8**	**20.8**
o.w. Venting	58.8	59.0	59.2	59.3	59.3	59.4	53.8	30.1	29.2	23.3	20.9	20.5	20.5	20.5
o.w. Flaring	0.8	0.7	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
1B2 Total	**97.4**	**97.3**	**96.3**	**95.5**	**94.4**	**93.7**	**88.2**	**62.3**	**59.7**	**53.2**	**50.4**	**50.2**	**49.9**	**49.5**
Difference														
1. B. 2. a. Oil	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
1. B. 2. b. Natural Gas	-19.3	-19.2	-18.4	-17.8	-16.6	-16.1	-16.3	-14.8	-11.7	-12.1	-12.2	-12.3	-10.4	-10.0
o.w. iii. Transmission	-18.7	-17.9	-17.1	-16.4	-15.9	-15.4	-14.9	-14.5	-13.9	-13.6	-13.2	-12.9	-12.6	-12.2
o.w. iv. Distribution	-18.7	-17.9	-17.1	-16.4	-15.9	-15.4	-14.9	-14.5	-13.9	-13.6	-13.2	-12.9	-12.6	-12.2
1. B. 2. c. Venting/flaring	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-3.5	-3.7
o.w. Venting	-2.8	-2.9	-3.1	-3.2	-3.1	-3.2	-2.8	-1.4	-1.4	-1.1	-1.0	-1.1	-4.2	-4.5
o.w. Flaring	2.8	2.9	3.1	3.1	3.1	3.2	2.8	1.4	1.4	1.1	1.0	0.9	0.7	0.7
1B2 Total	-19.4	-19.2	-18.3	-17.7	-16.6	-16.0	-16.3	-14.8	-11.7	-12.0	-12.2	-12.5	-14.0	-13.8

3.14.6 Source-specific planned improvements

Fugitive emissions from 'Charcoal Production', notably CH_4, may be included when a new data set for estimating biomass burning emissions (CBS, 2004) is used for the next inventory (see *Section 3.9.6*).

4. INDUSTRIAL PROCESSES [CRF sector 2]

Major changes in sector 4 Industrial Processes compared to the National Inventory Report 2005

Emissions: The time series of PFCs released in the aluminium production process is re-calculated, based on the 1999 measurement data on CF4 and C2F2 emissions of the largest aluminium production company (see 4.4.5). As a result, higher emission levels are reported in the period 1990–1998 and in 2000, and lower emission levels are reported in 2001. For the years 2002 and 2003 the company submitted new emission data that was also based on measurement data which resulted in considerably higher emission levels in 2002 and lower emission levels in 2003. Furthermore:

- Based on new activity data, the CO2 emissions from Cement clinker production (2A) and Flue gas desulphurisation (2A) were re-calculated, resulting in a decrease in the emissions from Cement clinker production for 1990 and 1991 and in Flue gas desulphurisation for the whole time series.
- Based on a country-specific emission factor, the CO2 emission from glass production is re-calculated.
- Due to the changed emission factor for natural gas, minor changes of CO2 emissions occurred.
- CO2 emissions from a newly identified source, ethylene oxide production, were added to category 2B.
- Due to data reprocessing errors, some allocations accidentally changed, although total emissions are not affected. The main differences are found in CO2 included in 1A2f/2G and in 1A2c (Liquid/solid allocation).

Key sources: SF6 emissions from SF6 use (included in 2F9) are no longer identified as a key source according to the improved IPCC tier 2 key source analyses.

Methodologies: There have been no methodological changes in this sector.

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 paragraphs.

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

- Protocol 5402: CO_2, CH_4 and N_2O from *Process emissions: fossil fuels*;
- Protocol 5414: CO_2, CH_4 and N_2O from *Process emissions and product use*;
- Protocol 5415: N_2O from *Nitric acid production* (2B2);
- Protocol 5416: N_2O from *Caprolactam production* (2B5);
- Protocol 5417: PFCs from *Aluminium production* (2C3);
- Protocol 5418: HFC23 from *HCFC22 production* (2E1);
- Protocol 5419: HFCs from *Handling* (2E3);
- Protocol 5420: HFCs from *Stationary refrigeration* (2F1);
- Protocol 5421 HFCs from *Mobile airconditioning* (2F1);
- Protocol 5422: HFCs from *Foams* (2F2);
- Protocol 5423: HFCs from *Aerosols* (2F4);
- Protocol 5426: SF_6 from *Electrical equipment* (2F8);
- Protocol 5425: SF_6 and PFCs from *Semiconductor manufacturing* (2F7);
- Protocol 5424: SF_6 from *Sound-proof windows* (2F9).

The IPPC sector 2 *Industry* contributes 8% to the national greenhouse gas emissions and is a major source of N_2O emissions in The Netherlands (see *Table 4.1*). The decreased total CO_2-equivalent emissions of approximately 34% between the base year (1990/1995) and 2004 can be explained by decreased HFC23 emissions from HCFK22 manufacture, PFC emissions from aluminium production, CO_2 emissions from iron and steel production (carbon inputs) and N_2O emissions from nitric acid production.

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. N_2O emission from *Nitric acid production* and *Caprolactam production* are major key sources, both in terms of level and trend. Other key sources are CO_2 emissions from *Ammonia production,* CO_2 emissions from *Iron and steel production* and

HFC emissions from *Substitutes for ozone-depleting substances*. In contrast to the NIR 2005, SF_6 emissions from SF_6 use is no longer identified as a key source.

Table 4.1 Contribution of the main categories and key sources in CRF sector 2 Industry.

Sector/category Key source	Gas	Key[1)]	Emissions base year (1990/1995[1)])		Emissions 2004		Contribution to total in 2004 (%):		
		Level, Trend	Gg	Tg CO_2-eq.	Gg	Tg CO_2-equivalents	By sector	Of total gas	To total CO_2-equivalents
2 Industry	CO_2			7.9		6.9	42	4	3
	CH_4		14.1	0.3	14.9	0.3	2	1.8	0.1
	N_2O		27.4	8.5	22.8	7.1	43	40	3
	HFC			6.0		1.5	9	100	0.7
	PFC			1.9		0.3	2	100	0.1
	SF_6			0.3		0.3	2	100	0.2
	All			**25.0**		**16.4**	**100**		**8**
2A. Mineral products	**CO_2**			**1.0**		**1.2**	**7**	**0.6**	**0.5**
2B. Chemical industry	CO_2			3.7		3.7	22	2	2
	N_2O		24.4	7.6	20.6	6.4	39	36	3
	All			**11.3**		**10.5**	**63**		**5**
2B1 Emissions from ammonia production	CO_2	L1		3.1		3.1	19	2	1
2B2 Nitric acid production	N_2O	L,T	20.4	6.3	18.1	5.6	34	32	2.6
2B5 Caprolactam production	N_2O	L,T	4.0	1.2	2.4	0.8	5	4	0.3
2B5 Other chemical product manufacture	CO_2	L2		0.6		0.8	3	0.3	0.3
2C. Metal production	CO_2			2.9		1.6	11	1.0	0.8
	PFC			1.9		0.1	1	37	0.0
	All			**4.8**		**1.7**	**12**		**0.9**
2C1 Iron/steel production (carbon inputs)	CO_2	L1,T1		2.5		1.1	8	0.7	0.6
2C3 PFC from aluminium production	PFC	T		1.9		0.1	0.6	37	0.0
2D. Other production	**CO_2**			**0.1**		**0.0**	**0.3**	**0.0**	**0.0**
2E. Production of halocarbons and SF6	**HFC**			**5.8**		**0.5**	**3**	**31**	**0.2**
2E1 HFC-23 from HCFC-22 manufacture	HFC	T		5.8		0.5	3	31	0.2
2F. Consumption of halocarbons and SF_6	HFC			0.2		1.0	6	69	0.5
	PFC			0.0		0.2	1	63	0.1
	SF_6			0.3		0.3	2	100	0.2
	All			**0.6**		**1.5**	**9**		**0.7**
2F (1-4). Emissions from substitutes for ozone-depleting substances	HFC	L,T		0.2		1.0	6	69	0.5
2G. Other	CO_2			0.2		0.3	2	0.2	0.1
	N_2O		3.0	0.9	2.3	0.7	4	4	0.3
	All			**1.2**		**1.0**	**6**		**0.5**
2G. Indirect N_2O from NO_2 from combustion and industrial processes	N2O	L,T	2.85	0.9	2.1	0.6	9	4	0.3
Total national emissions	CO_2			159.4		180.9		100	
	CH_4		1,211.5	25.4	823.5	17.3		100	
	N_2O		68.4	21.2	57.2	17.7		100	
	HFCs			6.0		1.5		100	
	PFCs			1.9		0.3		100	
	SF_6			0.3		0.3		100	
National total greenhouse gas emissions (excluding CO_2 from LULUCF)	All			214.3		218.1			100

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

4.2 Mineral products [2A]

4.2.1 Source category description

General description of the source categories

CO_2 emissions are generated in industrial applications involving the heating of limestone – mostly in the form of calcium carbonate ($CaCO_3$) or dolomite – at high temperatures. There are no key sources identified for CO_2 emissions from these source categories (see also *Annex 1*).

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* are not estimated due to the lack of consistent activity data (lime production is located at four sites), and those from 2A5 *Asphalt roofing* and 2A6 *Road paving with asphalt* are not estimated since no methodology is available. However, compared with national emission levels, emissions from these source categories are likely to be negligible.

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 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 0.55 t/t clinker (IPCC Default = 0.51 t/t clinker);
- *Limestone use:* EF= 0.440 t/t (IPCC default);
- *Dolomite use*: EF= 0.477 t/t (IPCC default);
- *Soda ash production:* EF= 0.415 t/t (IPCC default);
- *Glass production:* EF= 0.16 t/t (country specific), which is defined as total non-fossil CO_2 per unit of gross glass production from the use of limestone, dolomite and soda ash. The emission factor is derived from the average of the 1990 and 1995–1998 emissions reported by glass-producing facilities.

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 5402 and 5414 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 factor of 0.16 t/t glass.

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 judgement 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, since these sources are not identified key sources, these minor sources for CO_2 are 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 procedures discussed in *Chapter 1*.

4.2.5 Source-specific re-calculations

Based on new activity data the CO_2 emissions from *Cement clinker production* (2A) in 1990 and 1991 have been re-calculated. Other re-calculations were made for all years for *Flue gas desulphurisation* (2A) due to improved activity data. Re-calculations were also made for all years for glass production, due to the use of a country-specific emission factor.
The effects of these re-calculations are presented in *Table 4.2*

Table 4.2 Effect of re-calculating the CO_2 emissions from Mineral products (2A) due to new activity data becoming available for Clinker production and Flue gas desulphurisation and the use of a country-specific emission factor in glass production (Units: Tg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2.A *NIR 2005*	1.2	1.3	1.2	1.3	1.5	1.4	1.3	1.3	1.3	1.4	1.4	1.5	1.4	1.3
2.A *NIR 2006*	1.0	1.4	1.3	1.3	1.5	1.5	1.0	1.0	1.1	1.2	1.2	1.3	1.2	1.1
Difference	**-0.2**	**0.1**	**0.1**	**0.0**	**0.0**	**0.1**	**-0.3**	**-0.3**	**-0.2**	**-0.2**	**-0.2**	**-0.2**	**-0.2**	**-0.2**

4.2.6 Source-specific planned improvements

There are no source-specific improvements planned for these source categories. Possible future improvements would include the estimation of CO_2 emissions from lime production for which the availability of lime production data or capacity estimates would be a precondition. In addition, if the glass industry would report disaggregated data on the use of limestone, dolomite and soda ash, CO_2 estimates could be more accurate and double counting could be avoided.

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.
  - *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).

Emissions from *Ammonia production* and *Other chemical product manufacture* are identified as key-sources for CO_2 emissions. *Nitric acid production* and *Caprolactam production* are key-sources for N_2O emissions for both level and trend (see *Table 4.1*).

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in monitoring protocols 5402, 5414, 5415 and 5416 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. 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).

The e*mission 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 oxidised 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.

Table 4.3 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. 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 2003 and 2004 more accurate measurements were performed to estimate N_2O emissions from *Caprolactam production* (2B5), and these resulted in lower reported emission levels than in the years before. The pre-2003 emissions are based on measurement results of the mid-1990s, and the corresponding data are considered to be more representative for the period before 2003 than the newly measured results.

Table 4.3 Trend in N_2O emissions from Chemical industry processes (2B) (Units: Gg CO_2).

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2B2. Nitric acid production	20.4	20.7	20.9	22.7	21.5	20.3	20.2	20.2	20.1	19.2	19.0	17.2	16.2	16.3	18.1
2B5. Other	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.1	2.4
Total	24.4	24.7	24.9	26.7	25.5	24.3	24.2	24.2	24.1	23.2	23.0	21.2	20.2	19.4	20.6

4.3.2 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 (5402, 5414, 5415 and 5416) 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 oxidised 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 Emission Register* (PER).
- 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.

4.3.3 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 70%, 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 50% and 70%, respectively.

Time-series consistency
Consistent methodologies are used throughout the time series for the sources in this category. The time series involve some extrapolation of the emissions of *Caprolactam production* in the period 1999–2002, thereby slightly increasing uncertainties in the emissions of this source in this period.

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

4.3.5 Source-specific re-calculations
CO_2 emissions from *Ethylene oxide production* are added to the inventory. *Table 4.4* presents the emissions of this source.

Table 4.4 Emissions of Ethylene oxide production (Units: Tg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CO_2	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.15	0.15	0.16	0.16	0.16	0.16	0.18

4.3.6 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 *Aluminium production:* CO_2 and PFC emissions: in The Netherlands aluminium is produced at two primary aluminium 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 Aluminium industry are formed during the phenomenon known as the 'anode effect' (AE), which occurs when the concentration of aluminium oxide in the reduction cell electrolyte drops below a certain level.

2C2 *Ferroalloys production* and 2C4 *Magnesium and aluminium foundries*, both of which use SF_6 as a cover gas, do not occur in The Netherlands. No other sources of metal production (25C) are identified in the inventory.

Iron and steel production is identified as a key source for CO_2 emissions and *Aluminium production* is identified as one for PFC emissions (see *Table* 4.1).

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocols 5402, 5414 and 5417 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);
- *Aluminium 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 of the different sources 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);
- *Aluminium production*: EF (consumption of anodes) = 0.00145 tons CO_2 per ton aluminium (plant specific; IPCC default = 0.0015 t/t aluminium); EF for PFCs is plant-specific and confidential. Emissions of PFCs are obtained from the environmental reports of both companies.

Table 4.5 shows the trend in implied CF_4 and C_2F_6 emission factors (IEF) for aluminium production during the period 1990–2004. The largest company produces approximately two thirds of the national total production. The IEFs decreased by 95% between 1995 and 2004. 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 (see also *Section 2*). The higher level of the IEF in 2002 is caused by specific process-related problems during the switching process by the larger producer.

Table 4.5 Implied emission factors for CF_4 and C_2F_6 from Aluminium production (Units: kg/Tg) (2C3).

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CF_4	1.02	1.04	1.06	1.10	1.11	1.10	1.16	1.21	0.78	0.53	0.53	0.52	0.83	0.19	0.04
C_2F_6	0.18	0.18	0.18	0.18	0.19	0.18	0.19	0.19	0.15	0.12	0.12	0.12	0.20	0.04	0.01

4.4.2 Methodological issues

The methodologies used to estimate the greenhouse gas emissions for all of the 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 5402, 5414 and 5417 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):

$$CO_2 \text{ from coke/coal inputs} = \text{amount of coke} * EF_{coke} + \text{amount of coal} * EF_{coal} - (\text{blast furnace gas} + \text{oxygen oven gas produced}) * EF_{BFgas} \quad (1a)$$

$$CO_2 \text{ from additional carbon inputs} = [\text{C inputs (in tons)} * \text{MF (limestone)}] * EF_{limestone} \quad (1b)$$

$$CO_2 \text{ from iron ore} = (Frac_{C,iron\ ore} * \text{ore consumption} - Frac_{C,crude\ steel} * \text{crude steel production}) * 44/12 \quad (1c)$$

The same emission factors for blast furnace gas and oxygen furnace gas are used (see *Annex 2*). Since Corus does not report the specific amounts of materials used as additional carbon sources (including limestone and others), a multiplication factor (MF) is used to convert this carbon (C) into amounts of pure limestone-equivalents. (MF = Molecular weight of limestone/molecular weight of C). To calculate CO_2 from the fractions of carbon in the ore and crude steel, the carbon content in both the amount of pig iron purchased (i.e. not on-site produced) and the amount produced is assumed to be very small or nil, respectively; consequently, this amount is neglected in the overall calculation.

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 (2000–2002) of Corus are used to calculate the CO_2 emissions from additional carbon inputs and iron ore in the period 1990–2000. The amount of additional carbon was calculated from the average consumption in 2000–2002 of these other carbon inputs per ton of crude steel produced. A similar calculation was made for the CO_2 from the carbon fractions in ore and crude steel;

- *Aluminium 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 aluminium, with aluminium production being as activity data. In order to calculate the IPCC default emission factor the stoichiometric ratio of carbon needed to reduce the aluminium ore to pure aluminium 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 aluminium 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 aluminium production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990–2004. 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 5% for *Iron and steel production* and *Aluminium production* respectively, whereas the uncertainty in PFC emissions from *Aluminium production* is estimated to be 25%. The uncertainty in the activity data is estimated at 2% for *Aluminium 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 Aluminium 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 aluminium 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 re-calculations

CF_4 and C_2F_6 emissions reported by the main producer in 1999 are based on measurements, while the emission figures of the period 1990–1998 are based on estimates using default emission factors. The PFC emissions from the primary production of aluminium are re-calculated for the period 1990–1998 based on 1999 measurement data. In addition, new data are reported for the year 2002.

Table 4.6 Effects of the re-calculation of PFCs from primary Aluminium production (2C) 1990-2003 (Units: Gg).

		1990	1991	1992	1993	1994	1995[1)]	1996	1997	1998	1999	2000	2001	2002	2003
PFCs	*NIR 2005*	2097	2074	1881	1899	1822	1769	1952	2078	1618	1323	1336	1276	1249	1204
	NIR 2006	2246	2224	2019	2041	1958	1901	2104	2243	1715	1323	1387	1326	2066	439
	Difference	**149**	**150**	**138**	**142**	**136**	**132**	**152**	**165**	**97**	**0**	**51**	**50**	**817**	**-765**

[1)]Base year for F-gases in the *Kyoto Protocol*.

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. Emissions vary at around 0.05 Gg, and are rounded off to either 0.1 or 0.0 Gg, (see *Table 4.1*). This minor source is no key source for CO_2 (see also *Annex 1*).

Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in monitoring protocol 5402 on the website www.greenhousegases.nl.

The a*ctivity 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 2000-2003).

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 5402 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.

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 *Section 1*.

4.5.5 Source-specific re-calculations

There have been no source-specific re-calculations 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 SF6 [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.
  HFC22 is produced at one plant in The Netherlands. Tri-fluormethane (HFC23) is generated as a by-product during the production of chlorodifluormethane (HCFC22) and emitted through the plant condenser vent.

- 2E3 *Handling activities:* emissions of HFCs. In The Netherlands HFCs are released during the handling activities of HFCs at two companies.

The source category *Production of HCFC-22* is a key source; *see Table 4.1.*

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 the 1999 measurement data provided by one company. The other company uses both measurement data and a mass balance relating to the kind of handling activity used to estimate the emissions.

More detailed information on the activity data and emission factors can be found in the monitoring protocols 5418 and 5419 on the website www.greenhousegases.nl.

Table 4.7 shows the trend in HFC emissions from the categories *HCFC-22 production* and *HFCs from handling activities* for the period 1990–2004. 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 large interannual variation in handling emissions can be explained by variations in handling activities over time.

Table 4.7 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.).

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2E1. HFC-23	4432	3452	4423	4947	6278	5759	6887	6709	7791	3440	2421	450	685	415	354
2E3. HFCs	NO	NO	25	51	129	12	224	707	519	384	418	192	98	40	99
HFC total	4432	3452	4447	4998	6407	5771	7110	7416	8310	3825	2838	641	783	455	454

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 5418 and 5419 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 HFC23 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 50%. The uncertainty

in the activity data for these sources is estimated at 10%. The uncertainties in the emission factors for HFC23 from *HCFC-22 production* and for HFC from *Handling activities* are estimated at 10% and 50%, respectively. These figures are all based on the judgments of experts.

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

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

4.7 Consumption of halocarbons and SF6 [2F]

4.7.1 Source category description
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 categories:

2F(1-4): Emissions from substitutes for *Ozone- depleting* substances.
The inventory comprises the following sources in this source category:
- 2F1-i *Stationary refrigeration*: HFC emissions;
- 2F1-ii *Mobile air conditioning*: HFC emissions;
- 2F2-i *Foams*: HFC emissions; (included in 2F9);
- 2F4-i *Aerosols*: HFC emissions; (included in 2F9);
- 2F9-i Other: HFC emissions.

2F6: PFC emissions from *PFC use*.
The inventory comprises the following source in this source category:
- 2F7 *Semiconductor manufacture* (including SF_6 emissions).

2F9: SF6 emissions from *SF6 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.

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

The share of HFC emissions from the consumption of HFCs, PFCs and SF_6 (category 2F) in the national total F-gas emissions was 3% in the base year 1995; at the present time, it comprises 49% (0.5% in the total national inventory of greenhouse gas emissions).

Table 4.8 shows the trends in *actual* emissions from 1990 onwards. The level of HFC emissions increased by a factor of 3 in 2004 compared to 1995, mainly due to increased HFC consumption as a substitute for (H)CFC use. Only the use of HFC134a has decreased since 1999. The sometimes large interannual variation in the consumption and emissions of some sources can be explained by the variation in production levels of specific industries and service sectors. The actual emissions of SF_6 remained rather stable during the period 1995–2004.

Table 4.8 Actual emission trends specified per compound from the use of HFCs, PFCs and SF_6 (2F) (Units: Gg CO2-eq.).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
HFC-134a	NO	NO	NO	NO	17	48	81	116	137	130	162	210	259	312	375
HFC-143a	NO	NO	NO	NO	NO	6	26	48	68	73	106	143	179	217	255
HFC-125	NO	NO	NO	NO	NO	7	25	43	57	60	87	119	149	180	212
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other HFC's	NO	NO	NO	NO	57	188	435	678	770	772	630	357	172	155	181
HFC Total	NO	NO	NO	NO	74	249	567	885	1,032	1,035	985	828	759	863	1,023
PFC use	18	21	24	28	32	37	51	101	114	147	193	163	120	180	179
SF_6 use	217	134	143	150	191	301	312	345	329	317	335	356	332	309	328
Total HFC/PFC/SF_6	**236**	**155**	**167**	**178**	**297**	**587**	**931**	**1,331**	**1,474**	**1,499**	**1,514**	**1,347**	**1,211**	**1,353**	**1,530**

Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 5420–5426 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).

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.
- *Electrical equipment*: emission factors are confidential information of the companies.
- *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 airconditioning, Aerosols, Foams* and *Semiconductor manufacturing*.

The country-specific methods for the sources *Electrical equipment, Sound-proof windows* and *Electron microscopes* are equivalent to IPCC Tier 2 methods.

More detailed descriptions of the methods used and emission factors can be found in the protocols 5420-5426 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 judgements 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

Actual emissions of PFCs for 1996 onwards and of SF_6 for 2001 onwards have been re-calculated due to the availability of more detailed information on the use of PFCs in *Semiconductor manufacturing* (see *Table 4.9*). In addition, the actual emissions of HFCs for 1994 onwards have been slightly revised as more detailed information on the use of other HFCs in *Stationary refrigeration* has become available.

Table 4.9 Effects of the re-calculations of HFC and PFC emissions (2F) 1990-2003 (Units: Gg CO_2–eq.).

		1990	1991	1992	1993	1994	1995[1)]	1996	1997	1998	1999	2000	2001	2002	2003
HFCs	*NIR 2005*	0	0	0	0	111	240	554	879	1,038	1,044	1,001	851	784	890
	NIR 2006	0	0	0	0	74	249	567	885	1,032	1,035	985	828	759	863
	Difference	**0**	**0**	**0**	**0**	**-37**	**9**	**11**	**6**	**-6**	**-9**	**-16**	**-23**	**-25**	**-27**
PFCs	*NIR 2005*	18	21	24	28	32	37	49	99	111	142	185	141	167	192
	NIR 2006	18	21	24	28	32	37	51	101	114	147	193	163	120	180
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**3**	**5**	**8**	**22**	**-47**	**-12**
SF6	*NIR 2005*	217	134	143	150	191	301	312	345	329	317	335	357	359	334
	NIR 2006	217	134	143	150	191	301	312	345	329	317	335	356	332	309
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-1**	**-27**	**-25**

[1)] Base year for F-gases in the *Kyoto Protocol*.

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;
- *Deposition* of NO_x and NH_3 emitted by domestic non-agricultural sources: (indirect) 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).

Indirect N_2O from the deposition of NO_x is identified as a key source (see *Table 4.1).*

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

The main *non-agricultural source of NO_x emissions* in The Netherlands is the *Transport* sector, which provides a two thirds share of the non-agricultural sources in the national inventory. Minor sources include fuel combustion for power generation and for the manufacturing industry. At the present time the *Residential* sector (mainly humans and their pets) is the main source of *non-agricultural NH_3*; in 1990 the emission level of the *Chemical industry* was similar to that of the *Residential* sector.

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*).

Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 5402 and 5414 on the website www.greenhousegases.nl

The *activity data* used are based on the following sources:

- *Fireworks*: data on annual sales from branche organization;
- *Candles*: average use of 3.3 kg per person (www.bolsius.com);
- *Non-agricultural NO_x and NH_3 emissions*: Netherlands Emission Register (ER);
- *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);
- *NO_x and NH_3 emissions*: Netherlands Emission Register (ER);
- *Production of drinking water*: 2.47 tons CH_4 /10^6 m^3;
- *Use of fuels for production of lubricants*: ODU factor of 50% (the IPCC default);
- *Production of waxes*: ODU factor of 100% (the IPCC default).

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 5402 and 5414 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.
- *Deposition of NH_3 and NO_x from non-agricultural sources:* a Tier 1b method is used for estimating indirect N_2O emissions from the deposition of nitrogen from domestic anthropogenic sources of N_2O, NO_x and NH_3, including emissions from other source sectors than agriculture. Non-agricultural sources of N_2O were neglected because of their negligible size.
- *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 indirect N_2O emissions from non-agricultural sources of NO_2 and NH_3 are based on the default IPCC methodology for indirect N_2O emissions from atmospheric deposition. The methodology applied to estimate the emissions – using default IPCC emission factors – results in highly uncertain annual emissions that are estimated to be of a factor of 2 at the very least. The uncertainty in the activity data – i.e. emissions of NO_x and NH_3 – are estimated to be 25%, based on an uncertainty assessment made in 2004 (TNO, 2004).

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 re-calculations compared to the previous submission.

4.8.6 Sourcespecific planned improvements

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

5. SOLVENT AND OTHER PRODUCT USE [CRF sector 3]

Major changes in sector 3 *Solvent and other product use* compared to the National Inventory Report 2005

Emissions: Emissions included in category 3B are slightly higher than those reported in this category in the previous submission for the whole time series. The re-allocation of the emissions from non-methane volatile organic compounds from car window cleaners (included in 1A3 *Transport* in the previous CRFs) explains the difference.

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 of 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 anaesthesia and as a propelling agent in aerosol cans (for example, in cream).
The Netherlands recognises 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 all *non-combustion* emissions from sectors other than those of the manufacturing and energy industries, with the exception of emissions from:

- Indirect CO_2 emissions from 3C *Chemical products, manufacture and processing*. For this source category NMVOC emissions are included in categories 3A, 3B and 3D.
- 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 fuels (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 2G as well because the CRF does not permit methane emissions to be included in sector 3.

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 5414: CO_2, N_2O en CH_4 from *Other process emissions and product use*.

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 2004. This represents a decrease of approximately 57% between 1990 and 2004, which is mainly the result of decreased indirect CO_2 emissions from paint application and the decreased use of N_2O for anaesthesia.

Table 5.1.Contribution of main categories and key sources in CRF sector 3

Sector/category Key source	Gas	Key	Emissions base year (1990/1995[1)]		Emissions 2004		Contribution to total in 2004 (in %)		
		Level, Trend	Gg	Tg CO_2-equivalents	Gg	Tg CO_2-eq.	By sector	Of total gas	Of total CO_2-equivalents
3 Solvents and other product use	CO_2			0.3		0.1	62	0.1	0.1
	N_2O		0.73	0.2	0.28	0.1	38	0.5	0.0
	All			0.5		0.2	100		0.1
3A Paint application	CO_2			0.2		0.1	35	0.0	0.0
3B Degreasing and dry cleaning	CO_2			0.0		0.0	1	0.0	0.0
3D Other	CO_2			0.1		0.1	27	0.0	0.0
	N_2O		0.73	0.2	0.28	0.1	38	0.5	0.0
	All			0.3		0.1			0.1
3D1 Anaesthesia	N_2O		0.65	0.2	0.17	0.1	23	0.3	0.0
3D3 Aerosol cans	N_2O		0.08	0.0	0.11	0.0	15	0.2	0.0
Total National Emissions	CO_2			159.4		180.9		100	
	N_2O		68.5	21.2	57.2	17.7		100	
National total GHG emissions (excluding CO_2 from LULUCF)	All			214.3		218.1			100

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

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 in sector 3 *Solvent and other product use* are indirect CO_2 emissions from *Paint application* and use of N_2O for A*naesthesia* in hospitals.

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 CO_2 emissions of solvents from the use of both industrial and decorative paints. Indirect emissions from the use of solvents in *Degreasing and dry cleaning* are included in CRF source category 3B, which sector 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 5414 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). More details can be found in Spakman *et al.* (2003).

The consumption of almost all solvent-containing products has increased since 1990. However, the general NMVOC content of products (especially in 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 during recent years. The NMVOC contents of these products have remained the same during the whole period.

Emission factors: it is assumed that all of NMVOC in the product is emitted. 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 estimate indirect CO_2 emissions. Country-specific methods are used for estimating NMVOC emissions from these sources.

The indirect CO_2 emissions from NMVOCs are calculated from the average carbon contents of the NMVOC emissions reported in categories 3A, 3B and 3D. The carbon contents are based on the

composition of compounds responsible for 85–95% of the total NMVOC emission within the category. Because of the lack of data for 3C, the weighted average of the other three is used to estimate the carbon fraction for this category. The fractions are calculated on the basis of the 1990 and 2000 emissions. This simplification is justified due to the small contribution of these emissions to the total inventory of national NMVOC emissions. The following fixed carbon fractions are used for the total time series:

3A	3B	3C	3D
0.72	0.16	0.68	0.69

The emissions are then calculated as follows:

CO_2 (in Gg) = Σ{NMVOC emission in subcategory i (in Gg) * C-fraction subcategory i } * 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 judgments of experts, 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 25%.

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. The emission estimates for the source categories are expected to be quite 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 re-calculations

Compared to the previous submission, some sources have been re-allocated in order to bring the report more in line with IPCC guidelines. The re-allocations have only a minor impact on the emissions reported. NMVOC emissions of car window cleaners (3 kton NMVOC) are included in 3B *Degreasing and dry cleaning*, whereas formerly they were included in 1A3b *Road transport*.

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 anaesthesia [3D1] and N_2O from aerosol cans [3D3])

5.3.1 Source category description

Emissions of N_2O from the use of *Anaesthesia* 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 5414 on the website www.greenhousegases.nl.

Activity data: The major hospital supplier of N_2O for anaesthetic use reports the consumption data of anaesthetic 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 these data. More details can be found in Spakman *et al*. (2003).

Domestic sales of cream in aerosol cans have been stable since 2000. In 2004 sales increased 14%, which is reflected in the increased emission in that year.

Emission factors: The emission factor used for N_2O in anaesthesia is 1 kg/kg. Sales and consumption of N_2O for anaesthesia are assumed to be equal each year. The emission factor for N_2O from aerosol cans is estimated to be 7.6 g/can, and – based on data provided by the producer – it 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 5414 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 re-calculations

There are no source-specific re-calculations 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 2005

Emissions: Compared to the previous NIR submission, N_2O and CH_4 emissions have increased slightly as a result of:

- Increases in the number of poultry following the recovery from the avian flu in 2004;
- The development of a country-specific method, resulting in an increase in the CH_4 emission factors applied to estimate enteric fermentation by cattle (see also *Section 6.2.5*).

Key sources: The key source classification in this NIR has been changed compared to the previous NIR. This is the result of changing emission levels in 2004 compared to 2003 and of re-calculations and improvements in the key source analysis. The animal category swine is no longer a key source for CH_4 emissions for the source category enteric fermentation. CH_4 emissions from poultry as a result of manure management represent a minor key source.

Methodologies: Methodological changes were applied to CH_4 from enteric fermentation and N_2O from agricultural soils:

- CH_4 from enteric fermentation. Due to the development of a country-specific method, methane emissions from enteric fermentation by cattle are estimated with improved accuracy. Changes in emission factors for cattle over time reflect changes in Dutch values for dry matter intake (linked to changes in milk production per cow amongst others). Feed nutrient composition changes (affecting digestibility and the MCF) over time are now also reflected in the emission factor (and MCF) of adult dairy cows.
- N_2O from agricultural soils. The application of sewage sludge and horse manure to soils has improved the inventory on completeness. Furthermore, a distinction was made between ammonium phosphate/sulphate and other synthetic fertilizers with respective low and high N_2O emission factors.

6.1 Overview of the sector

Emissions of greenhouse gases from this sector include all anthropogenic emissions from *Agriculture*, with the exception of emissions from fuel combustion and sewage. These emissions are included in 1A *Energy* and 6B *Waste*. In The Netherlands three source categories occur in this CRF sector:

- 4A *Enteric fermentation*: CH_4 emissions;
- 4B *Manure management*: CH_4 and N_2O emissions;
- 4D *Agricultural soils*: N_2O emissions.

The other 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, prohibited by law, is negligible in practice.

Manure management (4B) includes all emissions from confined animal waste management systems (AWMS). Two different approaches, both in accordance with the IPCC guidelines (IPCC, 2001), are used for reporting CH_4 and N_2O emissions from animal waste produced in the meadow during grazing. CH_4 emissions from animal waste 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*.

Methane emissions from agricultural soils are regarded as natural (non-anthropogenic) emissions and therefore are not estimated. CO_2 emissions from agricultural fuel combustion are included in category 1A4c *Agriculture/forestry/fisheries*. CO_2 emissions from agricultural soils are included in Sector 5 LULUCF (5D, see *Section 7.5*).

The following protocols on www.greenhousegases.nl describe the methodologies applied in estimating N_2O and CH_4 emissions in the agricultural sector in the Netherlands:

- Protocol 5427: CH_4 from *Enteric fermentation*: cattle (4A1);
- Protocol 5428: CH_4 from *Enteric fermentation: other animal categories* (4A2-13);
- Protocol 5430: CH_4 from *Manure management: cattle* (4B1);
- Protocol 5431: CH_4 from *Manure management: swine* (4B8);
- Protocol 5432: CH_4 from *Manure management: other animal categories* (4B2-7, 9-13);
- Protocol 5429: N_2O from *Manure management* (4B);
- Protocol 5433: N_2O from *Agricultural soils: indirect emissions* (4D);

- Protocol 5434: N_2O from *Agricultural soils: direct emissions and emissions from animal production* (4D).

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 (see also *Annex 1)*.

Table 6.1 Contribution of main categories and key sources in Agriculture

Sector/category *Key source*	Gas	Key*	Emissions base year		Emissions 2004		Contribution to total in 2004 (%)		
		Level, Trend, Non-Key	Gg	Tg CO_2-equivalents	Gg	Tg CO_2-eq.	By sector	Of total gas	Of total CO2-equivalents
4 Agriculture	CH_4		499.7	10.5	419.7	8.8	48	51	4.0
	N_2O		37.1	11.5	30.4	9.4	52	53	4.3
	All			22.0		18.2	100		8.4
4A Enteric fermentation	CH_4		358.4	7.5	302.3	6.3	35	37	2.9
4A1 Cattle	CH_4	L,T	322.3	6.8	272.0	5.7	31	33	2.6
4A8 Swine	CH_4	NK	20.9	0.4	16.7	0.4	2	2	0.2
4A2-13 Other animals	CH_4	NK	15..2	0.3	13.6	0.3	2	2	0.1
4B Manure management	CH_4		141.4	3.0	117.4	2.5	14	14	1.1
	N_2O	L	2.2	0.7	2.3	0.7	4	4	0.3
	All			3.7		3.2	17		1.5
4B2 Cattle	CH_4	L,T2	74.9	1.6	70.2	1.5	8	9	0.7
4B8 Swine	CH_4	L,T2	54.3	1.1	43.8	0.9	5	5	0.4
4B9 Poultry	CH_4	T2	11.6	0.2	2.7	0.1	0	0	0.0
4B2-7, 10-13 Other animals	CH_4	NK	0.6	0.0	0.8	0.0	0	0	0.0
4D Agricultural soils	N_2O		34.8	10.8	28.1	8.7	48	49	4.0
4D1 Direct soil emissions	N_2O	L	14.8	4.6	15.6	4.8	27	27	2.2
4D2 Animal production on agricultural soils	N_2O	L,T	4.2	1.3	2.1	0.7	4	4	0.3
4D3 Indirect emissions	N_2O	L,T	15.7	4.9	10.4	3.2	18	18	1.5
	CH_4		1,211.5	25.4	823.5	17.3		100	
Total National Emissions	N_2O		68.4	21.2	57.2	17.7		100	
National Total GHG emissions (excl. CO_2 from LULUCF)	All			214.3		218.1			100

*Key sources: L = Level; T= Trend; 1 = tier 1; 2 = tier 2.

Total greenhouse gas emissions from *Agriculture* were 22.0 Tg CO_2-eq. in 1990 and 18.2 Tg CO_2-eq. in 2004. The emissions decreased by approximately 17% between 1990 and 2004, mainly as a result of the decreasing numbers of livestock, a decreased application of animal waste and a decreased use of synthetic fertilisers. Compared to the previous NIR submission, emissions of N_2O and CH_4 emissions increased slightly due to:

- Increased number of poultry following the recovery from the avian flu in 2004;
- Increased CH_4 emission factors applied for estimating enteric fermentation by dairy cattle (see also *Section 6.2.5*).

In 2004, emissions of CH_4 and N_2O from agricultural sources each accounted for about 50% of the national total CH_4 and N_2O emissions.

6.2 Enteric fermentation [4A]

6.2.1 Source category description

Methane emissions 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 and sheep) 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.

In 2004 *Enteric fermentation* accounted for 35% 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 the production of cattle; this source contributed substantially to the greenhouse

gas emissions from agriculture in 2004 (31%). The second largest CH_4 emission source in category 4A is pig production. 4A *Other* (sources of enteric fermentation) consists of sheep, goats and horses.

Buffalo and camels do not occur in The Netherlands. The emissions from llamas, mules and donkeys are negligible and, therefore, are not taken up in the estimation. Enteric fermentation emission from poultry is not estimated due to the lack of data on CH_4 emissions and 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.

Activity data and (implied) emission factors

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

- Protocol 5427: CH_4 from *Enteric fermentation*: cattle (4A1);
- Protocol 5428: CH_4 from *Enteric fermentation: other animal categories* (4A2-13);

More details and specific data (activity data and emission factors), including data sources, are incorporated into background documents (mentioned below). All relevant documents concerning methodology, emission factors and activity data are published on the website www.greenhousegases.nl.

Activity data for the animal population (see also *Table 6.2*) are based on the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl and in background documents (Smink et al., 2005; Van der Hoek and Van Schijndel, 2006). Three categories are distinguished for cattle:

- Dairy cattle: adult female cows (for milk production);
- Non-dairy cattle: adult cows (for meat production);
- Young cattle showing a mix of different age categories (for breeding and meat production).

This classification was introduced in the CRF categories after the submission of *NIR 2005*. It makes it possible to report separately on animal numbers and CH_4 emission factors of adult female dairy cattle and young dairy cattle. The total number of cattle animals decreased by 24% between 1990 and 2004. The number of (adult female) dairy cattle, which is determined mainly by EU policy on milk quotas, decreased by 22% during the period 1990–2004 (see *Table 6.2*). Milk production per cow increased almost 23% between 1990 and 2004, a development which has resulted from both genetic changes in cattle (due to breeding programmes) and the changing composition of feed intake. With the national milk quota remaining unchanged, dairy cattle numbers for female cows decreased by the same order of magnitude. Between 1990 and 2004 the numbers of young (dairy) cattle follow the same trends as those of adult female cattle – namely, a decrease.

In addition, by regulating the amount of manure production and manure application, the Dutch policy on manure management directly influences livestock numbers in The Netherlands. As a result, the numbers of (dairy and non-dairy) young cattle and swine have decreased by 27% and 20%, respectively. The increased number of swine in 1997 was a direct result of the outbreak of classical swine fever in that year. In areas where this disease was present, the transportation of pigs, sows and piglets to the slaughterhouse was not allowed, so the animals had to stay on the pig farms. This explains why the annual census of 1997 shows a relatively high number of pigs.

Poultry numbers decreased between 1990 and 2004 by 7%. This is not a result of the Dutch policy on manure management. *Table 6.2* shows an increase in the number of poultry animals between 1990 and 2002. In 2003, however, poultry animal numbers decreased by almost 30% as a direct result of the avian flu outbreak; in 2004, the poultry population had partly recovered.

Table 6.2 Numbers of animals in 1990–2004 (1000 heads) (CBS, 2005).

Animal type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cattle	4,926	5,062	4,920	4,797	4,716	4,654	4,551	4,411	4,283	4,206	4,070	4,034	3,858	3,759	3,767
- dairy cattle	1,878	1,852	1,775	1,747	1,698	1,708	1,665	1,591	1,611	1,588	1,504	1,546	1,486	1,478	1,471
- non-dairy cattle	120	139	146	156	146	146	146	145	145	153	163	161	151	144	145
- young cattle	2,929	3,071	2,999	2,894	2,871	2,800	2,740	2,676	2,527	2,465	2,403	2,328	2,222	2,137	2,151
Sheep	1,702	1,882	1,952	1,916	1,766	1,674	1,627	1,465	1,394	1,401	1,308	1,289	1,186	1,185	1,236
Goats	61	70	63	57	64	76	102	119	132	153	179	219	255	274	282
Horses	70	77	86	92	97	100	107	112	114	115	118	120	121	126	129
Swine × 1000	13.9	13.2	14.2	15.0	14.6	14.4	14.4	15.2	13.4	13.6	13.1	13.0	11.6	11.2	11.2
Poultry × 1000	95.6	96.6	102.4	98.6	94.5	92.2	94.1	96.0	101.8	107.9	107.2	103.4	104.0	74.9	88.5

Key source (dairy) cattle emission factors are calculated using following data:

- Milk yield and composition of milk (Annual Agricultural Survey: CBS, 2005; www.cbs.nl);
- Feed components intake (Van Bruggen, 2006);
- Nutrient composition of feed components (Smink *et al.*, 2005).

Table 6.3 shows the implied emission factors (IEF) of the different cattle categories reported.

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Adult dairy cattle	108	108	108	111	112	113	111	114	115	117	118	120	119	125	126
Adult non-dairy cattle	67	67	67	67	67	67	66	67	66	68	68	68	68	73	74
Young cattle	38	38	38	39	38	39	37	37	36	36	35	35	35	36	35

Compared to the IPCC default emission factor of 118 kg per cow for highly productive dairy cows (with a milk production of approximately 6700 kg milk per cow per year), the emission factors calculated by The Netherlands are about 7–8% lower. *Table 6.4* shows that, in 2000, a milk production of about 7400 kg per year per cow leads to an emission factor of 118 kg. This is in compliance with the higher digestibility of the feed in The Netherlands (70–75%) compared to the feed digestibility underlying the IPCC default value (65%). The IEF follows the increasing trend in milk production during the period 1990–2004 (which is a result of an increase in feed intake). For adult non-dairy cattle, the IEF is higher than the IPPC default (48 kg per head per year). Emission factors for young cattle are relatively low due to the relatively large share of meat calves for white and rose veal production.

Table 6.4 Milk production (kg milk/cow/year) and IEF (kg/animal) for adult dairy cows.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Milk production	6050	6090	6140	6270	6405	6580	6626	6803	6827	7034	7416	7336	7187	7494	7415
CH_4 IEF	108	108	108	111	112	113	111	114	115	117	118	120	119	125	126

Figure 6.1 shows the relation between the trends in the number of cattle (dairy, non-dairy and young) and the methane emission due to enteric fermentation from these categories. The figure clearly shows that for the period 1990–2004 the pace at which methane emissions have declined does not match the trend for declining numbers of dairy cattle animals: the number of dairy cattle decreased by 22% compared to a 9% decrease in methane emissions. The difference can be explained by an increased methane emission factor per cow of 17% due to a change in total feed intake, the share of feed components and in the nutrient composition of the feed components in this time span.

Non-dairy cattle emissions increased by 35% between 1990 and 2004. This increase is not fully reflected in the 21% increase in animal numbers. The difference can be explained by an increased emission factor (10%) due to a change in total feed intake and in the share of feed components.

For young cattle as well reduced methane emissions cannot be completely explained by the decrease in animal numbers. The 27% decrease between 1990 and 2004 in the number of young cattle mentioned above is reflected in the decreased methane emissions (32% by order of magnitude). The difference is explained by the 8% decrease in the methane emission factor for young cattle due to a change in the total feed intake and in the share of feed components in the same period. This change was caused by a change towards a relatively high share of meat calves in the young cattle population.

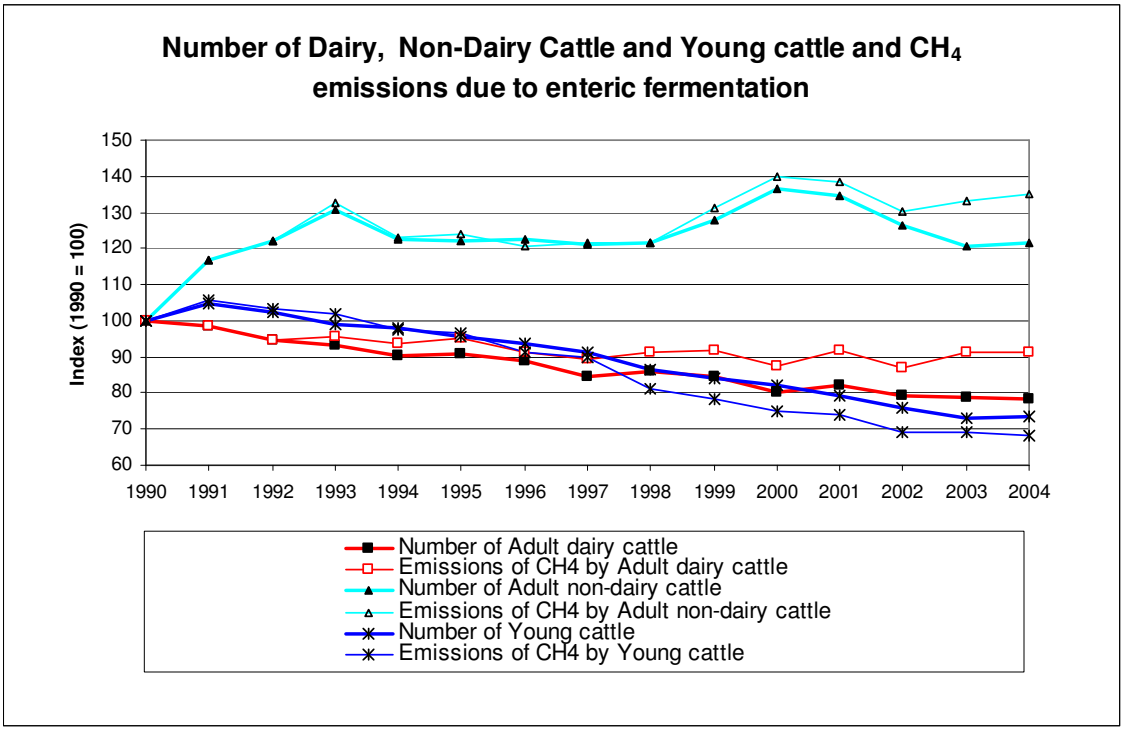


Figure 6.1 Number of cattle and CH_4 emissions due to enteric fermentation from cattle.

6.2.2 Methodological issues

In the previous submission, enteric fermentation by cattle was calculated using the IPCC Tier 2 formulas. However, using these IPCC formulas, the feed intake level (on dry matter basis) calculated for dairy cows is lower than the feed intake level calculations based on the Dutch Net Energy system. Furthermore, the IPCC formulas use a fixed methane conversion factor (MCF) of 6% for dairy cows. As a consequence, changes in feed rations are not accounted for in the MCF. Because of these shortcomings in the IPCC method, The Netherlands revised its calculation method in 2005. A more detailed description of the method used and the emission factors are found in the protocols on the website www.greenhousegases.nl, as indicated in *Section 6.1*. A specified description with more details on data and data sources on cattle can be found in Smink *et al.* (2005) and Smink (2005). Emissions from enteric fermentation are calculated from animal population data 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, non-dairy and young cattle, respectively. A new country-specific method based on a Tier 3 procedure was followed; for the other categories, the calculation was based on a country-specific Tier 2 procedure.

The dry matter intake of cattle, which is estimated from the energy requirement calculation used in The Netherlands, is the most important parameter in the calculation of methane production. For *dairy cows* the energy requirement (i.e. VEM or feed unit of lactation) is calculated on the basis of total milk production. The intake of grass silage, maize silage, wet by-products and concentrates is estimated from national statistics. On the basis of the energy requirement, the other part of the ration is assumed to be meadow grass, which means that the calculated feed intake is suitable to cover the need for VEM. More information on the Dutch VEM system is presented in Smink *et al.* (2005).

Adult dairy cows

The production of methane from enteric fermentation by dairy cows is calculated using dynamic modelling (Smink *et al.,* 2005), employing the model of Mills *et al.* (2001), 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 intake and methane production 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, etc).

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) uptake by a methane conversion factor (Smink, 2005). Changes in gross energy uptake are based on changes in the total feed intake and on the share of feed components. Total feed intake is calculated on basis of various factors, including weight gain.

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

$$EF = (Y_m * GE * 365 \text{ day/yr}) / 55.65 \text{ MJ/kg } CH_4$$

Where:
EF: Emission factor (kg CH_4/animal/year);
Y_m: Methane conversion factor; fraction of the gross energy of feed intake converted to methane;
GE: Gross energy uptake (MJ/animal/day).

Where:

- GE intake = 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 adult non-dairy cattle (IPCC, 2001)

Other livestock
Emission factors for the source categories swine, sheep, horses and sheep are based on default IPCC Tier 1 emission factors are based on an OECD publication in 1991 and documented in Van Amstel *et al.* (1993). In the previous submission, a country-specific EF for goats (8 kg per goat per year) was used. However, it was subsequently determined that the country-specific input data underlying the EF calculation had not been published. For this reason, it was decided to use the IPCC default EF (5 kg per goat per year) instead.

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 was already mentioned in *Section 6.2.1*, enteric fermentation emission from poultry is not estimated due to 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 also do not estimate emissions from poultry.

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 20% in annual emissions, using a 5% uncertainty for animal numbers and 20% for the emission factor. The uncertainty in the emission factor for swine and other animals is estimated to be 50% and 30%, respectively.

Time-series consistency
A consistent methodology is used throughout the time-series. Emissions are calculated from animal population data and the appropriate emission factors. The animal population data are collected in an annual census and published by Statistics Netherlands. The compilers of the activity data for this long-time publication strive to use consistent methods to produce the activity data. The time-series consistency of these activity data is 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 *Section 1.*

6.2.5 Source-specific re-calculations

Re-calculations were carried out for cattle and goats.

Emissions from goats decreased by approximately 37% as a result of the change in the emission factor by the same order of magnitude (see also *Section 6.2.2*).

Table 6.5 shows the results of the re-calculations on the cattle emission levels during the 1990–2004 period. Re-calculations were necessary because the emission factors applied to cattle underwent a change in comparison to the last submission. Due to the application of a country-specific method, the methane emissions from enteric fermentation by cattle are estimated with improved accuracy. Changes in emission factors for dairy cattle over time reflect not only changes in the milk production per cow (which goes together with changes in energy uptake) but also changes in the feed nutrients' chemical composition (affecting digestibility and the methane conversion factor of the feed). These methodological changes were included as part of the inventory improvement programme (also in response to previous reviews).

Table 6.5 Results of re-calculations in Enteric fermentation (CH_4 emissions in Gg).

	Submission	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
4A Enteric	*NIR 2005*	349	354	347	340	336	334	328	318	314	311	307	307	293	289
fermentation	*NIR 2006*	358	364	356	358	347	348	333	328	319	318	305	313	295	302
	Difference	**10**	**10**	**9**	**17**	**11**	**14**	**6**	**10**	**5**	**7**	**-2**	**6**	**2**	**14**
Of which:															
Dairy cattle	*NIR 2005*	191	188	182	181	179	180	177	170	176	176	173	175	168	170
	NIR 2006	203	200	192	194	190	193	185	181	185	186	177	186	177	185
	Difference	**11**	**12**	**10**	**13**	**11**	**13**	**8**	**11**	**9**	**10**	**5**	**11**	**9**	**14**
Non-dairy	*NIR 2005*	8	9	9	10	9	9	9	9	9	10	11	10	10	9
Cattle	*NIR 2006*	8	9	10	11	10	10	10	10	10	10	11	11	10	11
	Difference	**0.2**	**0.3**	**0.3**	**0.4**	**0.3**	**0.4**	**0.2**	**0.3**	**0.3**	**0.6**	**0.6**	**0.6**	**0.6**	**1.3**
Young cattle	*NIR 2005*	113	120	117	112	110	107	104	101	85	90	90	88	84	78
	NIR 2006	112	118	115	114	109	108	102	100	90	88	83	83	77	77
	Difference	**-2**	**-2**	**-1**	**2**	**-1**	**1**	**-2**	**-1**	**5**	**-3**	**-7**	**-6**	**-7**	**-1**

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. These emissions are related to the quantity and the composition of the manure, and to the manure management system types and conditions. In general: In comparison to anaerobic conditions, aerobic conditions in the manure management system will increase N_2O emissions and decrease CH_4 emissions.

In 2004, *Manure management* accounted for 17% of the total greenhouse gas emissions from the agricultural sector (*Table 6.1*). In The Netherlands CH_4 emissions from *Manure management* are particularly related to the production of cattle and swine, which, in 2004, contributed 8% and 5%, respectively. Poultry is a minor key source for methane emissions by manure management (tier 2 trend key source). Furthermore, N_2O emissions from *Manure management* contribute 4% of the total greenhouse gas emissions from the agricultural sector.

The category 4B *Other animals* (sources of *Manure management*) reflects the emissions of sheep, goats and horses. Buffalo and camels do not occur in The Netherlands, and llamas, mules and donkeys are negligible and therefore not estimated. Three animal waste management systems (AWMS) are distinguished for emission estimations of both CH_4 and N_2O: liquid and solid manure management systems and manure produced in the meadow while grazing.

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*).

Activity data and (implied) emission factors

A description of the methodology can be found in the monitoring protocols:

- Protocol 5430: CH4 from *Manure management: cattle* (4B1);
- Protocol 5431: CH4 from *Manure management: swine* (4B8);
- Protocol 5432: CH4 from *Manure management: other animal categories* (4B2-7, 9-13);
- Protocol 5429: N2O 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 activity data are published on the website www.greenhousegases.nl.

Activity data on animal population are based on the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl and in a background document (Van der Hoek and Van Schijndel, 2006).

Manure production (volume) and *Manure N excretion* are estimated on the basis of animal numbers per animal category (see *Table 6.2*) and manure production or manure N excretion per animal. Standard factors for manure production and manure N excretion per animal per animal category and per manure management system, decided on by WUM (Working group for Uniform calculations on Manure and minerals) annually, are calculated by Statistics Netherlands on the basis of specific data such as milk yield. More specified data on *Manure management* are based on statistical information on management systems; these data are documented in Van der Hoek and Van Schijndel, 2006.

CH_4 emission factors for Manure management

Emission factors for CH_4 are based on country-specific values for:

- Organic Matter (OM) ;
- Maximum potential CH_4 production (BO);
- Methane conversion factor (MCF);

Table 6.6 shows the share of *dairy cattle* CH_4 emissions to be almost 80% of the total *cattle* CH_4 manure management emissions.

Table 6.6 Trend in CH_4 emissions from Manure management, 1990-2004 (Units: Gg).

Animal type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cattle	74.9	75.6	72.9	70.9	69.0	75.6	73.4	70.4	69.4	67.7	67.7	68.7	69.7	68.2	70.2
- dairy cattle	52.1	51.4	49.2	48.5	47.1	52.2	50.8	48.6	49.2	48.5	49.9	51.1	53.0	52.8	55.2
- non-dairy cattle	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.5
- young cattle	22.5	23.8	23.2	22.0	21.4	23.0	22.1	21.4	19.7	18.7	17.3	17.1	16.1	14.9	14.6
Sheep	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Goats	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Horses	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
Swine	54.3	54.5	54.1	56.3	54.4	60.3	60.2	62.7	56.1	56.1	52.8	50.1	45.7	43.7	43.8
Poultry	11.6	11.7	11.8	11.2	9.4	8.2	8.4	8.5	5.7	5.9	6.0	5.9	4.0	2.6	2.7
Total	**141.4**	**142.3**	**139.4**	**139.1**	**133.4**	**144.7**	**142.7**	**142.3**	**131.9**	**129.4**	**127.3**	**125.5**	**120.4**	**115.3**	**117.4**

The total number of dairy cattle in The Netherlands has decreased by 22% from 1990 to 2004 (*Table 6.2).* This decrease does not reflect the 6% increase in dairy cattle CH_4 emissions during the same period (*Table 6.3*).

Table 6.7 shows the implied emission factors for Manure management specified by the animal categories that contribute the most to CH_4 emissions.

Table 6.7 CH_4 implied emission factor (kg/head) for Manure management as specified by animal category, 1990–2004.

Animal type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cattle															
- dairy cattle	27.74	27.74	27.74	27.74	27.74	30.54	30.53	30.53	30.53	30.53	33.17	33.03	35.70	35.70	37.50
- non-dairy cattle	3.26	3.23	3.29	3.26	3.28	3.35	3.35	3.32	3.37	3.28	3.43	3.48	3.44	3.47	3.51
- young cattle	7.67	7.74	7.74	7.59	7.47	8.20	8.05	7.98	7.80	7.59	7.19	7.35	7.26	6.99	6.77
Swine*	3.91	4.12	3.82	3.76	3.73	4.19	4.18	4.13	4.17	4.06	4.02	3.84	3.92	3.91	3.92
Poultry	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.06	0.05	0.06	0.06	0.04	0.04	0.03

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

These emission factors cannot be directly compared to the IPCC default values because of the assumptions on the share of the animal waste management systems underlying the IPCC defaults. However, the values of the underlying parameters (OM, B0 and MCF) can be compared per waste management system. An overview of the values used is given in the protocols. Compared to the IPCC default B0 values, the Dutch B0 values are slightly higher for adult dairy cattle, higher for non-dairy cattle, sheep and goats and lower for horses and swine. The differences can be explained by differences in feed composition. Compared to the IPCC default MCF values, the Dutch MCF values for liquid manure systems of swine, poultry and cattle are 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; for manure production in the meadow, it uses the IPCC default MCF value.

In general terms, there is no difference between methane calculations based on Organic Matter (OM) values as used by the Netherlands and methane calculations based on Volatile Solids (VS) values, as used in calculation equations by IPCC. However, the country-specific OM values used by the Netherlands are expressed as the amount of OM per kg *manure*. For this reason these values cannot be compared to the IPCC default VS values, because these are expressed as amount of VS per kg of *feed intake* per animal per year.

The IEF for adult dairy cows increased by 35% between 1990 and 2004. This increase is explained as follows:

- Starting from 2000, manure production per dairy cow in the Netherlands increased by 13% compared to 1990.
- Starting from 2000, the CH_4 emission factor for the liquid manure management system increased by 6% compared to 1990 because the organic matter content in the manure increased by 7%.

Between 1990 and 2004 there was a shift towards a 13% greater share of liquid stable manure (compared to the share of manure produced in the meadow).

The increase in milk production of approximately 24% during the period 1990–2000 is accompanied by an apparent increase in the amount of manure per cow and in the organic matter content of the manure (as a result of higher feed intake). This has led to a 20% increase in the methane emission factor for manure management per cow (see also *Section 6.2.1*). However, these two factors cannot fully explain the almost 35% increase in the CH_4 emission factor per cow.

A third explanation concerns the shift in the proportion of the two dairy manure management systems (liquid manure in the stable and manure in the meadow). The share of the amount of stable manure increased from 70% to approximately 79% between 1990 and 2004, while the amount of manure produced in the meadow during grazing was reduced by keeping dairy cattle indoors more often due to the following reasons:

- An increase the cost-effectiveness of milk production;
- An increase in the efficiency of manure application (one of the effects of The Netherlands' manure policy).

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 by 12%.

The conclusion is that between 1990 and 2004, the increases in the manure production per cow (+13%) and organic matter content of manure (+7%) combined with a shift to more stable manure (+12%) resulted in a 35% increase in the methane emission from manure management per cow. These

changes combined with the 22% decrease in the number of adult dairy cow since 1990 provides an explanation for the 6% increase in the total CH_4 emission of milk-producing cows.

For *swine* the 19% decrease in emissions between 1990 and 2004 (*Table 6.5*) is closely related to the observed decrease in animal numbers (–19%), as is shown in *Table 6.2.*

The 11% increase in CH_4 emission in 1995 can not be explained by the slight decrease in the number of animals (1.5%). The main explanation of the increase in emissions is the 20% increase in the emission factor for *fattening pigs'* manure. This is the result of an increase in the organic matter concentration of manure caused by a changed manure management: in order to decrease the manure volume, the mixing of rinsing water with manure was prevented as much as possible. The emission factor for *breeding pigs'* manure remained unchanged.

The numbers of fattening pigs and breeding pigs account for approximately 80% and 20% of the total number of adult swine numbers. (Piglet numbers – representing about 40% of the total number of pigs – are excluded here because manure production by piglets is accounted for in manure production by adult breeding swine). At the same time, the IEF for fattening pigs is about 50% of the IEF of breeding swine. The overall IEF increased by 13%. Combined with the small decrease in animal numbers, this leads to an 11% increase in CH_4 emissions by swine.

The 4% increase in CH_4 emissions between 1996 and 1997 cannot be fully explained by the increase in total swine numbers (almost 6% due to the outbreak of swine fever). Total *adult* swine numbers (excluding piglets) account for about 60% of total number of swine. Between 1996 and 1997 there was a 4.5% increase in the number of adult pigs; this increase explains the increase in CH_4 emissions in the same period.

For *poultry,* the 77% decrease in CH_4 emissions in 2004 compared to 1990 cannot be explained by the 7% decrease in animal numbers. In the period 1990–2004 there was a shift in the proportion of the two poultry manure management systems (solid and liquid manure). Between 1990 and 2004 the proportion of solid manure production increased from 44% to 86%. Compared to the liquid manure system the CH_4 emission factor for the solid system is about 15-fold lower. Overall, this leads to a decreased IEF of 75%. This decreased IEF in combination with the 7% decrease in animal numbers explains the 72% decrease in CH_4 emissions by order of magnitude.

N_2O emission factor for Manure management

Emission factors for N_2O from *Manure management* represent the IPCC default values for liquid and solid systems. *Table 6.8* shows that the N_2O emissions from *Manure management* increased from 2.24 to 2.28 Gg (+2%) between 1990 and 2004.

Table 6.8 N_2O implied emission factor for Manure management and total N-excretion per animal waste management system (Units: mln kg/year and kg N_2O/kg manure).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total N-excretion	493.0	497.7	491.9	523.6	503.7	500.5	482.5	470.5	461.4	446.6	414.9	411.8	394.9	375.6	373.2
-liquid system	431.2	430.2	418.9	451.8	435.8	429.3	411.6	400.1	383.7	365.8	338.0	338.8	318.7	316.1	305.1
-solid storage	61.9	67.6	73.0	71.9	67.9	71.2	70.9	70.4	77.7	80.8	76.9	73.0	76.2	59.6	68.1
N_2O emission manure management	2.24	2.37	2.50	2.52	2.39	2.49	2.45	2.43	2.62	2.66	2.51	2.46	2.51	2.06	2.28
N_2O IEF manure management	0.0045	0.0048	0.0051	0.0048	0.0047	0.0050	0.0051	0.0052	0.0057	0.0060	0.0060	0.0060	0.0064	0.0055	0.0061

This increase cannot be explained by the 24% decrease in total N excretion. Between 1990 and 2004 the proportion of the total solid manure N excretion increased from 13% to 18%. Compared to the liquid manure system, the N_2O emission factor for the solid system is about 20-fold higher, which explains the increased overall IEF of 34%. This increased IEF in combination with the 24% decrease in total N excretion explains the 2% N_2O emission increase.

The N_2O emissions of solid manure decreased in 2003 as 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, N_2O emissions increased once again following the recovery of poultry animal numbers.

6.3.2 Methodological issues

Methane emissions from animal manure

The methodologies used to calculate CH_4 from manure management systems are in accordance with the IPCC guidelines. However, the approach of the method applied by The Netherlands for CH_4 calculations differs slightly from the IPCC method. The Netherlands uses a country-specific emission factor for a specific animal category, which is expressed as amount of methane 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.

The amount of manure produced is calculated by multiplying manure production factors (in kiloggrammes per head per year) by animal numbers. Detailed descriptions of the methods can be found on the website www.greenhousegases.nl.

A Tier 2 approach is followed for CH_4 emissions. The amounts of manure (in kilogrammes) 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 and maximum methane-producing potential). Country-specific data on manure management system conditions (storage temperature and period) are also taken into account for liquid manure systems, which determine the methane conversion factor.

For the other manure systems (solid manure and manure produced in the meadow), IPCC default values for the methane conversion factor (MCF) 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 possibly 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 methane emission calculations.

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

The calculations of N_2O emissions are based on the same activity data as those for the calculations of CH_4 emissions. For the manure management systems and animal categories distinguished, the total N content of the manure produced – also called N excretion – (in kilogramme N) is calculated by multiplying N excretion factors (kg N per head × year) by animal numbers. Activity data are collected in compliance with a tier 2 level 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), because the N_2O emission from manure management is a 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 CH_4 and N_2O emissions from manure management from cattle and swine is estimated to be approximately 100% in annual emissions. 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%.

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 that are discussed in *Chapter 1*.

6.3.5 Source-specific re-calculations
Compared to the previous submission, there have been no major re-calculations. The methodology and/or the emission factors applied and the activity data used in the inventory remain unchanged. However, there have been some error adjustments that have resulted in only minor changes in the (implied) emission factor and emission level. Methane emissions by horses were re-calculated for the whole period (1990–2004). The 1993 value was corrected for sheep as this value was detected to be out of line by the centralised review carried out in Bonn, Germany between 10 and 15 October 2005.

6.3.6 Source-specific planned improvements
A possible policy measure to prevent methane emissions due to Manure management is manure treatment in an anaerobic digester. The Netherlands will examine future needs and possibilities in this area to include anaerobic treatment in the methodology and extended calculations, thereby taking the impact of this measure on emissions into account.

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

Both direct and indirect N_2O soil emissions are major-level and/or trend key sources (see *Table 6.1*). The share of N_2O emission from *Agricultural soils* in the national total N_2O emissions was approximately 50% in both 1990 and 2004. The most important sources of N_2O emissions from *Agricultural soil* are direct emissions due to the application of synthetic fertilisers and animal manure to soil and indirect emissions caused by nitrogen leaching and run-off. The share of direct N_2O emissions in the national total was about 22% in 1990 and about 27% in 2004. The share of indirect N_2O emissions in the national total was about 23% in 1990 and about 18% in 2004 (see also *Table 6.1*).

Activity data and (implied) emission factors
Detailed information on the methodology can be found in the following monitoring protocols:

- Protocol 5434: N_2O from *Agricultural soils*: direct emissions and emissions from animal production (4D);
- Protocol 5433: N_2O from *Agricultural soils*: indirect emissions (4D).

More details and specific data (activity data and emission factors), including data sources (emission factors), are documented in background documents (mentioned below). All relevant documents concerning methodology, emission factors and activity data are published on the website www.greenhousegases.nl.

Activity data
The calculation of **direct N_2O emissions from *Agricultural soils*** and **N_2O emissions from animal production** is based on various activity data:

- Activity data on *animal population, crop cultivation area, manure N exported* and sewage *sludge application* are based on the annual agricultural survey, performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl and in background documents (Van der Hoek and Van Schijndel, 2006; Van der Hoek *et al.*, 2006);
- *Manure N-excretion* estimates are based on *animal numbers per animal category* (see also *Section 6.2.1*) and *manure N-excretion per animal category*. Standard factors for manure N excretion per animal per animal category in the stable (liquid and solid systems) and in the meadow are calculated annually by Netherlands Statistics and decided on by WUM (Working group for Uniform calculations on Manure and minerals), based on specific data such as milk yield. Data

can be found on the website www.cbs.nl (Van Bruggen, 2006) and in a background document (Van der Hoek and Van Schijndel, 2006);
- The *share of manure incorporated* into the soil is based on Van der Hoek (2002).
- *Ammonia emissions* are calculated annually by LEI. Data are published on the websites www.cbs.nl (statline) and www.mnp.nl (milieucompendium).
- Total *chemical fertiliser N* and the share of *ammonium fertiliser N* (fertiliser without nitrate) is published annually (LEI/CBS: agricultural and horticultural figures).
- The *area of histosoils* and *N mineralisation per unit of area* was established recently (Kuikman *et al.,* 2005).;
- The percentage of *crop residue removal* is documented in Van der Hoek *et al.* (2006).
- The N content of *crop residue* was established by Velthof and Kuikman (2000).

Specific information on the activity data and the time-series of relevant data is published in Van der Hoek *et al.* (2006).

Activity data for **indirect N_2O emissions from *Agricultural soils*** are based on the activity data needed for N_2O emissions from direct and animal production:
- *Ammonia emissions* (LEI/CBS/MNP): according to *IPCC Guidelines*, ammonia emissions from agriculture are used to estimate total NH_3 deposition (total agricultural ammonia emissions are included in the calculation, although deposition might be outside The Netherlands).
- *Fraction of N leaching to ground water and surface water* is based on the calculation of total N to soils by manure application, animal production and chemical fertilizer. The default IPCC fracleach of 30% is used for estimation of the fraction of N leaching to groundwater and surface water.

The amount of nitrogen in manure (applied to soil and produced in the meadow) and fertiliser applied to agricultural soils decreased by approximately 28% between 1990 and 2004. This is explained by the Dutch policy on manure management, which regulates the amount of manure production and its application.

Table 6.9 presents the nitrogen flows from synthetic fertilisers and from animal waste management systems. About 80–85% of the manure collected in the stable and in storage is applied to Dutch soils. A small portion of the manure (approximately 2–4%) is exported; the remainder is emitted as ammonia during storage. Ultimately, approximately 20% of the N in manure and synthetic fertiliser is emitted as NH_3 (during storage, grazing and application to the field). Of the total nitrogen flow to the soil only 30% (default IPCC fracleach) is subject to leaching and run-off.

Table 6.9 Nitrogen flows related to N_2O emissions from soils.

Nitrogen flows (Gg N per year)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Use of synthetic fertilisers	412.0	400.1	391.8	389.9	371.6	406.0	389.0	401.0	402.9	383.3	339.0	298.0	292.0	291.0	300.5
N-input from manure applied to soils	413.1	415.3	405.4	430.4	407.0	404.5	398.7	391.8	387.8	367.9	339.5	340.9	323.2	315.0	308.7
N-input from animal production	170.8	189.1	180.3	167.0	153.7	156.5	163.3	151.8	130.5	119.7	113.1	115.5	94.4	95.0	87.8
As percentage of total in AWMS	84	83	82	82	81	81	83	83	84	82	82	83	82	84	83
N fixation by legumes	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
Atmospheric deposition	195.8	202.2	176.3	179.2	160.0	147.7	147.1	145.0	131.7	127.0	115.2	107.8	104.2	100.6	99.5
Nitrogen leaching and run-off	1,113.7	1,124.3	1,095.9	1,107.1	1,048.2	1,080.6	1,061.4	1,050.7	1,023.9	977.4	891.2	846.1	801.8	789.4	783.7

The N-input to soil in The Netherlands decreased by 30% from 1990 to 2004, mainly as a result of the Dutch manure policy aimed at reducing N leaching and run-off. The application of synthetic fertilisers and animal wastes to soil consequently also decreased. This decrease is not fully reflected in the 20% decrease in agricultural soil N_2O emissions during the same period (*Table 6.3*). The 33% decrease in **indirect** N_2O emissions is reflected by the decrease of the same order of magnitude (37%) in N-input by atmospheric deposition, and nitrogen leaching and run-off. The decrease in N-input by atmospheric deposition of almost 50%, as a result of ammonia legislation, was relatively high.
The 49% decrease in N_2O emissions by ***Animal production*** is completely reflected in the decrease in N-input by this source. However, the 5% increase in **direct** N_2O emissions does not reflect the 26% decrease in the direct N-input soil by manure and chemical fertiliser application.

(Implied) emission factors

IPCC default emission factors are used to calculate indirect N_2O emissions from atmospheric deposition and nitrogen leaching and run-off. Country-specific emission factors are used for calculations on animal production and direct soil N_2O emissions.

Table 6.10 shows the implied emissions factors (IEF) for N_2O emissions from *Agricultural soils*. For direct soil emissions by manure application to soil a doubling of the IEF occurs in the period 1990–2004 which is caused by a shift from the surface spreading of manure to the incorporation of manure into the soil.

Table 6.10 N_2O implied emission factor for Agricultural soils by CRF category (Units: kg N/kg N-input).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nitrogen input from applic. of synthetic fertilizers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrogen input from manure applied to soils	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Nitrogen fixed by N-fixing crops	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrogen in crop residues returned to soils	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Area of cultivated organic soils (ha/year)	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71

Between 1990 and 1995, N_2O emissions from manure application (4.D.1.2) increased by approximately 94%. This increase cannot be explained by the 3% decrease in N-input to the soil. During this period there was a change in the method of animal manure application to agricultural soils. Until 1990 manure was applied by spreading on the surface of grasslands and agricultural soils. Initiated by The Netherlands' policy to reduce ammonia emissions, this practice changed in 1991 into manure incorporation into the soil (e.g. sod injection and ploughing in). The N_2O emission factor for incorporation into mineral soils is twice as high as the N_2O emissions factor for surface spreading. In combination with the 3% decease in N-input, this explains the 94% increase in N_2O emissions by manure application.

Between 1995 and 2004 direct soil N_2O emissions from manure application decreased by 20%. This decrease is reflected in the decrease of the same order of magnitude (24%) in N-input during the same period.

Table 6.11 shows the emission factors applied to estimate agricultural soil N_2O emissions from different sources. The country-specific emission factors are lower than the IPCC default and higher for organic soils. For incorporation into soil a higher emission factor than the IPCC default is also used (see also *Section 6.4.3*). In theory, these new incorporation methods will increase the local concentration of nitrogen in the upper layer of the soil, resulting in a different microbial environment and therefore influencing microbial processes. Ultimately, N_2O emissions per amount of manure applied will increase, as has been shown in past research projects (mostly on laboratory scale) (Kroeze, 1994).

Table 6.11 Emission factors N_2O emission factors from soils for different sources.

	Mineral soils	Organic soils	Other	Reference[1)]
DIRECT EMISSIONS				
Synthetic fertilizer				
Ammonium fertilizer	0.005	0.01		2
Other fertilizer	0.01	0.02		1
Manure (animal wastes applied to soils)				
Surface spreading	0.01	0.02		1
Incorporation into soil	0.02	0.02		1
N-fixing crops	0.01			1
Crop residues	0.01			2
Cultivation of histosols		0.02		2
ANIMAL PRODUCTION				
Faeces	0.01	0.01		1
Urine	0.02	0.02		1
INDIRECT EMISSIONS				
Atmospheric deposition	0.01	0.01		2*
Nitrogen leaching and run-off			0.025	2*

[1)] *References: 1= Kroeze, 1994; 2= Van der Hoek et al., 2006; *= IPCC default.*

6.4.2 Methodological issues

Direct and indirect soil N_2O emissions, as well as N_2O emissions by animal production are estimated using country-specific activity data on N-input to soil and NH_3 volatilisation during grazing, manure management (storage) and manure application. Most of these data are estimated on 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.* (2006), with more details in Kroeze (1994).

Direct N_2O emissions and animal production

The IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions from animal production. Emissions from the application of synthetic fertiliser and manure have been estimated according to different subsources: organic and inorganic soils, ammonium phosphate/sulphate and other synthetic fertilisers and different manure application methods.

For *Animal production* a distinction is made between nitrogen in urine and in faeces. Direct N_2O emissions from histosols, crop residues and nitrogen fixation are also estimated using country-specific Tier 2 methods.

Country-specific emission factors are used for direct N_2O emissions and emissions from animal production. The country-specific emission factors for mineral soils are lower than IPCC defaults and higher for organic soils.

A higher emission factor than the IPCC default is also used for incorporation into soil. A recent survey on N_2O emission factors for the field-scale application of animal manure (Kuikman *et al.*, 2006) showed that on the basis of available data it was not possible to make an update of the N_2O emission factors applied in the past (Kroeze *et al*., 1994). Very few comparative trials between surface spreading and incorporation have been carried out in The Netherlands to date, resulting in very low emission rates for both techniques. Field-scale comparative experiments carried out in other countries show that, in most cases, N_2O emissions increased and seldom were lower in comparison with surface application. However, it was not possible to deduce long-term average N_2O emission factor from these findings and to translate these to the Dutch circumstances. Therefore, it was not possible to underpin an update of the N_2O emission factor for the application of animal manure. More research is needed in order to be able to take the specific circumstances of The Netherlands into account.

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 ammonia emissions (estimated at a Tier 3 level; LEI-MAM). 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. 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 (fraction leached) and for N_2O emission factors. The reason for this is the lack of country-specific data that can be used consistently together with data employed in the estimation of direct soil 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 nitrogen used in agriculture is estimated to be more than a factor of 2.

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 *Section 1.*

6.4.5 Source-specific re-calculations

Compared to the previous submission, there have been no major re-calculations. Completion of the inventory was improved by the incorporation of data on the application of sewage sludge to *Agricultural soils*. For other source categories the methodology, emission factors applied and the activity data used in the inventory have remained unchanged. However, there have been some error adjustments; these have resulted in only in minor changes in the activity data and emission level on manure application and animal production.

6.4.6 Source-specific planned improvements

IPCC default values are used to estimate the fracleach (fraction of N-input to soil leaching from the soil and being released partly as N_2O from groundwater and surface water) for the indirect N_2O emissions from agricultural soils and the N_2O emission factors. The main reason for this approach is the lack of country-specific data that is consistent with the data used to estimate direct soil emissions. The present methodology fully complies with the *IPCC Good Practice Guidance* (IPCC, 2001). The specific characteristics of Dutch 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 take specific Dutch circumstances into account.

A higher emission factor than the IPCC default is used for the incorporation of manure into soil. In the past, research (mostly on laboratory scale) has shown an increase in N_2O emissions (Kroeze, 1994). However, the findings of a recent survey on N_2O emission factors for the field-scale application of animal manure did not provide the necessary underpining for an update of long-term average N_2O emission factors for the application of manure under specific Dutch circumstances. Consequently, more research is needed to take the specific Dutch circumstances into account.

7. LAND USE, LAND USE CHANGE and FORESTRY [CRF sector 5]

Major changes in the LULUCF sector compared to the National Inventory Report 2005

Emissions: The net emissions in 1990 reported in this NIR decreased from 2.9 Tg CO_2-equivalents to 2.4 Tg CO_2-equivalents and the net emissions in 2003 decreased from 2.8 Tg CO_2-equivalents to 2.4 Tg CO_2-equivalents. These lower net emissions are mainly due to a lower estimate of the dynamics of land use change than that used in previous NIRs. This has resulted in lower emissions of CO_2 from *Land converted to Grassland* and a lower sink activity in *Land converted to Forest Land*). The very small emissions of N_2O reported last year are no longer reported in this sector but are included in the *Agriculture* sector.

Key sources: CO_2 from 5A1 *Forest Land remaining Forest Land,* 5C1 *Grassland remaining Grassland* and 5F2 *Land converted to Other Land*.

Methodologies: Changes in methodology have not been made. The main target of the re-calculation was to improve and refine the results in the land use change matrix. Also, the soil carbon calculation has been improved using data for soil carbon for individual soil strata instead of for class averages. A few corrections were made.

7.1 Overview of sector

The sector *Land Use, Land Use Change and Forestry* (LULUCF) covers the emissions and removals of CO_2 and the emissions of non-CO_2 greenhouse gases. For The Netherlands only emissions and removals of CO_2 are reported (N_2O from land use is included in the *Agriculture* sector in category 4D, *Agricultural soils*). 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.

The methodology of The Netherlands 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 carbon cycle of a managed forest and wood production system is considered in the calculations of the relevant CO2 emissions. The carbon stocks in soils from a single stratified measurement campaign for the various types of land use are used to calculate the emissions from land use categories.

Approximately 57% of the territorial area of The Netherlands is agricultural (grassland and cropland), 13% is used for settlements and 10% is forested (including trees outside forests) and 2% comprises dunes, nature reserves, wildlife areas and heather. The remaining area in The Netherlands is open water (19%).

The changes in land use have been calculated by comparing topographical maps that best represent 1990 and 2000. Changes after 2000 have been obtained by linear extrapolation. The land use changes, as they occurred during the period 1990–2000, show that the area used for settlements increased at a rate similar to the decrease in the area under grassland (about 100,000 ha in 10 years; approximately 2% of the total territorial area). Changes in the area under cropland and forest during this period were relatively small. The net increase in forested area, including a category of forest that does not meet the forest definition (‘trees outside forest’), was about 3000 ha and the decrease in cropland was about 3000 ha.

The contribution of the sector LULUCF was reported for the first time in 2003, when it covered only 5A *Forest Land*. It was in the *NIR 2005* that **all** LULUCF categories were included for the first time in the inventory. As a result of this inclusion, the contribution of the LULUCF sector to the total national greenhouse gas emission inventory changed from a net sink in the NIRs of 2003 and 2004 – which included only forestry – to a net source of CO_2 (including all LULUCF categories) in the *NIR 2005*.

The national inventory of Netherlands comprises seven source/removal categories in the LULUCF:

- 5A: *Forest Land*;
- 5B: *Cropland*;
- 5C: *Grassland*;
- 5D: *Wetlands*;
- 5E: *Settlements*;
- 5F: *Other Land*;
- 5G: *Other*.

All categories are relevant in The Netherlands. The net emissions of land use categories remaining unchanged (e.g. cropland remaining cropland) are assumed to be zero, except for the stocks in *Forest Land* (5A1) due to stock growth, felling and thinning and in *Grasslands* (5C1) due to (water) the management of organic soils.

The availability in The Netherlands of detailed information on the use of the entire land area allows the establishment of a land use matrix according to IPCC guidance. As a result, the information on carbon contents can be expressed with a relatively high degree of accuracy. The Netherlands has an intensive agricultural system with high inputs of nutrients and organic matter, and much agricultural land is in a rotation (within arable land and between grassland and cropland (especially maize). On this basis we have assumed that the impact of land use in The Netherlands in terms of loss of soil carbon is likely to be relatively small. We have assumed no changes in the carbon stocks due to land and soil management and cultivation practices over the period 1990–2004.

Emissions from liming are also presented in CRF *Table 5(iv)*. The available data on the use of limestone and dolomite are not considered separately for grassland and cropland.

The data and methods used for this sector were validated for the *NIR 2006*, and the data used were refined. This has changed the reported net emission of CO_2 compared with the previous submission. The changes imply a more accurate calculation of the carbon stock in soils (average stock is now calculated using 70 soil strata instead of seven soil classes), a correction of the carbon stock in peat soils with a specific ground water level (gtII) and an improvement of the land use and land use change maps for 1990 and 2000, which affects area data, carbon stock in soils and deforestation and afforestation data.

In adjusting the methodologies, the *IPCC Good Practice Guidance on Land Use, Land Use Change and Forestry* (IPCC, 2003) was taken into account. The methodologies applied for estimating CO_2 emissions and removals of the land use change and forestry in The Netherlands are described in the following two protocols (see also the website at www.greenhousegases.nl):

- Protocol 5435: *CO_2 from forest* (5A);
- Protocol 5436: *CO_2 from total land use categories* (5B-5G).

Table 7.1 shows the sources and sinks in the LULUCF sector in 1990 and 2004. For 1990 and 2004 the total net emissions were estimated to be 2.4 Tg CO_2–equivalents (1.3% in 1990 and 1.1% in 2004 of the total CO_2 emissions). The key sources are 5A1 (*Forest Land remaining Forest Land*), 5C1 (*Grassland remaining Grassland*) and 5F2 (*Land converted to Other Land*). The major source is CO_2 emissions from the decrease in carbon stored in organic soils and peat lands (4.2 Tg CO_2-equivalents included in 5C1 *Grassland remaining Grassland*) resulting from agricultural and water management. The major sink is the storage of carbon in forests (-2.5 Tg CO_2-equivalents included in 5A1 *Forest Land remaining Forest Land*).

The net emission from *Forest Land converted to Other Land* category is 369 Gg CO_2. Of this net emission 75.8% is from forests (according the definition) and 24,2% is from trees outside forests and from heather. The net emissions from forests is an information item in CRF Table 5 for LULUCF; relevant for the assessment of the Assigned Amount (75,8% of 369 Gg CO2 = 280 Gg CO2). The contribution of LULUCF to the reported ***Assigned Amount*** of The Netherlands is less than 0.13%.

Table 7.1 Contribution of main categories and key sources in sector 5 LULUCF

Sector/category *Key sources*	Gas	Key	Emissions base year		Emissions 2004		Contribution to total in 2004 (%)		
		Level, Trend, Non-Key	Gg	Tg CO_2-equivalents	Gg	Tg CO_2-eq.	By sector	Of total gas	Of total CO_2-equivalents
5. Total land use categories	CO_2		**2,392**	**2.4**	**2,356**	**2.4**	**100**[1)]	**1.3**	**1.1**
5A. Forest land	CO_2		**-2,516**	**-2.5**	**-2,448**	**-2.4**	**-34**		
5A1. Forest Land remaining Forest Land	CO_2	L,T	-2,505	-2.5	-2,289	-2.3	-32		
5A2. Land converted to Forest Land	CO_2		-11	0.0	-159	-0.1	-2		
5B. Cropland	CO_2		**-36**	**0.0**	**-36**	**0.0**	**-0.5**		
5B1. Cropland remaining Cropland	CO_2		NA, NE		NA, NE				
5B2. Land converted to Cropland	CO_2		-36	0.0	-36	0.0	-0.5		
5C. Grassland	CO_2		**4,195**	**4.2**	**4,195**	**4.2**	**59**		
5C1 Grassland remaining Grassland	CO_2	L	4,246	4.2	4,246	4.2	59		
5C2. Land converted to Grassland	CO_2		-51	-0.1	-51	-0.1	-0.7		
5D. Wetlands	CO_2		**NE**		**NE**				
5D1. Wetlands remaining Wetlands	CO_2		NE		NE				
5D2. Land converted to Wetlands	CO_2		NE		NE				
5E. Settlements	CO_2		**-152**	**-0.2**	**-152**	**-0.2**	**-2**		
5E1. Settlements remaining Settlements	CO_2		NE		NE				
5E2. Land converted to Settlements	CO_2		-152	-0.2	-152	-0.2	-2		
5F. Other Land	CO_2		**717**	**0.7**	**717**	**0.7**	**10**		
5F1. Other Land remaining Other Land	CO_2		0	0.0	0	0.0	0		
5F2. Land converted to Other Land	CO_2	L	717	0.7	717	0.7	10		
5G. Other	CO_2		**183**	**0.2**	**79**	**0.1**	**1**		
Total National Emissions	**CO_2**		**161,771**	**161.8**	**183,300**	**183.3**		**100**	
National Total GHG emissions (incl. CO_2 LULUCF)	All			216.7		220.4			100

[1)] *Absolute value 2004 (sinks and sources total: 7159 Gg)*

7.2 Forest Land [5A]

7.2.1 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. Over the last decades the share of mixed and broad-leaved forests has been growing (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.

Forest land is defined as land with woody vegetation and with tree crown cover of more than 20% over an area in excess of 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ. Forest land may consist either of closed forest formations, where trees of various heights and undergrowth cover a high proportion of the ground, or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 20%. Young natural stands and all plantations established for forestry purposes (that have yet to reach a crown density of 20% or a tree height of 5 m) are included in the term 'forest', as are areas normally forming part of the forest area which are temporally unstocked as a result of human intervention or natural causes, but which are expected to revert to forest land.

Forest land also includes:

- Forest nurseries and seed orchards that constitute an integral part of the forest;
- Forest roads, cleared tracts, firebreaks and other small open areas smaller than 6 m within the forest;
- Forest in national parks, nature reserves and other protected areas, such as those of special environmental, scientific, historical, cultural or spiritual interest, that cover an area of over 0.5 ha and have a width crown cover of more than 30 m;

- Windbreaks and shelterbelts of trees covering an area of over 0.5 ha and have a width of crown projection of more than 30 m.

It also includes systems with vegetation that currently falls below, but is expected to exceed, the threshold of the forest land category. In our case, "heather" is included in the forest definition. Tree stands in agricultural production systems – for example, in fruit plantations and agro-forestry systems – are not included.

Activity data and (implied) emission factors

Activity data are based on forest inventories carried out in 1988–1992 (HOSP data) and in 2001–2002 (MFV data). HOSP data, which include 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, were used for the 1990 situation. Forward calculation with these data was applied to the year 1999. Additional data on felling, final cut, thinning and outgrown coppice were used to complete the data set. MFV plot level data (in total 1440 plots, with same items as HOSP) were applied to the years 2000, 2001 and 2002. In addition, in order to assess the changes in activity data, databases with tree biomass information, with allometric equations to calculate above- and below ground biomass and with forest litter, respectively, as well as wood harvest statistics, soil carbon estimations and high-resolution topographical maps of 1990 and 2000 were used. See the website at www.greenhousegases.nl for more details on activity data.

Land use changes have an impact on carbon stored in forest and forest soil. As the sampling density of the national inventory was not dense enough to assess the carbon stock of the actual deforested lot, a static approach is followed to quantify the carbon implications of land use changes. This approach includes the assumption that at the time of deforestation, the living biomass is lost in the same year; the loss in biomass is estimated using the Dutch average forest biomass carbon stock (on average, 71 Mg C ha^{-1}). For afforestations, it is assumed that one half of the carbon uptake factor applies, as this has been found to be the average for the existing forest. This was the only reasonable assumption as specific data on each afforested lot were not available. In the future, more specific data of each afforested lot will be registered within the framework of the "Groenfonds".

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.

7.2.2 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 to carbon. Detailed descriptions of the methods used and emission factors can be found in the protocol 5435 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 aboveground biomass, belowground biomass, litter, dead wood, and soil organic carbon. Changes in the carbon stock are calculated for aboveground biomass, belowground biomass and dead wood in forests. For litter and soil organic carbon and for biomass in other nature terrains, it is assumed that the stock did not change during the period 1990–2000. 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- and belowground 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 2 years, the basic wood density and the carbon content of the dry mass. This last step is represented in the following equation:

$$\Delta C(trees)_{plot} = \frac{\left(M_{tree}(t) - M_{tree}(t+1)\right)}{\Delta t} \times N_{trees} \times F_{carbon}$$

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 (year)

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. A net build up may exist, since Dutch forestry just 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

7.2.3 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 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 and Brandes (2006) for details. *Uncertainty in the implied emission factor of 5A1 Forest Land remaining Forest Land*

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 living biomass* is calculated at 13% (rounded at 15% in the calculation spreadsheet). The uncertainty in the implied emission factor of *decrease living biomass* is calculated at 30%. The uncertainty in the net carbon flux from dead wood is calculated at 30% (rounded at 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, thus, 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 are the same (Groot *et al*, 2005). Thus, the uncertainty is the uncertainty of the change in carbon content in mineral soil, which is calculated at 38% (rounded at 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 are area changes calculated by comparing two topographic maps. The uncertainty of one topographic map is estimated at 5% (expert judgement). Thus, 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 time series for category 5A shows a slight decrease in sink strength from 1990 to 2002 (see *Table 7.2*). The figures in category 5A1 for the period after 2000 are copied from 2000. Without taking into consideration afforestation, the decrease in sink strength is even more profound over the same period, mainly due to a slight increase in harvest and a slight decrease in incremental carbon biomass. Although different databases have been used, the time series shows a stable trend. The figures in category 5A2 are based on up-to-date afforestation data. The very limited changes over time are a direct result of averaging the results over the period 1990–2000 and extrapolation after 2000 (see dead wood and trees outside forest). In addition, harvest figures show a rather stable pattern.

Table 7.2 CO_2 emissions/removals from changes in forest and other woody biomass stocks (IPCC category 5A) (Units: Gg CO_2)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5A Forest Land	-2516	-2567	-2674	-2695	-2659	-2621	-2603	-2419	-2511	-2487	-2406	-2416	-2427	-2437	-2448
5A1 Forest Land remaining Forest Land	-2.505	-2.546	-2.642	-2.653	-2.606	-2.558	-2.529	-2.335	-2.416	-2.382	-2.289	-2.289	-2.289	-2.289	-2.289
Of which:															
Live trees	*-4.073*	*-4.030*	*-3.994*	*-3.962*	*-3.935*	*-3.912*	*-3.893*	*-3.876*	*-3.863*	*-3.851*	*-3.959*	*-3.959*	*-3.959*	*-3.959*	*-3.959*
Harvest	*2.110*	*2.028*	*1.895*	*1.854*	*1.876*	*1.901*	*1.911*	*2.089*	*1.995*	*2.018*	*2.214*	*2.214*	*2.214*	*2.214*	*2.214*
Trees outside Forest	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*	*-209*
Dead wood	*-334*	*-334*	*- 335*	*-336*	*-337*	*-338*	*-338*	*-339*	*-339*	*-339*	*-336*	*-336*	*-336*	*-336*	*-336*
5A2 Land converted to Forest Land (Afforestion)	-11	-21	-32	-42	-53	-64	-74	-85	-95	-106	-117	-127	-138	-148	-159

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

7.2.5 Source-specific recalculations
The main objective of the re-calculation was to improve the results of the land use change matrix for deforestation and afforestion. The deforestation and afforestation figures, originating from a digital overlay of the topographical maps of 1990 and 2000, appeared to be relatively high in an earlier version. The fact that a very fine pattern of single grid cell deforestation seemed to occur was particularly important in determining the necessity of a field validation. The results were used to quantify an average correctness level. This improvement had an impact on the sink due to afforestation, but had no impact on 5A *Forest Land remaining Forest Land*. It also had impact on the deforestation (see 5C: *Land converted to Grassland*).

In the previous national inventory report (*NIR 2005*) the sequence of sinks due to afforestation since 1990 ranges from 0.02 Tg CO_2 to 0.27 Tg CO_2 in 2003. Following re-calculation, the figures are reduced to about one-third of the earlier figures and range from 0.01 Tg CO_2 to 0.16 Tg CO_2 in 2004. Consequently, the total sink from category 5A decreased by 0.01 Tg in 1990 and by 0.1 Tg in 2004

7.2.6 Source-specific planned improvements

Planned improvements address the verification of the topographical maps that are used to obtain land use information. A comparison will be made between the maps used and satellite observations. It is expected that this comparison will provide – at the very least – information on the categories forest land, grassland and cropland.

7.3 Cropland [5B]

7.3.1 Source category description

The source category 5B *Cropland* includes only the *emissions* of CO_2 from 5B2 *Land converted into Cropland*. Cropland is defined here as all land used as building land or where crops are grown. The emissions from 5B1 *Cropland remaining Cropland* is put at zero, since management-related changes in soil carbon are considered to be small in the Dutch intensive agricultural land use system. Therefore, the emissions due to soil management and cultivation practices of this category are not considered in the inventory.

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 (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.

7.3.2 Methodological issues

A country-specific Tier 2 method is used to estimate CO_2 emissions from soils resulting from changes in land use. The methodology can be summarized in two steps. In the first step, the type of land use is determined using digitized topographical maps (scale: 1:10,000), which allows the land use matrix to be completed conform to the recommendations in the *Good Practice Guidance on Land Use, Land Use Change and Forestry* (IPCC, 2003). Areas are thus obtained for the six main categories of land use as well as for the gross land use changes in (and between) these categories. The second step is the calculation of the carbon stock. Using the soil map combined with soil profile details based on *LSK* (see above) it is possible to produce a map and achieve a spatially explicit picture of the carbon stocks in the topsoil by applying the following formula:

$$SOC_{(1990\text{-}2000),S1} = \sum_{1}^{n} (\text{Os} \times \text{bulk density} \times \text{average C-content} \times \text{topsoil}) / n$$

Where:

$SOC_{(1990\text{-}2000),s1}$	Soil organic matter in the period 1990–2000 for soil unit S1 in ton C ha^{-1}
Os	Organic substance level in dry ground (%)
Bulk density	kg m^{-3} dry ground
Average C-content	kg C kg^{-1} os (default is 0.5)
Topsoil	Thickness of the topsoil in metres (default is 0.3 m)
N	Number of soil samples in soil unit S1

The change in carbon content of mineral soils in The Netherlands is calculated by:

$$\Delta C_{(c,\ mineral)} = \sum_{S} [(SOC_{(1990\text{-}2000)} \times A]$$

Where:

$\Delta C_{(c,\ mineral)}$	Annual change in carbon content in mineral soil (ton C $year^{-1}$)
$SOC_{(1990\text{-}2000)}$	Stock of soil organic substances in the relevant year (ton C ha^{-1})
$SOC_{(0\text{-}T)}$	Soil organic matter stocks in T years for the relevant inventory (ton C ha^{-1})
T	Inventory period in years
A	Land area of a specific land use (ha)
S	Varying and differentiated soil types

The relevant data and calculations can lead to changes in the areas of specific land use and to changes in the carbon levels, and they follow the IPCC requirements concerning methodologies and concepts.

The years 1990 and 2000 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 2000 are obtained by means of extrapolation. More detailed descriptions of the methods used and emission factors can be found in the protocols 5435 and 5436 on the website www.greenhousegases.nl.

7.3.3 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 used a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The uncertainties of 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 and Brandes (2006) 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 at 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 are area changes calculated by comparing two topographic maps. The uncertainty of one topographic map is estimated to be 5% (expert judgement). Thus, 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 time series does not show any differentiation. This is due to the averaging of the emissions from the converted lands into cropland over the entire period concerned on the basis of two measurements. The yearly sink of CO_2 due to the conversion of *Other Land* uses to cropland is 36 Gg CO_2.

7.3.4 Source-specific QA/QC and verification

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

7.3.5 Source-specific re-calculations

In addition to the improvement in the land use change matrix (see *Section 7.2 Forest Land*), the soil carbon calculation is improved and a few corrections are made. In more detail:

- Improved soil carbon calculation by using stratified soil data instead of more generic soil data;
- A few corrections (for example: total land area, average carbon content for some locations where there are no data available on soil/land use and improvement of the groundwater classification for 25,000 ha of peat soils.

The improved soil stratification, in combination with the a few corrections in the carbon stock, led to a 0.3% lower carbon stock in 1990. However, the improvements have very little effect on the final year-by-year results.

7.3.6 Source-specific planned improvements

See *Section 7.2.6* for information on the planned verification of the land use and land use change maps.

7.4 Grassland [5C]

7.4.1 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*. Grasslands are defined as all managed grasslands, natural grassland and grassland for recreation. 5C1 *Grassland remaining Grassland* includes the emissions from drained organic soils (peat soils). Additional CO_2 emissions are created when peat soils settle due to water level management,. Since most of the organic soils are under permanent

grassland, they are reported in their entirety in this category. The source category 5C1 is by far the most important source of CO_2 within the sector LULUCF. 5C2 *Land converted to Grassland* includes all deforestations.

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 (see *Section 7.3.1*). The activity data for organic soils are based on soil maps (1:50,000 for the 1960–1990), recent inventories on organic soils (2001–2003), profile information from *LSK* and data on field levels in 1990 and 2000.

7.4.2 Methodological issues
A country-specific Tier 2 method is used to estimate CO_2 emissions from soils that result from changes in land use (*Land converted to Grassland*) and from the drainage of organic soils (*Grassland remaining Grassland*). A detailed description of category 5C2 *Land converted to Grassland,* the methods used and the emission factors on emissions from soils as a result of changes in land use is given in *Section 7.3.2*.

For grassland, CO_2 emissions resulting from soil settlement of peat land due to drainage are added. The calculation of the CO_2 emission of 5C1 *Grassland remaining Grassland* is based on a drop in ground level for various types of peat and available information on the extent of drainage (Kuikman *et al.*, 2005). The country-specific method used is based on the recommendations given in the *IPCC 2003 Good Practice Guidance* (IPCC, 2003). Uncertainty over 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 be considered to be stable since 1990 (223,000 ha). The 2003 stated area of organic soils with the relevant water management conditions assumes an emission factor of 19.04 ton CO_2/ha (Kuikman, 2005). More detailed descriptions of the methods used and emission factors can be found in protocols 5435 and 5436 on the website www.greenhousegases.nl.

7.4.3 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 and Brandes (2006) 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 are area changes calculated by comparing two topographic maps. The uncertainty of one topographic map is estimated to be 5% (expert judgement). Thus, 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
This time series does not distinguish between the CO_2 emissions from drained organic soils and those from *Land converted into Grassland (deforestation)*. This results from the averaging of the emission from both subcategories of grasslands over the entire period concerned on the basis of two measurements. The yearly source of CO_2 that results from the drainage of organic soils is 4.246 Gg

CO_2. The yearly sink of CO_2 due to the conversion of forest land and 'other land' to grassland (an emission due to deforestation and to a much larger sink due to conversion from 'other land' to grassland) is 51 Gg CO_2.

7.4.4 Source-specific QA/QC and verification

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

7.4.5 Source-specific re-calculations

The general aspects of the re-calculations are described under *Section 7.2.5* (Improvement in land use change) and under *Section 7.3.5* (Improved soil carbon content calculations and some corrections in the calculations).

In the last national inventory report the average emission due to deforestation was 866 Gg CO_2. Following re-calculation, the average emission decreased to 125 Gg CO_2. If the conversion from *Other Land* uses to grasslands is included, the net emission in the last inventory was about 1.0 Tg CO_2. After re-calculation, the net emission from this source is about 0.5 Tg CO_2. The emission from drained organic soils was not the subject of improvement and remained the same. The net emission from category 5C decreases – after re-calculation – by 0.4 Tg CO_2. to become 4.0 Tg CO_2.

7.4.6 Source-specific planned improvements

In the near future more attention is required for the change and the amount of carbon stored in peat soils. Attention should also be paid to the classification of grasslands. Some grassland areas follow a pattern that comes closer to arable land than to grassland, while others are managed like nature reserves and are not used for production purposes. These uses all affect the amount of soil carbon that is stored and affects the year-by-year emission or sink. See also *Section 7.2.6* for information on the planned verification of the land use and land use change maps.

7.5 Wetland [5D]

7.5.1 Source category description

The source category 5D *Wetland* includes only CO_2 emissions from 5D1 *Wetland remaining Wetland* and 5D2 *Land converted to Wetland*. Wetlands are defined as all land that is covered, or saturated, with water for part or all of the year and which does not fall under the categories forest, cropland, grassland or settlements.

Activity data and (implied) emission factors

The activity data are 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 put at zero in the land use change matrix.

7.5.2 Methodological issues

A country-specific Tier 2 method is used to estimate CO_2 emissions from soils that result from changes in land use and for the unchanged use of land. For a detailed description of the methods used and the emission factors of emissions from soils as a result of changes in land use, see *Section 7.3.2*. The CO_2 emissions have not been estimated for either of these categories – 5D1 *Wetland remaining Wetland* and 5D2 *Land converted to Wetlands*. 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 5435 and 5436 on the www.greenhousegases.nl.

7.5.3 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 emission is zero over the entire period.

7.5.4 Source-specific QA/QC and verification

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

7.5.5 Source-specific re-calculations
Re-calculations have been described in *Section 7.2.5* (Improvement in land use change).

7.5.6 Source-specific planned improvements
See *Section 7.2.6* for information on the planned verification of the land use and land use change maps.

7.6 Settlement [5E]

7.6.1 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*. Settlements are defined as all land that has been developed and consists of infrastructure and land suitable for construction. Small sections of grassland, cropland and forests that are located within a primarily built environment area are not viewed as settlements but as belonging to one of the aforementioned main categories.

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.

7.6.2 Methodological issues
The reporting is considered as to be a Tier 2 level (see protocol 5_CO_2_Emissions_Total Land Use categories). Because there has been no change in soil carbon and, in any case, no loss of soil carbon was expected for the period 1990–2000, 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. In the case of conversion from *Other Land*, with no carbon stock, to settlements, there is a sink of carbon, which results from the wall-to-wall approach and the assumption that *Other Land* has no carbon stock. More detailed descriptions of the methods used and the emission factors can be found in the protocols 5435 and 5436 on the website www.greenhousegases.nl, as indicated in *Section 7.1*.

7.6.3 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 yearly sink of CO_2 due to the conversion of *Other Land* uses to settlements is 152 Gg CO_2. This value is the same for all years due to the averaging of two emission measurements over the entire period concerned.

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

7.6.5 Source-specific re-calculations
Re-calculations have been described under *Sections 7.2.5* (Improvement in land use change) and *7.3.5* (Improved soil carbon content calculations and some corrections in the calculations).

7.6.6 Source-specific planned improvements
See *Section 7.2.6* for information on the verification of the land use and land use change maps.

7.7 Other Land [5F]

7.7.1 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*. *Other Land* is defined as land such as rocks, uncultivated land and all non-managed land that does not belong to one of the other categories. In The Netherlands this refers to the coastal areas (beaches, dunes, sandy roads, uncultivated land alongside rivers, streams and sea waters).

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).

7.7.2 Methodological issues

A country-specific Tier 2 method is used to estimate CO_2 emissions from soils resulting from changes in land use (*Land converted to Other Land*) and for the unchanged use of land (*Other Land remaining Other Land*). For a detailed description of the methods used and the emission factors of emissions from soils as a result from changes in land use see *Section 7.3.2*. Because there has been no change in soil carbon and, in any case, no loss of soil carbon was expected for the period 1990–2000, the emission from the 5F1 *Other Land remaining Other Land* conforms to the recommendations of *Good Practice Guidance* set at zero.

More detailed descriptions of the methods used and the emission factors can be found in protocols 5435 and 5436 on the website www.greenhousegases.nl, as indicated in *Section 7.1*.

7.7.3 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 methodology used to calculate the figures for the period 1990–2000 is consistent over time and uses topographic maps to determine land use and the most recent soil data for soil carbon stocks. The category 5F2 *Land converted to Other Land* addresses the change from mainly grassland and cropland into other types of land (dunes as well as water). Although the land included in this category is small in area, the net emission from *Grasslands converted to Other Land* (water) is significant. The net CO_2 emission per annum is 717 Gg CO_2. This is the same for all years due to the averaging of the emissions over the entire period concerned based on two measurements.

7.7.4 Source-specific QA/QC and verification

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

7.7.5 Source specific recalculations

Recalculations have been described under *Section 7.2.5* (improvement in land use change) and under *Section 7.3.5* (elaborated soil carbon content calculations and some corrections in the calculations).

7.7.6 Source-specific planned improvements

See *Section 7.2.6* for information on the verification of the land use and land use change maps.

7.8 Other [5G]

7.8.1 Source category description

This 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 are derived from agricultural statistics for total lime fertilizers (period: 1990–2004). Data available on the application of limestone and dolomite do not address their use on grassland and cropland separately.

7.8.2 Methodological issues

The reporting is considered to be at the Tier 2 level (see protocol on Land Use). 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 5435 and 5436 on the website www.greenhousegases.nl, as indicated in *Section 7.1*.

7.8.3 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 CO_2 emissions from limestone and dolomite vary per annum, since the amounts used also vary from year to year (see *Table 7.3*). The methodology used to calculate the figures for the period 1990-2004 is consistent over time.

Table 7.3 CO_2 emissions from using limestone and dolomite in agriculture (Units: Gg CO_2)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5G Other (liming of agricultural soils)	183	147	141	134	96	98	111	110	104	84	98	80	85	86	79

7.8.4 Source-specific QA/QC and verification

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

7.8.5 Source-specific recalculations

There have been no source-specific recalculations. Only the figure for 1993 has been updated (one of the fertilizers was lacking in the previous submission).

7.8.6 Source-specific planned improvements

There are no source-specific improvements planned.

8. WASTE [CRF sector 6]

Major changes in *Waste* sector compared to the National Inventory Report 2005

Emissions: Compared to 2003, greenhouse gas emissions included in the *Waste* sector decreased in 2004 (from 7.5 Gg to 7.3 Gg CO_2–eq.). This is explained by the decreasing amount of solid waste disposed of by municipalities and the increasing amount of methane (CH_4) recovered from landfills. CH_4 emissions from wastewater handling have increased relative to 2003, a development which can be explained by the relatively dry weather conditions in 2003 (see *Section 8.3.1*). Emissions in the period 1990–2003 did not change compared to the previous NIR.

Key sources: *Waste water handling* (6B) is no longer identified as a key source for N_2O emissions using IPCC Tier 2 key source analysis, as a result of improvements in the key source analysis.

Methodologies: There have been no methodological changes.

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). However, methodological issues of 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 5401: CO_2 from *Waste incineration* (included in 1A1a);
- Protocol 5437: CH_4 from *Waste disposal* (6A1);
- Protocol 5438: CH_4, N_2O from *Wastewater treatment* (6B);
- Protocol 5439: CH_4, N_2O from *Industrial composting* (6D).

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 7.3 Tg CO_2-eq. in 2004. This decrease is mainly due to:

- 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 (see *Annex 1*).

Table 8.1 Contribution of main categories and key sources in sector 6 Waste

Sector/category Key source	Gas	Key	Emissions base year (1990)		Emissions 2004		Contribution to total in 2004 (%)		
		Level, Trend	Gg	Tg CO_2-equivalents	Gg	Tg CO_2-equivalents	by sector	of total gas	Of total CO_2-equivalents
6 Waste	CH_4		585.8	12.3	324.7	6.8	94	39	3
	N_2O		1.7	0.5	1.4	0.4	6	2	0.2
	All			**12.8**		**7.3**	**100**		**3**
6A. Solid waste disposal on land	**CH_4**		**571.9**	**12.0**	**310.5**	**6.5**	**90**	**38**	**3**
6A1. CH_4 emissions from solid waste disposal sites (SWDS)	CH_4	L,T	571.9	12.0	310.5	6.5	90	38	3
6B. Wastewater handling	N_2O		1.7	0.5	1.3	0.4	5	2	0.2
	CH_4		13.8	0.3	10.7	0.2	3	1	0.1
	All			**0.8**		**0.6**	**9**		**0.3**
6D. Other	CH_4		0.06	0.0	3.4	0.1	1	0.4	0.0
Total National Emissions	CH_4		1,211.5	25.4	823.5	17.3		100	
	N_2O		68.4	21.2	57.2	17.7		100	
National Total GHG emissions (excluding CO_2 LULUCF)	All			214.3		218.1			100

8.2 Solid waste disposal on land [6A]

8.2.1 Source category description

General description of the source category

In 2004 there were 27 operating landfill sites as well as a few thousand older sites that are still reactive. CH_4 recovery takes place at 50 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 will not be 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, 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*).

In 2004 solid waste disposal on land accounted for 90% of the total emissions in the *Waste* sector and 3% of the total 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 landfill. This policy requires enhanced prevention of waste production and recycling 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 Mton in 1990 to 3.3 Mton in 2004.

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 5437 on the website www.greenhousegases.nl.

Activity data on the amount of waste disposed on 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. These data can be found on the website www.uitvoeringafvalbeheer.nl and are documented in SenterNovem (2005). 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 5437 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[2]:

- 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 years, respectively (see *Table 8.2* for a detailed time-series);
- CH_4 oxidation factor: 10%;
- Fraction of DOC actually dissimilated (DOC_F): 0.58;
- 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 of land-filling 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 1990s. The integration time for the emission calculation is defined as the period from 1945 to the year for which the calculation is made.

Table 8.2 Parameters used in the IPCC Tier 2 method that change over time (additional information on solid waste handling part[1)]

Parameter	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Waste generation rate[1)] (kg/cap/day)	1.52	1.52	1.52	1.52	1.54	1.50	1.54	1.62	1.62	1.64	1.69	1.68	1.70	1.67	1.70
Fraction MSW disposed to SWDS	0.38	0.38	0.38	0.38	0.33	0.29	0.20	0.12	0.09	0.07	0.09	0.08	0.08	0.03	0.01
Fraction DOC in MSW	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.10	0.10	0.11	0.10	0.10	0.09	0.08
Fraction of waste incinerated	0.08	0.08	0.08	0.08	0.09	0.09	0.11	0.12	0.11	0.12	0.11	0.12	0.13	0.13	0.13
Fraction of waste recycled	0.63	0.67	0.68	0.69	0.72	0.75	0.76	0.77	0.76	0.76	0.79	0.79	0.79	0.80	0.80
CH_4 generation rate constant (k)	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Number of SWDS recovering CH_4	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	47	51	50	50
Waste incineration (Tg)	3.9	4.1	4.0	3.8	4.4	4.7	5.6	6.7	6.8	7.1	7.2	7.6	7.6	7.6	7.6

[1)]Waste generation rate refers to MSW (muncipal solid waste), excluding inorganic industrial waste such as construction or demolition waste.

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

[2)] 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.

activity data and the emission factor are estimated to be 30% and 15%, respectively. For a more detailed analysis of these uncertainties, see Olivier and Brandes, 2006.

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 2001 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.

8.2.4 Source-specific QA/QC and verification
The source categories are covered by the general QA/QC procedures that are discussed in *Section 1*.

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

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

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) as well as nitrogen compounds can lead to 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.

N_2O emissions from wastewater treatment (see *Table 8.1*) contributed about 2% to the total N_2O emissions in 2004 (as well as in 1990) and 0.2% in total CO2-equivalents. The contribution of wastewater handling in the national total of CH_4 emissions in 2004 was 1%. Since 1993, CH_4 emissions from WWTPs have decreased due to the introduction in 1990 of a new sludge stabilization system in one of the largest WWTPs in The Netherlands. However, the operation of this plant took a few years to optimize, which caused increased venting emissions in the introductory period (199–1993) compared to normal operating conditions.

Table 8.3 shows the trend in greenhouse gas emissions from the different sources of wastewater handling.

Table 8.3 Wastewater handling emissions of CH_4 and N_2O (Units: Gg/year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CH_4 industrial wastewater	0.25	0.28	0.30	0.32	0.31	0.33	0.33	0.33	0.34	0.34	0.34	0.35	0.36	0.34	0.34
CH_4 domestic & commercial wastewater	9.07	13.97	14.20	14.47	9.71	7.90	7.93	7.84	7.99	8.46	7.96	8.15	8.55	7.99	8.71
CH_4 septic tanks	4.47	4.15	3.83	3.51	3.38	3.25	3.06	2.86	2.64	2.42	2.20	1.98	1.76	1.53	1.65
Net CH_4 emissions	13.79	18.39	18.33	18.30	13.40	11.48	11.31	11.03	10.97	11.23	10.50	10.47	10.67	9.86	10.69
CH_4 recovered and/or flared	33.0	32.6	33.3	32.7	35.3	39.2	38.5	40.2	38.0	39.2	40.4	39.6	43.3	43.2	43.2
Recovery/flared (% gross emission)	71	64	64	64	72	77	77	78	78	78	79	79	80	81	80
N_2O domestic & commercial wastewater	0.81	0.84	0.85	0.86	0.87	0.84	0.83	0.85	0.86	0.85	0.85	0.86	0.86	0.84	0.84
N_2O from human sewage	0.85	0.85	0.80	0.76	0.74	0.65	0.63	0.60	0.62	0.57	0.53	0.54	0.51	0.44	0.44
Total N_2O emissions	1.66	1.69	1.65	1.61	1.61	1.49	1.46	1.44	1.48	1.42	1.38	1.39	1.37	1.28	1.29

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 5438 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 22% from 1990 to 2004. This decrease is mainly caused by improved nitrogen removal at urban WWTPs, which has resulted in lower effluent loads (see *Table 8.4*) and a subsequent decrease in the (indirect) N_2O emissions from human sewage.

From *Table 8.4* it can be concluded that the DOC of treated wastewater and sludge does not change to any extent 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 thus no longer using septic tanks.

Table 8.4 Activity data of domestic and commercial wastewater handling (Gg/year) and total volume of treated urban waste water (Units: Mm^3/year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Wastewater DOC[1)]	933	940	948	960	970	921	921	916	930	915	921	937	939	923	923
Sludge DOC	254	263	248	246	251	269	283	270	279	282	281	299	290	290	290
Nitrogen in effluent	53.8	54.0	51.1	48.3	47.3	41.5	40.3	37.9	39.6	36.0	33.8	34.2	32.4	28.3	28.3
Treated volume	1711	1683	1836	1897	2062	1908	1681	1717	2194	2034	2034	2169	2083	1791	1791

[1)]DOC, Degradable organic component.

8.3.2 Methodological issues

A full description of the methodology is provided in the monitoring protocol 5438 (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 WWTP, the CH_4 emission factor is expressed as 0.056 t/t DOC design capacity, assuming a utilization rate of 80% 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 $DOC_{influent}$. 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%. 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. 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.

N_2O emissions

N_2O emissions from the biological N-removal 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, respectively. Since N_2O emissions from wastewater handling was identified in the previous NIR as a key source, the present Tier 2 methodology complies with the *IPCC Good Practice Guidance* (IPCC, 2001). In the improved key source analysis this category is no longer a key source.

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 judgements 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 that are discussed in *Chapter 1*.

8.3.5 Source-specific re-calculations

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

8.3.6 Source-specific planned improvements

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

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 electricity 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 5401on 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, 2005a).

8.4.2 Methodological issues

A more detailed description of the method used and the emission factors can be found in the protocol 5401 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 8.6* 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.

Table 8.5 Composition of incinerated waste: carbon fraction and fossil fraction (%)

Waste type	Carbon fraction	Fossil fraction
WIP[1)]: paper/cardboard (%)	30	0
WIP: wood (%)	45	0
WIP: other organic (%)	20	0
WIP: plastics (%)	54	100
WIP: other combustible (%)	32	50
WIP: non-combustible (%)	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).

Table 8.6 Composition of incinerated waste

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total waste incinerated (Gg)	2.8	2.7	2.7	2.9	2.7	2.9	3.6	4.1	4.6	4.6	4.9	4.7	5.0	5.1	5.1
of wich residential waste (Gg):	2.3	2.2	2.2	2.2	2.0	2.1	2.6	3.0	2.9	3.1	3.1	3.4	3.6	3.6	3.6
Of which:															
WIP[1)]: paper/cardboard (%)	*25*	*25*	*25*	*25*	*28*	*29*	*30*	*30*	*29*	*29*	*27*	*28*	*27*	*26*	*26*
WIP: wood (%)	*2*	*2*	*3*	*3*	*3*	*4*	*4*	*5*	*5*	*5*	*6*	*5*	*5*	*5*	*5*
WIP: other organic (%)	*46*	*46*	*44*	*40*	*37*	*33*	*32*	*32*	*33*	*31*	*32*	*32*	*32*	*32*	*32*
WIP: plastics (%)	*9*	*9*	*9*	*9*	*9*	*10*	*11*	*12*	*13*	*13*	*13*	*13*	*13*	*15*	*15*
WIP: other combustible (%)	*8*	*9*	*9*	*11*	*11*	*11*	*10*	*9*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
WIP: non-combustible (%)	*11*	*10*	*11*	*11*	*12*	*12*	*11*	*11*	*11*	*12*	*12*	*12*	*13*	*13*	*13*
Energy content (MJ/kg)	8.2	8.4	8.5	9	9.3	9.8	10.1	10.1	10.2	10.3	10.2	10.3	10.3	10.6	10.6
Fraction organic (%)	58	57	57	56	55	54	53	52	52	51	51	50	50	47	47
Amount of fossil carbon	162	161	161	191	189	221	294	352	380	404	405	408	435	477	477
Amount of organic carbon	530	517	508	554	510	563	709	836	891	920	929	897	932	924	924

[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).

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 *Section 1*.

8.4.5 Source-specific re-calculations
There are no source-specific re-calculations 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 plant.
The amount of composted organic waste from households increased from nearly 0 Mton up to 1.4 Mton in 2004. In 2004 there were 24 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 5439 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, 2005a). This document contains also the amount of compost produced on a yearly basis.

The *emission factors* are based on the average emissions (per metric tonne of composted organic waste) of a number of facilities that were measured in the late 1990s (during a large-scale monitoring programme in The Netherlands); no actual data have been become available since this time.

8.5.2 Methodological issues
A more detailed description of the method used and the emission factors can be found in protocol 5439 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 *Section 1*.

8.5.5 Source specific re-calculations
There are no source-specific re-calculations compared to the previous submission.

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

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. RE-CALCULATIONS AND IMPROVEMENTS

Major changes compared to the National Inventory Report 2005

This chapter addresses the main changes in emissions compared to the previous submission reported by Klein Goldewijk *et al.* (2005). Most changes are the result of re-calculations in different sectors in order to improve accuracy and completeness. Most of the re-calculations are performed for the whole time series. For more details on the effect and justification of the re-calculations, the reader is referred to *Chapters 3–8*.

10.1 Explanation and justification for the re-calculations

For this submission (*NIR 2006*), The Netherlands uses the CRF reporter software. During the import of the 2005 submission data into the reporter software by the secretariat some errors were introduced. Although these are now corrected, they unfortunately show up as if they were re-calculations. These instances are noted in the CRF reporter. These "fake" re-calculations are not elaborated on in this NIR.

The present CRF tables are based on improved methodologies as described in the monitoring protocols. So this year will be the last year with methodological changes. Changes due to improved allocations or to error corrections will be possible in the future.

This section does provide elaborations on the relevant changes in emission figures compared to the *NIR 2005*. A distinction is made between:

1. *Methodological changes:* new emission data are reported resulting from revised or new estimation methods; improved emission factors or activity data are also captured in re-calculations as a result of methodological changes;
2. *Allocation:* changes in the allocation of emissions to different sectors (only affecting the totals per category or sector);
3. *Error corrections:* correction of incorrect data.

As described in the sectoral chapters of this report, several methodological changes have been implemented in this submission. The methodologies are explained in the relevant chapters, and the justifications for the changes are the improvement of the inventory for greenhouse gases in terms of:

- Transparency (1A, 1B);
- Completeness (2B5, 2G, 4B, 4D, 5);
- Consistency (1A, 1A1, 1A3d, 1B, 2C, 4A),
- Accuracy (1A, 1A3d, 1B, 2A1, 2A3, 2A7, 2C3, 2E, 2F, 4A,4B, 4D, 5);
- Better compliance with IPCC guidelines (higher tiers for key sources and source allocation) (1B, 4A, 5).

In particular, the transparency, accuracy and consistency of categories 1A and 1B have been improved substantially, the methodologies for gas distribution and enteric fermentation from cattle comply better with *IPCC Good Practice Guidelines* and the estimates of CO_2 from LULUCF and of indirect N_2O from agricultural soils have been improved with respect to completeness of the data. All of the re-calculations are performed as a result of the improvement plan, which is described in *Section 10.4.7*.

10.1.1 Methodological changes

The following methodological changes were implemented:

1. Changed methodology:

- Re-calculation of CH_4 emissions from 1B2b-iv *Gas distribution* based on detailed data (Gastec/KIWA, 2005) and country-specific emission factors determined by the gas distribution sector;
- Re-calculation of emissions from *Oil and gas production* (1B2c) from venting and flaring based on the assessment of past activities of individual companies by the industry association NOGEPA and the PER.
- Re-calculation of CH_4 from 4A *Enteric fermentation* based on a country-specific, method Tier 2 emission factors, calculated for each year (sector 4).

- Improved emissions for biomass combustion based on new activity data from the Energy statistics. The new activity data is based on the protocol for monitoring renewable energy (Abeelen and Bosselaar, 2004) for the whole time-series. This had impact on the total inventory of CH_4 and N_2O emissions and the memo item '*CO_2 from biomass'*.
- Re-calculation of N_2O emissions from *Manure management and agricultural soils* [inclusion of horse manure, sludge application and some error corrections on N-input manure (sectors 4B, and 4D)];

2. *Data improvement:*

- Re-calculation of CO_2 emissions from the *Combustion of natural gas* based on the revised emission factor of 56.8 kg/GJ (sector 1);
- Re-calculation of CO_2 , CH_4 and N_2O emissions from *Navigation* based on the IPCC default emission factors;
- Improved activity data for the years 2000–2003 for *Navigation* (category 1A3d);
- Re-calculation of the emissions (CO_2, CH_4, N_2O) from *Oil and natural gas production* based on detailed data from the industry (category 1B2); see *Section 3.14.6*;
- Improved activity data for the *Clinker production* in 1990 and 1991 (CO_2 in sector 2A1);
- Improved data on lime use in the *Flue gas desulphurization* (CO_2 in sector 2A3);
- Improved emission factor for CO_2 emissions in the glass industry (CO_2 in sector 2A7);
- Addition of the source *Ethylene oxide production* for the whole time series (sector 2B5);
- Based on more accurate data (based on measurements) the PFC emissions from 2C3 *Primary aluminium production* are re-calculated for the whole-time series;
- Based on more accurate data the HFC emission from 1994 is improved (sector 2E and F);
- Based on more accurate data, improvement of the SF_6 emissions for 2001–2003;
- Re-calculation and update of CO_2 from *LULUCF*. The land use change matrix was improved. As a result, the land use change dynamics decreased, affecting all source categories of LULUCF. In addition, the soil carbon calculation was improved (using more detailed data on soil stratification), thereby affecting the CO_2 figures included in 5B.

These re-calculations had little or no effect on the emissions of the precursor gases.

10.1.2 Source allocation

In this submission the source allocation was improved in the following cases:

- Emissions from gas compressors formerly reported under 1.B.2. are now re-allocated and included in 1A1c *Manufacture of solid fuels and other energy industries*.
- Emissions formerly allocated in 2B5 *Other non-specified* are now allocated in the categories 2B.5.2, 2B.5.3 and 2B.5.4.
- Emissions formerly allocated in 2G4 *Process emissions in other economic sectors* are now allocated in the categories 2B5 *Other chemical industries*.
- NMVOC emissions of car window cleaners (3 kton NMVOC) are included in 3B *Degreasing and dry cleaning*, whereas they were previously included in 1A3b *Road transport*.
- Process emissions which were erroneously allocated in 1A2f, 1A2d and 1A4b are now allocate in sector 2.

10.1.3 Error correction

During the compilation of the CRF based on the PER inventory for 2004 and the review of the *NIR 2005*, a few minor errors were detected in the emissions reported in the CRF. These include:

- HFC emissions included in 2E3 *Other* production of halocarbons and SF_6; these were corrected for a number of years;
- Minor error adjustments in 4B *Manure management*, resulting only in minor changes of the (implied) emission factor and emission levels;
- Minor error adjustments in 4D *Agricultural Soils* in activity data and emissions for manure application and animal production;
- A few corrections were made (total land, average carbon content and groundwater classification), affecting the CO_2 figures in 5B *Cropland*.

10.2 Implications for emission levels

This section outlines the implications of the different improvements, 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 (*Chapters–8*).

10.2.1 Effect of re-calculations on base year and 2003 emission levels

Effect of the re-calculations on the base year emission levels

The total CO_2-equivalent emissions (excluding LULUCF) in the base year 1990 increased by 1.3 Tg CO_2-eq. (0.6 %) compared to the last submission. The total CO_2-equivalent emissions (including LULUCF) increased by 0.8 Tg CO_2-eq. (0.4%). This is explained by the following – most relevant – changes for 1990 **(all in CO_2-equivalents)**:

- **CO_2:** +0.87 Tg in the *Energy* category (1A) due to the revised emission factor (56,8 t/TJ) for natural gas combustion;
- **CO_2:** +0.59 Tg in category 1A due to re-calculations of emissions from *Oil and gas exploration*;
- **CO_2:** –0.09 Tg in the *Industrial Processes* category (2A) due to re-calculations of emissions from *Cement clinker production*;
- **CO_2:** –0.16 Tg in category 2A due to re-calculations of emissions from *Flue gas desulphurization*;
- **CO_2:** +0.04 Tg in category 2A due to re-calculations of emissions from glass production;
- **CO_2:** +0.13 Tg in category 2B due to the identification of a new source ethylene oxide production;
- **CH_4:** re-calculations of 1B *Fugitive emission from fuels* decreased the emissions in category 1 *Energy* by –0.4 Tg CO_2-eq. The emissions of CH_4 from 4 *Agriculture* increased by 0.2 Tg due to the use of a new, country-specific method to estimate emissions from 4A *Enteric fermentation*;
- **N_2O:** the emissions decreased 0.4%, mainly in 4 *Agriculture*, due to re-calculation of the emissions from 4D *Agricultural soils* (–0.09 Tg CO_2-eq);
- **F-gases:** Changes in 1995 – the base year for the emissions of the fluorinated gases – due to re-calculations amount to +0.13 Tg CO_2-eq. for PFCs and 0.01 Tg CO_2-eq. for HFC. The re-calculation was based on new sector data. SF_6 emissions did not change in the base year 1995.

Table 10.1 Differences between NIR 2005 and NIR 2006 for the period 1990–2003 due to re-calculations.

Gas	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2 [Tg]	NIR2005	160.9	165.7	163.8	168.2	168.2	172.3	180.0	173.0	174.9	169.7	171.7	177.1	176.7	179.6
Incl.	NIR2006	161.8	166.7	164.6	169.0	168.9	172.8	179.9	173.5	175.6	170.0	172.0	177.6	177.3	180.9
LULUCF	***Difference***	*0.9*	*1.0*	*0.8*	*0.8*	*0.7*	*0.5*	*0.0*	*0.5*	*0.7*	*0.4*	*0.3*	*0.4*	*0.6*	*1.3*
CO2 [Tg]	NIR2005	**158.0**	162.9	161.1	165.5	165.5	169.7	177.3	170.2	172.2	166.9	168.9	174.4	173.9	176.9
Excl.	NIR2006	**159.4**	164.4	162.4	166.8	166.7	170.6	177.7	171.1	173.2	167.7	169.6	175.2	174.9	178.5
LULUCF	*Difference*	***1.4***	*1.5*	*1.3*	*1.3*	*1.2*	*1.0*	*0.4*	*0.9*	*1.1*	*0.8*	*0.7*	*0.8*	*1.0*	*1.7*
CH4 [Gg	NIR2005	**25,630**	25,890	25,431	24,959	24,247	23,829	23,231	22,090	21,280	20,223	19,518	19,005	18,221	17,455
CO2-eq]	NIR2006	**25,441**	25,718	25,208	24,933	24,107	23,792	23,027	22,010	21,166	20,135	19,251	18,884	17,992	17,547
	Difference	-189	-171	-223	-27	-140	-37	-204	-80	-113	-88	-268	-121	-229	92
N2O [Gg	NIR2005	**21,312**	21,708	22,397	23,126	22,276	22,421	22,186	21,958	21,694	20,948	19,894	18,878	17,971	17,321
CO2-eq]	NIR2006	**21,219**	21,634	22,361	23,077	22,251	22,394	22,154	21,922	21,668	20,941	19,867	18,844	17,970	17,374
	Difference	**-93**	-74	-36	-49	-24	-27	-31	-36	-26	-7	-27	-34	-1	54
PFC [Gg	NIR2005	2,115	2,095	1,905	1,926	1,853	**1,806**	2,002	2,177	1,730	1,466	1,521	1,417	1,416	1,396
CO2-eq]	NIR2006	2,264	2,245	2,043	2,068	1,990	**1,938**	2,155	2,344	1,829	1,471	1,581	1,489	2,186	620
	Difference	*149*	*150*	*137*	*142*	*136*	***132***	*154*	*167*	*100*	*5*	*60*	*72*	*769*	*-777*
HFC [Gg	NIR2005	4,432	3,452	4,447	4,998	6,518	**6,011**	7,664	8,295	9,348	4,868	3,839	1,492	1,566	1,450
CO2-eq]	NIR2006	4,432	3,452	4,447	4,998	6,480	**6,020**	7,678	8,300	9,341	4,859	3,824	1,469	1,541	1,319
	Difference	*0*	*0*	*0*	*0*	*-37*	***9***	*13*	*5*	*-6*	*-9*	*-15*	*-23*	*-25*	*-131*
SF6 [Gg	NIR2005	217	134	143	150	191	**301**	312	345	329	317	335	357	359	334
CO2-eq]	NIR2006	217	134	143	150	191	**301**	312	345	329	317	335	356	332	309
	Difference	*0*	*0*	*0*	*0*	*0*	***0***	*0*	*0*	*0*	*0*	*0*	*-1*	*-27*	*-25*
Total [Tg	NIR2005	214.6	219.0	218.1	223.3	223.3	226.7	235.4	227.9	229.3	217.5	216.8	218.3	216.2	217.6
CO2-eq.]	NIR2006	215.4	219.9	218.8	224.2	223.9	227.3	235.3	228.5	229.9	217.8	216.8	218.6	217.3	218.1
Incl.															
LULUCF	***Difference***	*0.8*	*0.9*	*0.7*	*0.9*	*0.7*	*0.6*	*-0.1*	*0.6*	*0.6*	*0.3*	*0.1*	*0.3*	*1.1*	*0.5*
Total [Tg	NIR2005	211.7	216.2	215.4	220.7	220.6	224.0	232.7	225.0	226.5	214.8	214.0	215.5	213.5	214.8
CO2-eq.]	NIR2006	213.0	217.6	216.6	222.0	221.8	225.1	233.0	226.0	227.6	215.4	214.4	216.2	214.9	215.7
Excl.															
LULUCF	***Difference***	*1.3*	*1.4*	*1.2*	*1.3*	*1.1*	*1.0*	*0.3*	*1.0*	*1.0*	*0.7*	*0.5*	*0.7*	*1.5*	*0.9*

Notes: base year values are indicated in bold. The data in this table are in line with the reported figures in the CRF/NIR 2005 and different with the data for' previous submission' in CRF table 8 (recalculations) as these hold 'fake'recalculations (see Section 10.1)

Please note that most of the re-calculations were performed not only for the base year, but also for the whole time series, and that they were in almost all cases restricted to the emissions of CO_2, CH_4, N_2O and the F-gases. Precursor emissions did not change, with the exception of emissions from *Transport* (all years).

Effect of re-calculations on 2003 emission levels
Compared to the previous submission, the total CO_2-equivalent emissions (excluding LULUCF) in 2003 increased by 0.9 Tg CO_2-eq. (0.4 %). This is explained by the following (only the most relevant) changes (all in CO_2 equivalents):

- **CO_2**: +1.67 Tg. This is the result of +0.99 Tg in sector 1 *Energy* due to the changed emission factor for natural gas, + 0.10 Tg due to the revised data for *Navigation*, +0.36 due to revised data for 2 Manufacturing Industries and Construction, +0.31 Tg for other sectors., -0.26 Tg in 1 *Energy* due to the use of the new method for the emissions in 1B, +0.17 Tg in 2 *Industrial Processes*, which is the result of revised data of -0.21 Tg in 2A *Mineral products,* +0.48 Tg for 2B *Chemical industry* and -0.09 Tg in 2G *Other industrial processes*.
- **CH_4**: +0.09. This is the result of –0.29 Tg re-calculations in the sector 1B *Fugitive emissions from fuels* based on new data from oil and gas production and the distribution sector, +0.29 Tg due to the re-calculations of the emissions from 4A *Enteric Fermentation* and -0.07 Tg from revised data in 6D *Other waste*.
- **N_2O.** +0.05 Tg: This is the result of –0.05 Tg decrease in emissions from 1A *Fuel combustion* due to re-calculations, +0.07 Tg increase in emissions from 4 *Agriculture* in 4A *Enteric fermentation* and 4D *Agricultural soils,* and +0.04 Tg from revised data in 6D *Other waste*.
- **F-gases**: -0.13 for HFCs and –0.78 Tg for PFCs and +0.03 for SF_6 as a result of to re-calculations based on new data from the industry.

10.3 Implications for emission trends, including time-series consistency

In general, the re-calculations improve both the accuracy and the time-series consistency of the estimated emissions. *Table 10.1* presents the changes in this NIR compared to the previous submission for emission levels per compound per year for the period 1990–2003. *Table 10.2* presents the changed trends in the greenhouse gas emissions during this period due to the re-calculations that were carried out.

In conclusion, relative to the emissions reported in the *NIR 2005*, the trend in the total national emissions decreased by 0.2% following the re-calculations. The largest changes in emission trends are observed for CH_4 from *Agriculture* and PFCs from *Industrial processes*.

*Table 10.2 Differences between NIR 2005 and NIR 2006 with respect to emission trends during the period **1990–2003** (Units: Gg CO_2-eq.)*

Gas	Trend (absolute)			Trend (percentage)		
	NIR 2005	**NIR2006**	*Difference*	**NIR 2005**	**NIR 2006**	*Difference*
CO_2 [1)]	18,862	19,139	*276*	11.9	12.0	*0.1*
CH_4	-8,175	-7,894	*281*	-31.9	-31.0	*0.9*
N_2O	-3,992	-3,845	*147*	-18.7	-18.1	*0.6*
HFC	-2,982	-3,113	*-131*	-67.3	-70.2	*-3.0*
PFC	-719	-1,645	*-926*	-34.0	-72.6	*-38.6*
SF_6	117	92	*-25*	53.9	42.3	*-11.6*
Total	**3,112**	**2,733**	***-379***	**1.5**	**1.3**	***0.2***

[1)]Excluding LULUCF.

Annex 8.3 shows the trends for all gases on a more detailed level, also found in the CRF file for 2004 (CRF *Table 10*). Additional information on the trends is given in the chapters on the different sectors (*Chapters 3–8*). Despite uniform source allocation, trends on source category levels may fluctuate due, for example, to differences in data quality. This applies especially for the years 1991–1994 since the activity data (energy statistics) for the fossil fuel-related emissions are composed on a more aggregated level during this period.

10.4 Re-calculations, response to the review process and planned improvements

10.4.1 Re-calculations

Some recalculations are anticipated in the next submission of the CRF in order to improve the accuracy and completeness of the inventory:

- Recalculations of refinery emissions for 2002 to 2004;
- Removal of erroneous allocation and erroneous activity data of some sources.

The anticipated recalculations have no effect on the total emissions in CO_2-equivalents for the base year.

10.4.2 Response to the review process

Public and peer review

Drafts of the NIR are subject to a general public review and a peer review. The public review of the draft *NIR 2006* of January 15, 2006 resulted in some minor remarks with respect to *Chapter 6 Agriculture*. These remarks (relating to N-input into soils and the handling of sewage sludge) were taken into account during the final stages of this chapter and in the maintenance of the monitoring protocols.

Based on the draft *NIR 2006* of December 15, 2005, the following chapters were selected for the peer review: *Industrial Processes* (CRF Sector 2), *Solvents and other product use* (CRF Sector 3) (Neelis, 2006) and *Land use, land use change and forestry* (CRF Sector 5) (Galinski, 2006).

The major recommendations that originated from the peer review of sectors 2 and 3 relate to the protocols developed and applied (Neelis, 2006). These recommendations will be taken into account in further improving the protocols and may be reflected in the *NIR 2007* (for example, assessing CO_2 emissions from ammonia production).

Recommendations with regard to the text relating to the iron and steel industry are taken into account in *Section 4.4.2*. Some recommendations of the peer review are included in this NIR. These recommendations also affected the base year emissions (see *Section 10.1.1*):

- New production figures for clinkers in the base year;
- Production of ethylene oxide is added;
- Improved data on lime use in the desulphurization of flue gas.

Recommendations from the LULUCF peer review are included in *Chapter 7*. These recommendations relate mainly to improved transparency with respect to the methodology applied by The Netherlands with a view to *IPCC Good Practice Guidance* for this sector. Detailed information on uncertainties was also added. The peer review did not give raise any further points with respect to methodologies or the emissions/sinks data in the chapter.
Major issues identified in the peer review of the *NIR 2005* (Pulles, 2005; van Amstel, 2005) are used as input for further improvements of the *NIR 2006*. Compared to *NIR 2005*, this NIR is shorter, follows the reporting guidelines more closely and is more targeted to explain and document the methods applied and the data used. For example, information on the (country-specific) emission factors is provided in *Annex 2*, a list of all protocols is included in *Annex 6* and the section on *Key source analysis* is revised and more in line with the system preferred by the UNFCCC. In addition, the graphical presentation is improved and more harmonized over the chapters.

UNFCCC reviews

The results of the issues raised in the different UNFCCC reviews of this NIR, which form an integral part of the preparation process, are summarized below:

In-country review NIR 2004

The *NIR 2004* was subject to an in-country review in the fall of 2004. Most of the recommendations of the Expert Review Team are addressed in the *NIR 2005*, and some are addressed in this *NIR 2006*.

The draft initial check for the 2005 inventory submission to the UNFCCC secretariat raised several comments and remarks. This resulted in:

- A re-submission of the CRF for 2003, since the original submission contained some minor errors in the trend tables;
- A re-submission of the whole time series for the new tables on LULUCF to mainly include observed gaps in *Summary Table 3* for all years and an updating of information in *Tables 8* and *9*;
- A comment on *Annex 7*, as *Table 6.1* was included in *Annex 1* (in the *NIR 2006 Tables 6.1* and *6.2* are included in *Annex 7*.

Synthesis & Assessment report NIR 2005
The draft Part I of the Synthesis & Assessment report on the *NIR 2005* showed that *Table G.3* (based on the information in the CRF files) contained the same data for both 1996 and 1995 due to a mistake during the preparation of the CRF. This error is corrected in the *CRF 2006*.

The response to Part II, the preliminary analysis of the 2005 Synthesis & Assessment report, contains mainly references to specific sections of the NIR that hold information on the issues raised.

Centralized review NIR 2005
The centralized review on the *NIR 2005* raised several questions that could be solved with additional information, such as some inconsistencies between the CRF and NIR and a number of minor mistakes. The following items have resulted in improvements in the *NIR 2006*:

- Inclusion of LULUCF categories in the key source assessment;
- For the *Energy* sector, a change of NO into IE (in 1A2a) for 1A1c-solid 1990–1994;
- for *Industrial processes*, a re-calculation of C_2F_6 emissions;
- for the LULUCF sector, the notation NE for N_2O emission from forest soils [CRF *Table 5(1)*] is replaced by NO; this issue is addressed in the monitoring protocols;
- for *Waste*, elaboration of new data for the differences between MSW and all waste;

Documentation of the justification (activity data or expert judgment) of the emissions (see *Section 10.4.3*) that are not estimated will be improved as part of the QA/QC improvement programme.
The complete list of comments by The Netherlands to the review report of the *NIR 2004* and *NIR 2005* can be found at www.greenhousegases.nl.

10.4.3 Completeness of sources

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*;*
- *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 *slugdge application on land* (4D4), due to missing activity data*;*
- CH_4 from *poultry* (4A9), due to missing emission factors*;*
- N_2O from *Industrial wastewater (*6B1), due to negligible amounts.
- A survey to check on unidentified sources of non-CO_2 emissions in The Netherlands showed that some minor sources of PFCs and SF_6 are not included in the present greenhouse gas inventory (DHV, 2000).

The above mentioned sources have been examined by the *Dutch Working Group Emission Monitoring of Greenhouse Gases* and only negleglible amounts have been found. Since no regular monitoring data are available, these sources are not included.

- Precursor emissions (i.e. CO, NO_x, NMVOC and SO_2) from *Memo item international bunkers* (international transport) have not been included.

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). Due to the structure of the CRF, most aggregated figures for potential emissions of PFCs and SF_6 appear as "0.0" or "value".

In the next submission the Netherlands can use the CRF reporter database for filling the recalculation tables in the CRF. This was not possible this submission due to the errors which were introduced in the CRF reporter database during the conversion of the CRF files from last submission to the software by the secretariat. Next submission the tables 8 and 9 from the CRF will be brought up to standard.

The same holds for the key sources analysis table which now hold some minor flaws (see *Table A1.1* in *Annex 1*).

10.4.5 Planned improvements

To timely comply with the requirements for National Systems under the *Kyoto Protocol* and under the *EU Monitoring Mechanism*, a monitoring improvement programme has been implemented in recent years (see *Section 1.6* for more information). The in-country review in 2004 both confirmed the relevancy of the improvement actions in this programme and endorsed the programme. At present, the planned actions, including most of the cross-cutting issues mentioned by the UNFCCC review team (see previous section), have been implemented, leading to some major and many minor re-calculations in the submissions of 2005 and 2006. The National System is now envisaged to be in compliance with the UNFCCC and EU requirements.

In this section we summarize the improvement actions anticipated in the future, including any additional issues identified in the recent reviews not addressed in the re-calculations.

Monitoring improvement

Although most of the planned improvement actions have been finalized, a few methodology-related actions are still anticipated (SenterNovem, 2005).

The most significant improvement planned for implementation and finalization in 2006 is an update of the uncertainty analyses. Furthermore, after implementation of the National System – and the re-calculations and uncertainty estimates that were made accordingly – some sources show up to be (minor) key sources where they were no keys sources in the past (see *Chapters 3 – 8*). Methodological improvements – if needed – will be considered as part of next years QA/QC programme (SenterNovem, 2005).

Monitoring protocols

As part of the improvement process, the methodologies and procedures for estimating greenhouse gas emission in The Netherlands are re-assessed and compared with UNFCCC and IPCC requirements. For the key emission sources and for sinks, the methodologies and processes are elaborated, re-assessed and revised where needed, and then used for the present CRF/NIR. Protocols describing the methodology, data sources and the rationale for their selection are available for most key sources on the website www.greenhousegases.nl. These monitoring protocols will be maintained (see also improving QA/QC system below) and –when needed– updated.

Improving the QA/QC system

As announced in the *NIR 2005*, the QA/QC programme is updated, and most procedures and processes are be established (as part of the annual activity programme of the Netherlands PER, among others), in time to meet the National System requirements. QA/QC activities to be undertaken as part of the National System have been described in *Chapter 1*. Some actions, however, still remain:

- The update of the description of QA/QC of external agencies;

- Results of a Tier 2 uncertainty analysis are now available. The results will be taken into account in next year's QA/QC programme. They will also be included in the monitoring protocols.

In 2006 the inventory experts' experiences with the monitoring protocols will be evaluated internally. The results will be used to improve the process of preparing the next reporting.

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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 one that is prioritised 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 preliminary identification of key sources in the Netherlands inventory we allocated the national emissions according to the 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 CO_2 emissions from stationary combustion (1A1, 1A2 and 1A4) are aggregated by fuel type. CO_2, CH_4 and 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 Gg CO_2 equivalents). Therefore, the 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. Therefore, the most important gas/source combinations in this category are separately assessed. The emissions in the other IPCC sectors are disaggregated as suggested by IPCC.

The IPCC Tier 1 method consists of ranking the list of source category/gas combinations, both for the contribution, to the national total annual emissions and to the national total trend.
The grey 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: 31 sources for annual level assessment (emissions in 2004) and 29 sources for the trend assessment out of a total of 72 sources. Both lists can be combined to get 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 to 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 and Brandes, 2006). The results of the Tier 1 and Tier 2 level and trend assessments are summarised in *Table A1.1* and show a total of 42 key sources. As could be expected, the Tier 2 level and trend assessment increases the importance of relatively very uncertain sources. It can be concluded that in using the results of a Tier 2 key source assessment, 6 more sources are added to the list of 36 Tier 1 level and trend key sources:

- N_2O emissions from mobile combustion (road vehicles), new key source (tier 2 trend);
- CH_4 emissions from stationary combustion (tier 2 level);
- CO_2 emissions from manufacturing of other chemical products (tier 2 level)
- Indirect N_2O emissions from combustion and industrial processes, new key source (tier 2 level and trend);
- CO_2 emission from Coke production (tier 2 level);
- CH_4 emissions from manure management: poultry (tier 2 trend).

Their share in the national annual total becomes more important when taking their uncertainty (50%-100%) into account (*Table 1.4*).

Next, we included the most important 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 resulted in 4 additional key sources from this sector, see also *Table A1.1*.

In this report, the key source assessment is based on emission figures from CRF version 1.6, submitted to UNFCCC in September 2006. However, this new list of key categories is not updated in the CRF Reporter and CRF version 1.6 files (see footnote by *Table A1.1*).

Table A1.1. Key source list identified by the Tier 1 and 2 level and trend assessments (based on CRF tables version 1.6. Level assessment for 2004 emissions.)

Cate-gory	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
ENERGY							
1A1a	CO2	Stationary combustion: Public Electricity and Heat Production: liquids	Key(L1,T)*	1	1		1
1A1a	CO2	Stationary combustion: Public Electricity and Heat Production: solids	Key(L,T1)	1	1	1	
1A1a	CO2	Stationary combustion : Public Electricity and Heat Production: gases	Key(L,T)	1	1	1	1
1A1a	CO2	Stationary combustion : Public Electricity and Heat Production: waste incineration	Key(L1,T)*	1	1		1
1A1b	CO2	Stationary combustion : Petroleum Refining: liquids	Key(L,T1)	1	1	1	
1A1b	CO2	Stationary combustion : Petroleum Refining: gases	Key(L1,T1)	1	1		
1A1c	CO2	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids					
1A1c	CO2	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	Key(L,T1)	1	1	1	
1A2	CO2	Emissions from stationary combustion : Manufacturing Industries and Construction, liquids	Key(L,T1)	1	1	1	
1A2	CO2	Emissions from stationary combustion : Manufacturing Industries and Construction, solids	Key(L,T1)	1	1	1	
1A2	CO2	Emissions from stationary combustion : Manufacturing Industries and Construction, gases	Key(L,T1)	1	1	1	
1A3	CO2	Mobile combustion: road vehicles: gasoline	Key(L,T1)*	1	1	1	
1A3	CO2	Mobile combustion: road vehicles: diesel oil	Key(L,T)	1	1	1	1
1A3	CO2	Mobile combustion: road vehicles: LPG	Key(L1,T)	1	1		1
1A3	CO2	Mobile combustion: water-borne navigation	Key(L1,T1)*	1	1		
1A3	CO2	Mobile combustion: aircraft	Non-key				
1A3	CO2	Mobile combustion: railways	Non-key				
1A3	CH4	Mobile combustion: other	Non-key				
1A3	N2O	Mobile combustion: other	Non-key				
1A3	CH4	Mobile combustion: road vehicles	Non-key				
1A3	N2O	Mobile combustion: road vehicles	Key (T2)*				1
1A4	CO2	Stationary combustion : Other Sectors, solids	Non-key				
1A4a	CO2	Stationary combustion : Other Sectors: Commercial/Institutional, gases	Key(L,T)	1	1	1	1
1A4b	CO2	Stationary combustion : Other Sectors, Residential, gases	Key(L)	1		1	
1A4c	CO2	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	Key(L,T)	1	1	1	1
1A4c	CO2	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	Key(L)	1		1	
1A4	CO2	Stationary combustion : Other Sectors, liquids excl. From 1A4c	Key(T)		1		1
1A5	CO2	Military use of fuels (1A5 Other)					
1A	CH4	Emissions from stationary combustion: non-CO2	Key(L2)*			1	
1A	N2O	Emissions from stationary combustion: non-CO2	Non-key				
1B1	CH4	Coal mining	Not Occuring				
1B1b	CO2	Coke production	Key(L2)*			1	
1B2	CO2	Fugitive emissions from venting/flaring: CO2	Key(T)*		1		1
1B2	CH4	Fugitive emissions venting/flaring	Key(T)*		1		1
1B2	CH4	Fugitive emissions from oil and gas: gas distribution	Non-key				
1B2	CH4	Fugitive emissions from oil and gas operations: other	Non-key				
INDUSTRIAL PROCESSES							
2A1	CO2	Cement production	Non-key				
2A3	CO2	Limestone and dolomite use	Non-key				
2A7	CO2	Other minerals	Non-key				
2B1	CO2	Ammonia production	Key(L1)	1			
2B2	N2O	Nitric acid production	Key(L,T)	1	1	1	1
2B5	N2O	Caprolactam production	Key(L,T)	1	1	1	1
2B5	CO2	Other chemical product manufacture	Key(L2)*			1	
2C1	CO2	Iron and steel production (carbon inputs)	Key(L1,T1)	1	1		
2C3	CO2	CO2 from aluminium production	Non-key				
2C3	PFC	PFC from aluminium production	Key(T)*		1		1
2F	SF6	SF6 emissions from SF6 use	Non-key				
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)*		1		1
2E	HFC	HFC by-product emissions from HFC manufacture	Non-key				
2F	PFC	PFC emissions from PFC use	Non-key				
2G	CO2	Other industrial: CO2	Non-key				
2G	CH4	Other industrial: CH4	Non-key				
2G	N2O	Other industrial: N2O	Non-key				
2G	N2O	Indirect N2O from non-agricultural sources	Non-key				
2G	N2O	Indirect N2O from NO2 from combustion and industrial processes	Key(L2,T2)*			1	1

Cate-gory	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
SOLVENTS AND OTHER PRODUCT USE							
3	CO2	Indirect CO2 from solvents/product use	Non-key				
3	CH4	Solvents and other product use	IE in 2G				
AGRICULTURAL SECTOR							
4A1	CH4	CH4 emissions from enteric fermentation in domestic livestock: cattle	Key(L,T)	1	1	1	1
4A8	CH4	CH4 emissions from enteric fermentation in domestic livestock: swine	Non-key				
4A	CH4	CH4 emissions from enteric fermentation in domestic livestock: other	Non-key				
4B	N2O	Emissions from manure management	Key(L)	1		1	
4B1	CH4	Emissions from manure management : cattle	Key(L,T2)	1		1	1
4B8	CH4	Emissions from manure management : swine	Key(L,T2)	1		1	1
4B9	CH4	Emissions from manure management : poultry	Key(T2)				1
4B	CH4	Emissions from manure management : other	Non-key				
4C	CH4	Rice cultivation	Not Occuring				
4D1	N2O	Direct N2O emissions from agricultural soils	Key(L)	1		1	
4D3	N2O	Indirect N2O emissions from nitrogen used in agriculture	Key(L,T)	1	1	1	1
4D2	N2O	Animal production on agricultural soils	Key(L,T)	1	1	1	1
WASTE SECTOR							
6A1	CH4	CH4 emissions from solid waste disposal sites	Key(L,T)	1	1	1	1
6B	CH4	Emissions from wastewater handling	Non-key				
6B	N2O	Emissions from wastewater handling	Non-key				
6C	CO2	Emissions from waste incineration	IE in 1A1				
	CH4	Misc. CH4	Non-key				
	N2O	Misc. N2O	Non-key				
KEY SOURCE CATEGORIES (EXCL. LULUCF)			**42**	31	29	28	24
LAND USE, LAND USE CHANGE AND FORESTRY							
5A1	CO2	5A1. Forest Land remaining Forest Land	Key(L,T)	1	1	1	1
5A2	CO2	5A2. Land converted to Forest Land	Non-key				
5B2	CO2	5B2. Land converted to Cropland	Non-key				
5C1	CO2	5C1. Grassland remaining Grassland	Key(L)	1		1	
5C2	CO2	5C2. Land converted to Grassland	Non-key				
5E2	CO2	5E2. Land converted to Settlements	Non-key				
5F2	CO2	5F2. Land converted to Other Land	Key(L)	1		1	
5G	CO2	5G. Other (liming of soils)	Non-key				
5A1	N2O	5A1. Forest Land remaining Forest Land	Non-key				
TOTAL KEY SOURCE CATEGORIES (INCL. LULUCF)			**45**	**34**	**30**	**31**	**25**

* The key source list presented above presents the most recent information on key sources. This list differs from information in Table 7 in the CRF files, since CRF Table 7 is not updated yet with the results of the recent key source analysis.

A1.1.1 Changes in key sources compared to previous submission

This year, we reviewed the spreadsheet for the key source and uncertainty analysis and took a closer look on the IPCC guidelines on this subject, especially the special considerations by Table 7.1 in the IPCC Good Practice Guidance (IPCC, 2000) and the Good practice Guideline for Land Use, Land use change and Forestry (LULUCF) (IPCC, 2003) We found an error in the calculation of the Tier 2 trend key source calculation and now use a 90% cumulative share instead of 95% cumulative share for the Tier 2 level and trend key sources. Together with the use of the new emission data and new uncertainty estimates provided by emission experts, this resulted in the following changes compared to the previous NIR:

For energy:

- Emission sources in 1A1, 1A2, 1A3 road transport and 1A4 are now aggregated by fuel type.

For industrial processes (i.e. non-combustion):

- SF_6 emissions from SF_6 use: no key source.

For agriculture:

- CH_4 emissions from manure management: poultry (new key source);
- N_2O emissions from animal production on agricultural soils (new key source).

For waste:

- N_2O emissions from wastewater handling: no key source.

For LULUCF:

- CO_2 emissions from 5A1. Forest Land remaining Forest land: new key source;
- CO_2 emissions from 5C1. Grassland remaining Grassland: new key source;
- CO_2 emissions from 5F2. Land converted to Other land: new key source.

A1.2 Tier 1 key source and uncertainty assessment

In *Tables A1.2. and A1.3.* the source ranking is done according to the contribution to the 2004 annual emissions total and to the base year to 2004 trend, respectively. This resulted in 31 level key sources and 29 trend key sources (indicated in the grey part at the top).

Table A1.2. Source ranking using IPCC Tier 1 level assessment 2004 (amounts in Gg CO_2-eq)

IPCC	Category	Gas	CO2-eq 2004	Share	Cum. share
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO2	26,919	12%	12%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO2	25,576	12%	24%
1A3b	Mobile combustion: road vehicles: diesel oil	CO2	19,542	9%	33%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO2	18,786	9%	42%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO2	15,369	7%	49%
1A3b	Mobile combustion: road vehicles: gasoline	CO2	13,168	6%	55%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO2	11,003	5%	60%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO2	9,556	4%	64%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO2	7,282	3%	67%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO2	7,041	3%	71%
6A1	CH4 emissions from solid waste disposal sites	CH4	6,521	3%	74%
4A1	CH4 emissions from enteric fermentation in domestic livestock: cattle	CH4	5,712	3%	76%
2B2	Nitric acid production	N2O	5,617	3%	79%
4D1	Direct N2O emissions from agricultural soils	N2O	4,839	2%	81%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO2	4,515	2%	83%
4D3	Indirect N2O emissions from nitrogen used in agriculture	N2O	3,209	1%	85%
2B1	Ammonia production	CO2	3,086	1%	86%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO2	2,581	1%	87%
1A1b	Stationary combustion : Petroleum Refining: gases	CO2	2,267	1%	88%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO2	2,198	1%	89%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO2	2,114	1%	90%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO2	1,987	1%	91%
4B1	Emissions from manure management : cattle	CH4	1,475	1%	92%
2C1	Iron and steel production (carbon inputs)	CO2	1,313	1%	92%
1A3b	Mobile combustion: road vehicles: LPG	CO2	1,131	1%	93%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1,023	0%	93%
4B8	Emissions from manure management : swine	CH4	919	0%	94%
1A3d	Mobile combustion: water-borne navigation	CO2	832	0%	94%
2B5	Caprolactam production	N2O	759	0%	95%
4B	Emissions from manure management	N2O	707	0%	95%
4D2	Animal production on agricultural soils	N2O	651	0%	95%
2G	Indirect N2O from NO2 from combustion and industrial processes	N2O	637	0%	96%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO2	629	0%	96%
2B5	Other chemical product manufacture	CO2	571	0%	96%
1A	Emissions from stationary combustion: non-CO2	CH4	565	0%	96%
1B1b	CO2 from coke production	CO2	509	0%	97%
1A3b	Mobile combustion: road vehicles	N2O	486	0%	97%
2C3	CO2 from aluminium production	CO2	479	0%	97%
2A1	Cement production	CO2	446	0%	97%
1A5	Military use of fuels (1A5 Other)	CO2	437	0%	97%
2A7	Other minerals	CO2	414	0%	98%
6B	Emissions from wastewater handling	N2O	399	0%	98%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	354	0%	98%
4A8	CH4 emissions from enteric fermentation in domestic livestock: swine	CH4	351	0%	98%
2G	Other industrial: CO2	CO2	342	0%	98%
2F	SF6 emissions from SF6 use	SF6	328	0%	98%
2G	Other industrial: CH4	CH4	312	0%	99%
1B2	Fugitive emissions venting/flaring	CH4	310	0%	99%
2A3	Limestone and dolomite use	CO2	297	0%	99%
4A	CH4 emissions from enteric fermentation in domestic livestock: other	CH4	286	0%	99%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH4	268	0%	99%
1A	Emissions from stationary combustion: non-CO2	N2O	240	0%	99%
6B	Emissions from wastewater handling	CH4	225	0%	99%
2F	PFC emissions from PFC use	PFC	179	0%	99%
1B2	Fugitive emissions from oil and gas operations: other	CH4	149	0%	99%
3	Indirect CO2 from solvents/product use	CO2	144	0%	100%
3, 6D	OTHER N2O	N2O	139	0%	100%
1A4	Stationary combustion : Other Sectors, solids	CO2	134	0%	100%
1B2	Fugitive emissions venting/flaring: CO2	CO2	125	0%	100%
1A3	Mobile combustion: other	CO2	109	0%	100%
2C3	PFC from aluminium production	PFC	106	0%	100%
2E	HFC by-product emissions from HFC manufacture	HFC	99	0%	100%
6D	OTHER CH4	CH4	72	0%	100%
1A3b	Mobile combustion: road vehicles	CH4	67	0%	100%
2G	Indirect N2O from NH3 from combustion and industrial processes	N2O	56	0%	100%
4B9	Emissions from manure management : poultry	CH4	56	0%	100%
1A3a	Mobile combustion: aircraft	CO2	41	0%	100%
4B	Emissions from manure management : other	CH4	16	0%	100%
2G	Other industrial: N2O	N2O	7	0%	100%
1A3	Mobile combustion: other	N2O	3	0%	100%
1A3	Mobile combustion: other	CH4	1	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO2	1	0%	100%
			218,086		

Table A1.3. Source ranking using IPCC Tier 1 trend assessment (amounts in Gg CO_2-eq.)

IPCC	Category	Gas	CO2-eq 1990	CO2-eq 2004	Level assess-ment 90/95	Level assess-ment 2004	Trend assess-ment	% Contr. to trend	Cumu-lative total
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO2	13,348	25,576	6%	12%	5.4%	18%	18%
1A3b	Mobile combustion: road vehicles: diesel oil	CO2	11,832	19,542	6%	9%	3.4%	11%	29%
6A1	CH4 emissions from solid waste disposal sites	CH4	12,011	6,521	6%	3%	2.6%	8%	37%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	354	3%	0%	2.5%	8%	45%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO2	6,634	11,003	3%	5%	1.9%	6%	51%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO2	19,020	15,369	9%	7%	1.8%	6%	57%
1A3b	Mobile combustion: road vehicles: gasoline	CO2	10,902	13,168	5%	6%	0.9%	3%	60%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO2	207	2,198	0%	1%	0.9%	3%	63%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO2	8,993	7,282	4%	3%	0.8%	3%	66%
2C3	PFC from aluminium production	PFC	1,901	106	1%	0%	0.8%	3%	69%
4D3	Indirect N2O emissions from nitrogen used in agriculture	N2O	4,861	3,209	2%	1%	0.8%	3%	71%
1A3b	Mobile combustion: road vehicles: LPG	CO2	2,738	1,131	1%	1%	0.7%	2%	74%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO2	592	2,114	0%	1%	0.7%	2%	76%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO2	8,328	7,041	4%	3%	0.6%	2%	78%
2C1	Iron and steel production (carbon inputs)	CO2	2,514	1,313	1%	1%	0.6%	2%	80%
1A1b	Stationary combustion : Petroleum Refining: gases	CO2	1,042	2,267	0%	1%	0.5%	2%	82%
4A1	CH4 emissions from enteric fermentation in domestic livestock: cattle	CH4	6,767	5,712	3%	3%	0.5%	2%	83%
1B2	Fugitive emissions venting/flaring	CH4	1,252	310	1%	0%	0.4%	1%	85%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO2	1,476	629	1%	0%	0.4%	1%	86%
2B2	Nitric acid production	N2O	6,330	5,617	3%	3%	0.4%	1%	87%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1,023	0%	0%	0.3%	1%	88%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO2	25,776	26,919	12%	12%	0.3%	1%	89%
4D2	Animal production on agricultural soils	N2O	1,308	651	1%	0%	0.3%	1%	90%
1B2	Fugitive emissions venting/flaring: CO2	CO2	775	125	0%	0%	0.3%	1%	91%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO2	9,999	9,556	5%	4%	0.3%	1%	92%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO2	5,033	4,515	2%	2%	0.3%	1%	93%
2B5	Caprolactam production	N2O	1,240	759	1%	0%	0.2%	1%	94%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO2	1,526	1,987	1%	1%	0.2%	1%	95%
1A3d	Mobile combustion: water-borne navigation	CO2	405	832	0%	0%	0.2%	1%	95%
2G	Indirect N2O from NO2 from combustion and industrial processes	N2O	883	637	0%	0%	0.1%	0%	96%
4B8	Emissions from manure management : swine	CH4	1,141	919	1%	0%	0.1%	0%	96%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO2	18,696	18,786	9%	9%	0.1%	0%	96%
1A3b	Mobile combustion: road vehicles	N2O	271	486	0%	0%	0.1%	0%	97%
4B9	Emissions from manure management : poultry	CH4	243	56	0%	0%	0.1%	0%	97%
3	Indirect CO2 from solvents/product use	CO2	316	144	0%	0%	0.1%	0%	97%
4D1	Direct N2O emissions from agricultural soils	N2O	4,597	4,839	2%	2%	0.1%	0%	97%
2F	PFC emissions from PFC use	PFC	37	179	0%	0%	0.1%	0%	98%
1A5	Military use of fuels (1A5 Other)	CO2	566	437	0%	0%	0.1%	0%	98%
4B1	Emissions from manure management : cattle	CH4	1,574	1,475	1%	1%	0.1%	0%	98%
6B	Emissions from wastewater handling	N2O	513	399	0%	0%	0.1%	0%	98%
3, 6D	OTHER N2O	N2O	250	139	0%	0%	0.1%	0%	98%
2A7	Other minerals	CO2	308	414	0%	0%	0.0%	0%	98%
1B1b	CO2 from coke production	CO2	403	509	0%	0%	0.0%	0%	99%
4A8	CH4 emissions from enteric fermentation in domestic livestock: swine	CH4	439	351	0%	0%	0.0%	0%	99%
1A3b	Mobile combustion: road vehicles	CH4	157	67	0%	0%	0.0%	0%	99%
2E	HFC by-product emissions from HFC manufacture	HFC	12	99	0%	0%	0.0%	0%	99%
2C3	CO2 from aluminium production	CO2	395	479	0%	0%	0.0%	0%	99%
6D	OTHER CH4	CH4	1	72	0%	0%	0.0%	0%	99%
6B	Emissions from wastewater handling	CH4	290	225	0%	0%	0.0%	0%	99%
2B1	Ammonia production	CO2	3,096	3,086	1%	1%	0.0%	0%	99%
1A4	Stationary combustion : Other Sectors, solids	CO2	189	134	0%	0%	0.0%	0%	100%
2B5	Other chemical product manufacture	CO2	606	571	0%	0%	0.0%	0%	100%
4A	CH4 emissions from enteric fermentation in domestic livestock: other	CH4	319	286	0%	0%	0.0%	0%	100%
1A	Emissions from stationary combustion: non-CO2	CH4	522	565	0%	0%	0.0%	0%	100%
2G	Other industrial: CO2	CO2	305	342	0%	0%	0.0%	0%	100%
2A1	Cement production	CO2	416	446	0%	0%	0.0%	0%	100%
2F	SF6 emissions from SF6 use	SF6	301	328	0%	0%	0.0%	0%	100%
1A	Emissions from stationary combustion: non-CO2	N2O	215	240	0%	0%	0.0%	0%	100%
1A3	Mobile combustion: other	CO2	91	109	0%	0%	0.0%	0%	100%
1B2	Fugitive emissions from oil and gas operations: other	CH4	162	149	0%	0%	0.0%	0%	100%
2A3	Limestone and dolomite use	CO2	276	297	0%	0%	0.0%	0%	100%
2G	Other industrial: CH4	CH4	297	312	0%	0%	0.0%	0%	100%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH4	255	268	0%	0%	0.0%	0%	100%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO2	2,544	2,581	1%	1%	0.0%	0%	100%
4B	Emissions from manure management : other	CH4	12	16	0%	0%	0.0%	0%	100%
2G	Other industrial: N2O	N2O	3	7	0%	0%	0.0%	0%	100%
2G	Indirect N2O from NH3 from combustion and industrial processes	N2O	52	56	0%	0%	0.0%	0%	100%
1A3	Mobile combustion: other	N2O	1	3	0%	0%	0.0%	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO2	2	1	0%	0%	0.0%	0%	100%
1A3a	Mobile combustion: aircraft	CO2	41	41	0%	0%	0.0%	0%	100%
1A3	Mobile combustion: other	CH4	1	1	0%	0%	0.0%	0%	100%
4B	Emissions from manure management	N2O	694	707	0%	0%	0.0%	0%	100%
			214,308	218,086	100%	100%		100%	

A1.3 Tier 2 key source assessment

Using the uncertainty estimate for each key source as a weighting factor (see *Annex 7*), we performed the key source assessment again. This is called the Tier 2 key source assessment. The results of this assessment are presented in *Tables A1.4 and A1.5* for the contribution to the 2004 annual emissions total and to the trend, respectively. Comparison with the Tier 1 assessment presented in *Tables A1.2 and A1.3* shows *less level and trend* key sources (28 and 24 respectively instead of 31 and 29).

Table A1.4. Source ranking using IPCC Tier 2 level assessment 2004 (in Gg CO2-eq.)

IPCC	Category	Gas	CO2-eq 1990	CO2-eq 2004	Uncer-tainty estimate	Level * Uncer-tainty	Share L*U	Cumu-lative total
4D3	Indirect N2O emissions from nitrogen used in agriculture	N2O	4,861	3,209	206%	6614	18%	18%
4D1	Direct N2O emissions from agricultural soils	N2O	4,597	4,839	61%	2944	8%	26%
2B2	Nitric acid production	N2O	6,330	5,617	51%	2864	8%	34%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO2	6,634	11,003	20%	2203	6%	40%
6A1	CH4 emissions from solid waste disposal sites	CH4	12,011	6,521	34%	2187	6%	46%
4B1	Emissions from manure management : cattle	CH4	1,574	1,475	100%	1482	4%	51%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO2	9,999	9,556	14%	1351	4%	54%
2G	Indirect N2O from NO2 from combustion and industrial processes	N2O	883	637	201%	1278	4%	58%
4A1	CH4 emissions from enteric fermentation in domestic livestock: cattle	CH4	6,767	5,712	21%	1178	3%	61%
1A3b	Mobile combustion: road vehicles: diesel oil	CO2	11,832	19,542	5%	978	3%	64%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO2	18,696	18,786	5%	958	3%	66%
4B8	Emissions from manure management : swine	CH4	1,141	919	100%	924	3%	69%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO2	25,776	26,919	3%	851	2%	71%
4B	Emissions from manure management	N2O	694	707	100%	710	2%	73%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO2	8,328	7,041	10%	708	2%	75%
4D2	Animal production on agricultural soils	N2O	1,308	651	100%	654	2%	77%
2B5	Caprolactam production	N2O	1,240	759	71%	536	1%	78%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1,023	51%	522	1%	80%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO2	2,544	2,581	20%	519	1%	81%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO2	5,033	4,515	10%	460	1%	83%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO2	1,526	1,987	21%	410	1%	84%
2B5	Other chemical product manufacture	CO2	606	571	71%	404	1%	85%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO2	8,993	7,282	5%	371	1%	86%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO2	19,020	15,369	2%	344	1%	87%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO2	13,348	25,576	1%	286	1%	88%
1A	Emissions from stationary combustion: non-CO2	CH4	522	565	50%	283	1%	88%
1A3b	Mobile combustion: road vehicles: gasoline	CO2	10,902	13,168	2%	269	1%	89%
1B1b	CO2 from coke production	CO2	403	509	50%	255	1%	90%
1A3b	Mobile combustion: road vehicles	N2O	271	486	50%	244	1%	91%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO2	592	2,114	11%	236	1%	91%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO2	207	2,198	10%	220	1%	92%
6B	Emissions from wastewater handling	N2O	513	399	54%	215	1%	92%
2F	SF6 emissions from SF6 use	SF6	301	328	56%	184	1%	93%
4A8	CH4 emissions from enteric fermentation in domestic livestock: swine	CH4	439	351	50%	176	0%	93%
1A3d	Mobile combustion: water-borne navigation	CO2	405	832	20%	166	0%	94%
2G	Other industrial: CH4	CH4	297	312	51%	159	0%	94%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH4	255	268	50%	134	0%	95%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO2	1,476	629	20%	126	0%	95%
1A	Emissions from stationary combustion: non-CO2	N2O	215	240	50%	120	0%	95%
2G	Indirect N2O from NH3 from combustion and industrial processes	N2O	52	56	206%	116	0%	96%
1A3b	Mobile combustion: road vehicles: LPG	CO2	2,738	1,131	10%	113	0%	96%
2A7	Other minerals	CO2	308	414	25%	106	0%	96%
1A5	Military use of fuels (1A5 Other)	CO2	566	437	20%	88	0%	97%
4A	CH4 emissions from enteric fermentation in domestic livestock: other	CH4	319	286	30%	87	0%	97%
1B2	Fugitive emissions from oil and gas operations: other	CH4	162	149	54%	80	0%	97%
1B2	Fugitive emissions venting/flaring	CH4	1,252	310	25%	78	0%	97%
2C1	Iron and steel production (carbon inputs)	CO2	2,514	1,313	6%	77	0%	97%
2A3	Limestone and dolomite use	CO2	276	297	25%	76	0%	98%
3, 6D	OTHER N2O	N2O	250	139	54%	75	0%	98%
6B	Emissions from wastewater handling	CH4	290	225	32%	72	0%	98%
2G	Other industrial: CO2	CO2	305	342	21%	71	0%	98%
2B1	Ammonia production	CO2	3,096	3,086	2%	69	0%	98%
1A4	Stationary combustion : Other Sectors, solids	CO2	189	134	50%	67	0%	99%
1B2	Fugitive emissions venting/flaring: CO2	CO2	775	125	50%	63	0%	99%
4B9	Emissions from manure management : poultry	CH4	243	56	100%	56	0%	99%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	354	14%	50	0%	99%
2A1	Cement production	CO2	416	446	11%	50	0%	99%
2F	PFC emissions from PFC use	PFC	37	179	25%	46	0%	99%
1A3b	Mobile combustion: road vehicles	CH4	157	67	60%	40	0%	99%
3	Indirect CO2 from solvents/product use	CO2	316	144	27%	39	0%	100%
2C3	CO2 from aluminium production	CO2	395	479	5%	26	0%	100%
1A1b	Stationary combustion : Petroleum Refining: gases	CO2	1,042	2,267	1%	25	0%	100%
6D	OTHER CH4	CH4	1	72	32%	23	0%	100%
2E	HFC by-product emissions from HFC manufacture	HFC	12	99	22%	22	0%	100%
2C3	PFC from aluminium production	PFC	1,901	106	20%	21	0%	100%
1A3a	Mobile combustion: aircraft	CO2	41	41	50%	21	0%	100%
4B	Emissions from manure management : other	CH4	12	16	100%	16	0%	100%
1A3	Mobile combustion: other	CO2	91	109	5%	5	0%	100%
2G	Other industrial: N2O	N2O	3	7	71%	5	0%	100%
1A3	Mobile combustion: other	N2O	1	3	112%	3	0%	100%
1A3	Mobile combustion: other	CH4	1	1	112%	2	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO2	2	1	20%	0	0%	100%
			214,308	218,086				

With respect to Tier 2 level key sources, perhaps surprisingly, the energy industries with the highest share of 30% in the national total are not number 1 when including the uncertainty estimates. As *Table A1.4* shows, two large but quite uncertain N_2O sources are now in the top 5 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 50 to 200%, with indirect N_2O emissions having an uncertainty of a factor 2; one or two orders of magnitude higher than the 4% uncertainty estimated for CO_2 from the energy industries.

Table A1.5 Source ranking using IPCC Tier 2 trend assessment (in Gg CO_2-eq.)

IPCC	Category	Gas	CO2-eq 1990	CO2-eq 2004	Level assess-ment 90/95	Level assess-ment 2004	Trend assess-ment	Uncerta inty estimat e	Trend * Uncer-tainty	% Contr. to trend	Cumu-lative total
4D3	Indirect N2O emissions from nitrogen used in agriculture	N2O	4,861	3,209	2%	1%	0.8%	206%	1.6%	25%	25%
6A1	CH4 emissions from solid waste disposal sites	CH4	12,011	6,521	6%	3%	2.6%	34%	0.9%	14%	39%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO2	6,634	11,003	3%	5%	1.9%	20%	0.4%	6%	45%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	354	3%	0%	2.5%	14%	0.4%	6%	50%
4D2	Animal production on agricultural soils	N2O	1,308	651	1%	0%	0.3%	100%	0.3%	5%	55%
2G	Indirect N2O from NO2 from combustion and industrial processes	N2O	883	637	0%	0%	0.1%	201%	0.2%	4%	59%
2B2	Nitric acid production	N2O	6,330	5,617	3%	3%	0.4%	51%	0.2%	3%	62%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1,023	0%	0%	0.3%	51%	0.2%	3%	65%
1A3b	Mobile combustion: road vehicles: diesel oil	CO2	11,832	19,542	6%	9%	3.4%	5%	0.2%	3%	67%
2C3	PFC from aluminium production	PFC	1,901	106	1%	0%	0.8%	20%	0.2%	3%	70%
2B5	Caprolactam production	N2O	1,240	759	1%	0%	0.2%	71%	0.2%	3%	72%
1B2	Fugitive emissions venting/flaring: CO2	CO2	775	125	0%	0%	0.3%	50%	0.1%	2%	75%
4B8	Emissions from manure management : swine	CH4	1,141	919	1%	0%	0.1%	100%	0.1%	2%	77%
4A1	CH4 emissions from enteric fermentation in domestic livestock: cattle	CH4	6,767	5,712	3%	3%	0.5%	21%	0.1%	2%	78%
1B2	Fugitive emissions venting/flaring	CH4	1,252	310	1%	0%	0.4%	25%	0.1%	2%	80%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO2	207	2,198	0%	1%	0.9%	10%	0.1%	1%	81%
4B9	Emissions from manure management : poultry	CH4	243	56	0%	0%	0.1%	100%	0.1%	1%	83%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO2	1,476	629	1%	0%	0.4%	20%	0.1%	1%	84%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO2	592	2,114	0%	1%	0.7%	11%	0.1%	1%	85%
1A3b	Mobile combustion: road vehicles: LPG	CO2	2,738	1,131	1%	1%	0.7%	10%	0.1%	1%	86%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO2	8,328	7,041	4%	3%	0.6%	10%	0.1%	1%	87%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO2	13,348	25,576	6%	12%	5.4%	1%	0.1%	1%	88%
4B1	Emissions from manure management : cattle	CH4	1,574	1,475	1%	1%	0.1%	100%	0.1%	1%	89%
1A3b	Mobile combustion: road vehicles	N2O	271	486	0%	0%	0.1%	50%	0.0%	1%	90%
4D1	Direct N2O emissions from agricultural soils	N2O	4,597	4,839	2%	2%	0.1%	61%	0.0%	1%	91%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO2	8,993	7,282	4%	3%	0.8%	5%	0.0%	1%	91%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO2	1,526	1,987	1%	1%	0.2%	21%	0.0%	1%	92%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO2	19,020	15,369	9%	7%	1.8%	2%	0.0%	1%	93%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO2	9,999	9,556	5%	4%	0.3%	14%	0.0%	1%	93%
1A3d	Mobile combustion: water-borne navigation	CO2	405	832	0%	0%	0.2%	20%	0.0%	1%	94%
2C1	Iron and steel production (carbon inputs)	CO2	2,514	1,313	1%	1%	0.6%	6%	0.0%	1%	94%
6B	Emissions from wastewater handling	N2O	513	399	0%	0%	0.1%	54%	0.0%	0%	95%
3, 6D	OTHER N2O	N2O	250	139	0%	0%	0.1%	54%	0.0%	0%	95%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO2	5,033	4,515	2%	2%	0.3%	10%	0.0%	0%	96%
1A3b	Mobile combustion: road vehicles	CH4	157	67	0%	0%	0.0%	60%	0.0%	0%	96%
1B1b	CO2 from coke production	CO2	403	509	0%	0%	0.0%	50%	0.0%	0%	96%
4A8	CH4 emissions from enteric fermentation in domestic livestock: swine	CH4	439	351	0%	0%	0.0%	50%	0.0%	0%	97%
3	Indirect CO2 from solvents/product use	CO2	316	144	0%	0%	0.1%	27%	0.0%	0%	97%
1A3b	Mobile combustion: road vehicles: gasoline	CO2	10,902	13,168	5%	6%	0.9%	2%	0.0%	0%	97%
2F	PFC emissions from PFC use	PFC	37	179	0%	0%	0.1%	25%	0.0%	0%	98%
2B5	Other chemical product manufacture	CO2	606	571	0%	0%	0.0%	71%	0.0%	0%	98%
1A4	Stationary combustion : Other Sectors, solids	CO2	189	134	0%	0%	0.0%	50%	0.0%	0%	98%
1A5	Military use of fuels (1A5 Other)	CO2	566	437	0%	0%	0.1%	20%	0.0%	0%	98%
2A7	Other minerals	CO2	308	414	0%	0%	0.0%	25%	0.0%	0%	98%
6D	OTHER CH4	CH4	1	72	0%	0%	0.0%	32%	0.0%	0%	99%
6B	Emissions from wastewater handling	CH4	290	225	0%	0%	0.0%	32%	0.0%	0%	99%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO2	25,776	26,919	12%	12%	0.3%	3%	0.0%	0%	99%
2E	HFC by-product emissions from HFC manufacture	HFC	12	99	0%	0%	0.0%	22%	0.0%	0%	99%
1A	Emissions from stationary combustion: non-CO2	CH4	522	565	0%	0%	0.0%	50%	0.0%	0%	99%
1A1b	Stationary combustion : Petroleum Refining: gases	CO2	1,042	2,267	0%	1%	0.5%	1%	0.0%	0%	99%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO2	18,696	18,786	9%	9%	0.1%	5%	0.0%	0%	99%
2F	SF6 emissions from SF6 use	SF6	301	328	0%	0%	0.0%	56%	0.0%	0%	99%
4A	CH4 emissions from enteric fermentation in domestic livestock: other	CH4	319	286	0%	0%	0.0%	30%	0.0%	0%	100%
1A	Emissions from stationary combustion: non-CO2	N2O	215	240	0%	0%	0.0%	50%	0.0%	0%	100%
1B2	Fugitive emissions from oil and gas operations: other	CH4	162	149	0%	0%	0.0%	54%	0.0%	0%	100%
2G	Other industrial: CO2	CO2	305	342	0%	0%	0.0%	21%	0.0%	0%	100%
2G	Indirect N2O from NH3 from combustion and industrial processes	N2O	52	56	0%	0%	0.0%	206%	0.0%	0%	100%
2G	Other industrial: CH4	CH4	297	312	0%	0%	0.0%	51%	0.0%	0%	100%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH4	255	268	0%	0%	0.0%	50%	0.0%	0%	100%
4B	Emissions from manure management : other	CH4	12	16	0%	0%	0.0%	100%	0.0%	0%	100%
2C3	CO2 from aluminium production	CO2	395	479	0%	0%	0.0%	5%	0.0%	0%	100%
2A3	Limestone and dolomite use	CO2	276	297	0%	0%	0.0%	25%	0.0%	0%	100%
2A1	Cement production	CO2	416	446	0%	0%	0.0%	11%	0.0%	0%	100%
2G	Other industrial: N2O	N2O	3	7	0%	0%	0.0%	71%	0.0%	0%	100%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO2	2,544	2,581	1%	1%	0.0%	20%	0.0%	0%	100%
2B1	Ammonia production	CO2	3,096	3,086	1%	1%	0.0%	2%	0.0%	0%	100%
1A3	Mobile combustion: other	N2O	1	3	0%	0%	0.0%	112%	0.0%	0%	100%
1A3	Mobile combustion: other	CO2	91	109	0%	0%	0.0%	5%	0.0%	0%	100%
1A3	Mobile combustion: other	CH4	1	1	0%	0%	0.0%	112%	0.0%	0%	100%
1A3a	Mobile combustion: aircraft	CO2	41	41	0%	0%	0.0%	50%	0.0%	0%	100%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO2	2	1	0%	0%	0.0%	20%	0.0%	0%	100%
4B	Emissions from manure management	N2O	694	707	0%	0%	0.0%	100%	0.0%	0%	100%
			214,308	218,086							

ANNEX 2. Detailed discussion of methodology and data for estimating CO2 emissions from fossil fuel combustion

In this Annex we include "**The Netherlands list of fuels and standard CO_2 emission factors**" published in 2004 and updated with some editorial changes in November 2005. Not included are Annex 2 and 3 of this publication as these hold a copy of Page 1.13 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) and of Page 1.6 IPCC Good Practice Guidance for National Greenhouse Gas Inventories Workbook.

A2.1 Introduction

For national monitoring of greenhouse gas emissions under the framework of the UN 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 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 organisations use for the individual energy carriers.

This document 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 information. 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.

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.

A2.2.1 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.

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 specification for one of the following fuels in:

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. Oxy gas;
10. Phosphor oven gas.

For industrial gases, chemical waste gas is also split from refinery gas. For the IPCC main group 'other fuels', only the (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 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 weighed average of three specified biogases is used as the standard factor for gaseous biomass, i.e.

1. Sewage treatment facility (RWZI) biogas;
2. Landfill gas;
3. Industrial organic waste gas.

For coke coals the standard CO_2 emissions factor is also a weighed average, e.g. 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.

A2.2.2 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 m^3 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).

A2.2.3 The Netherlands list in national monitoring, European CO2 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).

Table A2.1. Netherlands fuels and standard CO2 emission factors

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
Smeerolieën	Lubricants	kg	41.4	73.3
Petroleumcokes	Petroleum Coke	kg	35.2	100.8
Raffinaderij grondstoffen	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 olieen	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	Oxy Gas	MJ	1.0	191.9
Fosforovengas	Phosphor Gas	Nm3	11.6	149.5
	C. Gaseous Fossil Fuels			
Aardgas	Natural Gas (dry)	Nm^3 ae	31.65	56.1 **
Koolmonoxide	Carbon Monoxide	Nm^3	12.6	155.2
Methaan	Methane	Nm^3	35.9	54.9
Waterstof	Hydrogen	Nm^3	10.8	0.0
	Biomass *			
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	Wastewater 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

* biomass: the value of the CO2 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.

**EF CO_2 natural gas: This emission factor will be changed into 56.8 due to new information (TNO 2006). In the NIR 2006 this new factor is already used

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.

The Netherlands scheme for monitoring the trade in emission rights indicates that, in the first trading period (2005 through 2007) by Dutch companies, monitoring under the framework of the EU CO_2 emissions trade shows a deviation (for a number of fuels) to the values given on the Netherlands list. This is due to the fact that the allocation of CO_2 emission rights for this period assumes other values because, at that point in time, the Netherlands list was not yet defined. It was decided to leave these differing values for the first trading period as they are, so that the allocation to Dutch companies need not be changed. These differences are shown in table A2.2. Exactly when and how figures may deviate is indicated in the Netherlands system for monitoring the trade in emission rights.
It has been decided to leave these differences for the first trading period, so that the allocation to these 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.

Table A2.2. Comparison of emission factors in the allocation of CO2 emission rights with the National list

Energy carrier	Unit	Allocation		National list	
		Heating value (GJ/unit)	CO2 emission factor (kg/GJ)	Heating value (GJ/unit)	CO2 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 standard value
[3)] Country-specific factor (TNO, 2002).

(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 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 (e.g. monitoring energy covenants, predicting future CO_2 emissions etc.). Selections can be taken from the list, depending on the application. This usage is not defined in the legislation, but offers the advantage of harmonising the national monitoring under the UNFCCC framework. Whenever CO_2 emissions are defined for the government, the Netherlands list will be used wherever possible.

A2.2.4 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, i.e. RIVM, CBS, SenterNovem, plus other relevant organisations, such as the (e-)MJV, CO_2 emissions trade and 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 organisational 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 national monitoring of greenhouse gases, this list will be evaluated every three years. The values currently included are valid for (at least) the period from 1990 through 2007.

Appendix 1: 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)	
Energysource-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 <= 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	Nether-lands 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
	ER/TNO	

	MJA	
	CO_2 trade	
Names used in previous lists	EMJV	Petrol/motorbenzine
	ER/TNO	Petrol
	MJA	Petrol
	Benchmark	
Unit	Kg	

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 $_{CO2}$/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 analysed 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

- *Annex 3* of the *NIR 2005* (Klein Godewijk *et al*., 2005) provides detailed 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. ;
- *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 in the National Approach and Reference Approach

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 and 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* and *A2.3).*
In *Table A4.1* the results of the *Reference Approach* calculation are presented for 1990-2004 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 -4.3% for 1991 and 1992; and -0.3 for 2004. The largest differences are seen for the early 1990's.

Table A4.1. Comparison of CO_2 emissions: Reference Approach (RA) [1] versus National Approach (NA) (in Tg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Reference Approach															
Liquid fuels [1]	49.7	50.4	51.0	51.2	52.2	51.4	52.3	51.7	52.3	53.1	53.8	54.6	53.6	55.5	54.9
Solid fuels [1]	34.0	31.3	31.4	31.5	33.7	34.7	33.5	32.5	33.3	29.2	30.5	32.2	32.8	34.1	33.4
Gaseous fuels	71.9	80.3	78.1	80.7	77.7	79.9	88.4	82.8	82.3	80.0	81.0	83.4	83.1	83.6	85.3
Others	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	0.0
Total RA	**155.6**	**162.0**	**160.6**	**163.4**	**163.6**	**166.0**	**174.2**	**167.1**	**167.9**	**162.3**	**165.3**	**170.2**	**169.5**	**173.3**	**173.7**
National Approach															
Liquid fuels	49.8	49.6	50.0	51.5	52.1	52.3	52.7	52.3	53.8	54.5	54.4	55.5	55.2	57.1	57.5
Solid fuels	31.0	28.2	28.7	29.2	31.0	32.4	31.0	29.9	31.2	27.3	28.8	30.8	31.0	31.9	31.6
Gaseous fuels	68.6	76.5	74.4	77.0	73.7	76.0	84.5	78.7	78.2	76.0	76.7	79.7	79.6	80.2	82.0
Others [2]	0.6	0.6	0.6	0.7	0.7	0.8	1.1	1.3	1.4	1.5	1.5	1.5	1.6	1.7	2.1
Total NA	**150.0**	**155.0**	**153.7**	**158.4**	**157.5**	**161.5**	**169.3**	**162.2**	**164.6**	**159.3**	**161.4**	**167.6**	**167.4**	**170.9**	**173.2**
Difference [3] (%)															
Liquid fuels	0.2%	-1.5%	-2.1%	0.6%	-0.2%	1.7%	0.7%	1.1%	2.9%	2.6%	1.0%	1.7%	3.0%	2.9%	4.7%
Solid fuels	-8.9%	-9.9%	-8.5%	-7.5%	-8.1%	-6.7%	-7.4%	-8.0%	-6.2%	-6.5%	-5.7%	-4.3%	-5.5%	-6.6%	-5.6%
Gaseous fuels	-4.6%	-4.7%	-4.8%	-4.6%	-5.1%	-4.9%	-4.4%	-5.0%	-5.0%	-5.0%	-5.2%	-4.4%	-4.2%	-4.1%	-3.8%
Other	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total	**-3.6%**	**-4.3%**	**-4.3%**	**-3.1%**	**-3.7%**	**-2.7%**	**-2.8%**	**-2.9%**	**-1.9%**	**-1.9%**	**-2.4%**	**-1.6%**	**-1.2%**	**-1.4%**	**-0.3%**

[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: (NA-RA)/RA.

The *Reference Approach* (RA) and *National Approach* (NA) data show a 10% RA vs. 15% NA increase in emissions from liquid fuels (1990-2004) and a 19% RA vs. 20% NA increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period only by 2% in the RA vs. an increase of 2% 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 2.1 Tg CO_2 in 2004. 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.

Please note that as of this year, the new CRF software includes LPG in transport in the National Approach reported under 'liquid fuel' in the Reference Approach (previously this was reported under 'other fuel').

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 recalculations of this year 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');
- selected CRF sector 2 components listed in Table A4.2 and all fugitive CO_2 emissions included in CRF sector 1B.

If we correct the RA by including the fossil waste and the NA by including the 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 all below 2%: between -0.5% in 1992 and +1.3% in 1999.
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 1990-2004 trends also differ only slightly: 13.1% for the corrected *National Approach* (NA) (= sum of sectoral emissions in source category 1A plus selected 1B and 2 minus fossil waste) and 11.9% for the corrected *Reference Approach*. We conclude that in total annual emissions the remaining differences are now all smaller than ±1%, except for 2004 which shows a 1.6% difference, and on average only 0.7±1.1%.

The corrected approaches show differences in emissions from liquid fuels up to 4% vs. 3% for uncorrected comparisons; up to 3% vs. 10% for solid fuels and 1% vs. 5% for gaseous fuels, respectively, if corrections are made for 2G (lubricants and waxes) in NA-liquids, 1B (coke production) and 2C1 (blast furnaces) and others in NA-solids; and 1B1 (gas flaring) 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*).

Table A4.2. Corrections of Reference Approach and National Approach for a proper comparison (in Tg).

RA,NA, correction term	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*
Difference RA-NA	**4.5**	**10.8**	**9.4**	**12.3**	**12.5**	**14.9**	**23.1**	**15.9**	**16.7**	**11.1**	**14.2**	**19.1**	**18.3**	**22.1**	**22.5**
Reference Approach:	155.6	162.0	160.6	163.4	163.6	166.0	174.2	167.1	167.9	162.3	165.3	170.2	169.5	173.3	173.7
o.w. fossil C in waste	0.6	0.6	0.6	0.7	0.7	0.8	1.1	1.3	1.4	1.5	1.5	1.5	1.6	1.7	2.1
RA incl. fossil waste:	**156.2**	**162.6**	**161.2**	**164.1**	**164.3**	**166.9**	**175.3**	**168.4**	**169.3**	**163.8**	**166.8**	**171.7**	**171.1**	**175.0**	**175.8**
Diff. RAincl.Waste-NA:	6.3	7.6	7.5	5.8	6.8	5.4	6.0	6.2	4.7	4.5	5.4	4.1	3.7	4.1	2.6
National Approach:	150.0	155.0	153.7	158.4	157.5	161.5	169.3	162.2	164.6	159.3	161.4	167.6	167.4	170.9	173.2
CO_2 fossil in sector 1B:															
1B1b. Solid Fuel Transf.	0.4	0.4	0.4	0.4	0.6	0.5	0.7	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5
1B2c Flaring	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.1
CO_2 fossil in sector 2:	6.1	6.0	5.5	5.3	5.8	5.9	5.3	5.9	5.6	5.5	5.3	4.7	4.6	4.8	4.8
A. Mineral Products															
Soda Ash Production	0.1	0.4	0.4	0.4	0.3	0.4	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2
B. Chemical industry															
1. Ammonia production	3.1	3.5	3.5	3.4	3.6	3.6	3.4	3.6	3.6	3.6	3.6	3.0	2.9	2.9	3.1
4. Other, excl. act. carbon	0.6	0.2	0.2	0.2	0.2	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
C. Metal industry															
1. Inputs in blast furnace	2.2	1.9	1.3	1.2	1.5	1.5	1.5	1.8	1.4	1.3	1.0	1.0	1.1	1.2	0.9
D. Other Production															
1. Food and Drink	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
G. Other ***(please specify)***															
Other economic sectors	0.2	0.2	0.3	0.2	0.2	0.5	0.5	0.5	0.4	0.5	0.6	0.4	0.4	0.4	0.4
Not in NA-1A:	6.9	6.8	6.3	6.1	6.7	6.7	6.2	6.7	6.2	6.0	5.9	5.2	5.2	5.3	5.4
NA+1B+Ind. Proc.	156.3	161.2	159.4	163.8	163.5	167.3	174.4	167.6	169.5	163.8	165.8	171.3	171.0	174.5	176.5
RA+Waste:	155.6	162.0	160.6	163.4	163.6	166.0	174.2	167.1	167.9	162.3	165.3	170.2	169.5	173.3	173.7
New difference (abs)	**0.7**	**-0.8**	**-1.2**	**0.3**	**-0.1**	**1.3**	**0.2**	**0.5**	**1.6**	**1.5**	**0.4**	**1.0**	**1.5**	**1.3**	**2.8**
New difference (%)	*0.4%*	*-0.5%*	*-0.7%*	*0.2%*	*-0.1%*	*0.8%*	*0.1%*	*0.3%*	*0.9%*	*0.9%*	*0.3%*	*0.6%*	*0.9%*	*0.7%*	*1.6%*

* Using preliminary RA data; final data will be included in the NIR 2007.

Table A.4.3. Comparison of CO_2 emissions: differences between corrected Reference Approach (RA) versus corrected National Approach [(NA-RA)/RA)] (in %), based on CRF version 1.1 data March 2006)

Fuel type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Liquids [incl. 2G]	0.3%	-1.1%	-1.5%	1.0%	0.2%	2.1%	1.1%	1.9%	3.5%	3.7%	2.4%	2.8%	4.1%	2.9%	5.7%
Solids [incl. 1B1,2A,2B4,2C1,2D]	1.9%	-0.3%	-0.7%	-0.1%	0.2%	2.7%	2.4%	2.6%	1.3%	1.6%	1.3%	1.6%	0.6%	0.0%	-0.7%
Gas [incl. 1B2, 2B1]	0.2%	0.2%	0.2%	0.2%	0.0%	-0.2%	-0.4%	-0.4%	-0.5%	-0.5%	-0.7%	-0.8%	-0.7%	-0.4%	-0.1%
Total corrected (excl. waste)	**0.6%**	-0.3%	-0.5%	**0.4%**	**0.1%**	**1.1%**	**0.6%**	**0.9%**	**1.1%**	**1.3%**	**0.7%**	**0.8%**	**1.1%**	**0.8%**	**1.6%**

A4.2.1 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. 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.

A4.3 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. 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:

- 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). 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 increased by almost 30% or 2.6 Tg CO_2 (from 8.9 to 11.5 Tg CO_2), of which most are due to changes in emissions from liquid fuels (*Table 3.34*). In *Table A.4.6and A4.5* we show the carbon storage in the RA calculation. Its shows, that in the Netherlands about 20 to 30 Tg CO_2 or 12 to 15% of all carbon in the apparent consumption of fossil fuels is stored.

Table A4.4. 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).

Fuel type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*	Trend
Liquids [1) 2)]	5.0	5.0	4.7	3.9	4.0	5.1	4.8	5.1	5.0	5.6	6.1	6.5	6.8	7.8	7.9	3.0
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	0.4	0.4	0.2	-0.2
Gaseous	3.5	3.5	3.5	3.3	3.5	3.8	3.7	3.9	3.7	3.7	3.9	3.5	3.4	3.2	3.4	-0.1
Total	**8.9**	**8.9**	**8.5**	**7.6**	**7.9**	**9.3**	**8.9**	**9.4**	**9.2**	**9.7**	**10.4**	**10.4**	**10.6**	**11.4**	**11.5**	**2.6**
As % of RA	5.7%					5.6%	5.1%	5.6%	5.5%	6.0%	6.3%	6.1%	6.3%	6.6%	6.6%	

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.
* Using preliminary RA data; final data will be included in the CRF 2007 and NIR 2007.

Table A4.5. Carbon storage in the IPCC Reference Approach for CO_2 from fossil fuel use (in Tg CO_2)

Fuel type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*	Trend
Liquids	17.4	19.3	19.9	18.1	19	18	17	17.9	17.7	19.7	21.4	22.9	23.8	27.2	28.0	10.6
Solids	0.6	0	0	0	0	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.3	-0.3
Gaseous	2.2	2.4	2.3	2.2	2.4	2.4	2.3	2.5	2.3	2.3	2.4	2.2	2.1	2.0	2.1	-0.1
Total	20.2	21.7	22.2	20.3	21.4	20.9	19.9	21.0	20.6	22.5	24.3	25.6	26.5	29.8	30.4	10.2
% gross RA[1)]	12%	12%	12%	11%	12%	11%	10%	11%	11%	12%	13%	13%	14%	15%	15%	

1) Expressed as part of total carbon in apparent consumption of fossil fuels (without subtracting the stored part).
* Using preliminary RA data; final data will be included in the CRF 2007 and NIR 2007.

ANNEX 5. Assessment of completeness and (potential) sources and sinks excluded

The Netherlands greenhouse gas emission inventory includes *all* sources identified by the *Revised IPCC Guidelines* (IPCC, 1996) *except* for the following:

- CO_2 from 2A2 *lime production*, due to missing activity data;
- CH_4 from 4A9 *Enteric fermentation poultry*, due to missing emission factors;
- *Precursor emissions* (i.e. CO, NO_x, NMVOC and SO_2) from *international bunkers (international transport)* are not included;
- A survey to check on unidentified sources of non-CO_2 emissions in the Netherlands showed some minor sources of *PFCs* and *SF_6* not included in the present greenhouse gas inventory (DHV, 2000). Since no regular monitoring data are available, these sources are not included;
- Charcoal production (1B2) and use (1A4) is not included;
- The annual monitoring of biomass combustion is incomplete resulting in some (small) inconsistencies in the time series of activity data and emissions in 1A2 *Manufacturing industries* (*see Section 3.4*) and in category 1A4a *Commercial/Institutional* (*see Section 3.6*).

Documentation of the justification (activity data or expert judgment) of the emissions that are not estimated will be improved as part of the QA/QC improvement programme.

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; this information is available on the website www.greenhousegases.nl:

Table A6.1 Methodological description (monitoring protocols available at the website):

Protocol	IPCC-code	Description	Gas(es)
5400	All	Reference approach	CO_2
5401	1A1 1A2 1A4	Stationary combustion (fossil) *	CO_2 N_2O CH_4
5402	1A1b 1B1b 1B2aiv 2A4i 2B1 2B4i 2B5i 2B5vii 2B5viii 2C1vi 2D2 2Giv	Process emissions (fossil)	CO_2 N_2O CH_4
5403	1A2f 1A4c	Mobile equipment	CO_2 N_2O CH_4
5410	1A4c	Fisheries	CO_2 N_2O CH_4
5404	1A3a	Inland aviation	CO_2 N_2O CH_4
5405	1A3b	Road transport	CO_2
5406	1A3b	Road transport	N_2O
5407	1A3b	Road transport	CH_4
5408	1A3c	Rail transport	CO_2 N_2O CH_4
5409	1A3d	Inland navigation	CO_2 N_2O CH_4
5411	1A5	Defence	CO_2 N_2O CH_4
5412	1B2	Oil & gas production	CO_2 CH_4
5413	1B2	Oil & gas distribution/transport	CO_2 CH_4
5414	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
5415	2B2	Nitric acid	N_2O
5416	2B5	Caprolactam	N_2O
5417	2C3	Aluminium production	PFC
5418	2E1	HCFK-22 production	HFC
5419	2E3	HFC by-product emissions	HFC
5420	2F1	Stationary refrigeration	HFC
5421	2F1	Mobile refrigeration	HFC
5422	2F2	Hard foams	HFC
5423	2F4	Aerosols	HFC
5424	2F8	Sound proof windows	SF_6
5425	2F8	Semi-conductors	SF_6 PFC
5426	2F8	Electrical equipment	SF_6
5427	4A1	Enteric fermentation, cattle	CH_4
5428	4A2-13	Enteric fermentation, other	CH_4
5429	4B	Manure management	N_2O
5430	4B1	Manure management, cattle	CH_4
5431	4B8	Manure management ,swine	CH_4
5432	4B2-7,9-13	Manure management, other	CH_4
5433	4D	Agricultural soils, indirect	N_2O
5434	4D	Agricultural soils, direct	N_2O
5435	5A	Forest	CO_2
5436	5D	Soil	CO_2
5437	6A1	Waste disposal	CH_4
5438	6B	Waste water treatment	CH_4 N_2O
5439	6D	Large-scale composting	CH_4 N_2O
	1A, (CO2 memo item)	Biomass	CO_2 CH_4 N_2O
	Memo item in reports	International bunker emissions	CO_2 N_2O CH_4

* As explained in this NIR, a revised emission factor of 56.8 kg/GJ is used for the CO_2 emissions from the combustion of natural gas.

A6.1 Documentation of uncertainties used in IPCC Tier 1 uncertainty assessments and Tier 2 key source identification

- Olivier, J.G.J. and L.J. Brandes, 2006: *Estimate of annual and trend uncertainty for Dutch sources of greenhouse gas emissions using the IPCC Tier 1 approach.* RIVM, Bilthoven. *In prep.*
- 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; July 2006.

A6.2 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.
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A6.3 Documentation of present Quality Assurance and Quality Control for national greenhouse gas inventory compilation and reporting

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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[3]. 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 shows 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%'.

Table A7.1. Uncertainty estimates for Tier 1-trend

	Uncertainty in emission level	Uncertainty in emission trend
CO_2-eq.	5%	±3%-points of 2% increase
CO_2	3%	±3%-points of 13% increase
CH_4	25%	±11%-points of 32% decrease
N_2O	50%	±15%-points of 16% decrease
F-gases	50%	±7%-points of 75% decrease

Details on this calculation can be found in *Table A7.2* and in Olivier and Brandes, 2006. It should be stressed that most uncertainty estimates are ultimately based on (collective) expert judgement and therefore also rather uncertain (usually of the order of 50%). However, the reason to make these estimates is to identify the relative 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 prioritise 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 can not 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.

[3] 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 Van der Sluijs, 2006). This conclusion holds for both annual uncertainties and the trend uncertainty (see *Section 1.7* for more details).

Table A7.2. Tier 1 level and trend uncertainty assessment 1990-2004 (for F-gases with base year 1995) with the categories of the IPCC potential key source list (without adjustment for correlations between sources)

IPCC	IPCC Source category	Gas	CO2-eq 1990	CO2-eq 2004	Acti-vity data unc.	Emis-sion factor unc.	Com-bined unc.	Combined Uncertainty as % of total national emissions in 2004	Type A sensi-tivity	Type B sensi-tivity	Unc. in trend in national emissions introduced by emission factor uncertainty	Unc. in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO2	207	2,198	0.5%	10.0%	10%	0.1%	0.9%	1%	0.1%	0.0%	0.1%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO2	25,776	26,919	1.0%	3.0%	3%	0.4%	0.3%	13%	0.0%	0.2%	0.2%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO2	13,348	25,576	0.5%	1.0%	1%	0.1%	5.6%	12%	0.1%	0.1%	0.1%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO2	592	2,114	10.0%	5.0%	11%	0.1%	0.7%	1%	0.0%	0.1%	0.1%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO2	9,999	9,556	10.0%	10.0%	14%	0.6%	-0.3%	4%	0.0%	0.6%	0.6%
1A1b	Stationary combustion : Petroleum Refining: gases	CO2	1,042	2,267	0.5%	1.0%	1%	0.0%	0.6%	1%	0.0%	0.0%	0.0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO2	2	1	20.0%	2.0%	20%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO2	1,526	1,987	20.0%	5.0%	21%	0.2%	0.2%	1%	0.0%	0.3%	0.3%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO2	8,993	7,282	1.0%	5.0%	5%	0.2%	-0.9%	3%	0.0%	0.0%	0.1%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO2	5,033	4,515	2.0%	10.0%	10%	0.2%	-0.3%	2%	0.0%	0.1%	0.1%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO2	19,020	15,369	2.0%	1.0%	2%	0.2%	-1.9%	7%	0.0%	0.2%	0.2%
1A4	Stationary combustion : Other Sectors, solids	CO2	189	134	50.0%	5.0%	50%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO2	6,634	11,003	20.0%	1.0%	20%	1.0%	2.0%	5%	0.0%	1.5%	1.5%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO2	18,696	18,786	5.0%	1.0%	5%	0.4%	-0.1%	9%	0.0%	0.6%	0.6%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO2	8,328	7,041	10.0%	1.0%	10%	0.3%	-0.7%	3%	0.0%	0.5%	0.5%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO2	2,544	2,581	20.0%	2.0%	20%	0.2%	0.0%	1%	0.0%	0.3%	0.3%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO2	1,476	629	20.0%	2.0%	20%	0.1%	-0.4%	0%	0.0%	0.1%	0.1%
1A5	Military use of fuels (1A5 Other)	CO2	566	437	20.0%	2.0%	20%	0.0%	-0.1%	0%	0.0%	0.1%	0.1%
1A	Emissions from stationary combustion: non-CO2	CH4	522	565	3.0%	50.0%	50%	0.1%	0.0%	0%	0.0%	0.0%	0.0%
1A	Emissions from stationary combustion: non-CO2	N2O	215	240	3.0%	50.0%	50%	0.1%	0.0%	0%	0.0%	0.0%	0.0%
1A3b	Mobile combustion: road vehicles: gasoline	CO2	10,902	13,168	2.0%	0.4%	2%	0.1%	1.0%	6%	0.0%	0.2%	0.2%
1A3b	Mobile combustion: road vehicles: diesel oil	CO2	11,832	19,542	5.0%	0.2%	5%	0.4%	3.5%	9%	0.0%	0.6%	0.6%
1A3b	Mobile combustion: road vehicles: LPG	CO2	2,738	1,131	10.0%	0.2%	10%	0.1%	-0.8%	1%	0.0%	0.1%	0.1%
1A3d	Mobile combustion: water-borne navigation	CO2	405	832	20.0%	0.2%	20%	0.1%	0.2%	0%	0.0%	0.1%	0.1%
1A3a	Mobile combustion: aircraft	CO2	41	41	50.0%	0.5%	50%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: other	CO2	91	109	5.0%	0.2%	5%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: other	CH4	1	1	50.0%	100.0%	112%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: other	N2O	1	3	50.0%	100.0%	112%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A3b	Mobile combustion: road vehicles	CH4	157	67	3.0%	60.0%	60%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1A3b	Mobile combustion: road vehicles	N2O	271	486	5.0%	50.0%	50%	0.1%	0.1%	0%	0.0%	0.0%	0.1%

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Table A7.2. Tier 1 level and trend uncertainty assessment 1990-2004 (for F-gases with base year 1995) with the categories of the IPCC potential key source list (without adjustment for correlations between sources) (continued)

IPCC	IPCC Source category	Gas	CO2-eq 1990	CO2-eq 2004	Acti-vity data unc.	Emis-sion factor unc.	Com-bined unc.	Combined Uncertainty as % of total national emissions in 2004	Type A sensi-tivity	Type B sensi-tivity	Unc. in trend in national emissions introduced by emission factor uncertainty	Unc. in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1B2	Fugitive emissions venting/flaring	CH4	1,252	310	2.0%	25.0%	25%	0.0%	-0.4%	0%	-0.1%	0.0%	0.1%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH4	255	268	2.0%	50.0%	50%	0.1%	0.0%	0%	0.0%	0.0%	0.0%
1B2	Fugitive emissions from oil and gas operations: other	CH4	162	149	20.0%	50.0%	54%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
1B1b	CO2 from coke production	CO2	403	509	50.0%	2.0%	50%	0.1%	0.0%	0%	0.0%	0.2%	0.2%
1B2	Fugitive emissions venting/flaring: CO2	CO2	775	125	50.0%	2.0%	50%	0.0%	-0.3%	0%	0.0%	0.0%	0.0%
2A1	Cement production	CO2	416	446	5.0%	10.0%	11%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
2A3	Limestone and dolomite use	CO2	276	297	25.0%	5.0%	25%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
2A7	Other minerals	CO2	308	414	25.0%	5.0%	25%	0.0%	0.0%	0%	0.0%	0.1%	0.1%
2B1	Ammonia production	CO2	3,096	3,086	2.0%	1.0%	2%	0.0%	0.0%	1%	0.0%	0.0%	0.0%
2B2	Nitric acid production	N2O	6,330	5,617	10.0%	50.0%	51%	1.3%	-0.4%	3%	-0.2%	0.4%	0.4%
2B5	Caprolactam production	N2O	1,240	759	50.0%	50.0%	71%	0.2%	-0.2%	0%	-0.1%	0.3%	0.3%
2B5	Other chemical product manufacture	CO2	606	571	50.0%	50.0%	71%	0.2%	0.0%	0%	0.0%	0.2%	0.2%
2C1	Iron and steel production (carbon inputs)	CO2	2,514	1,313	3.0%	5.0%	6%	0.0%	-0.6%	1%	0.0%	0.0%	0.0%
2C3	CO2 from aluminium production	CO2	395	479	2.0%	5.0%	5%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
2C3	PFC from aluminium production	PFC	1,901	106	2.0%	20.0%	20%	0.0%	-0.9%	0%	-0.2%	0.0%	0.2%
2F	SF6 emissions from SF6 use	SF6	301	328	50.0%	25.0%	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	1,023	10.0%	50.0%	51%	0.2%	0.4%	0%	0.2%	0.1%	0.2%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	354	10.0%	10.0%	14%	0.0%	-2.6%	0%	-0.3%	0.0%	0.3%
2E	HFC by-product emissions from HFC manufacture	HFC	12	99	10.0%	20.0%	22%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
2F	PFC emissions from PFC use	PFC	37	179	5.0%	25.0%	25%	0.0%	0.1%	0%	0.0%	0.0%	0.0%
2G	Other industrial: CO2	CO2	305	342	5.0%	20.0%	21%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
2G	Other industrial: CH4	CH4	297	312	10.0%	50.0%	51%	0.1%	0.0%	0%	0.0%	0.0%	0.0%
2G	Other industrial: N2O	N2O	3	7	50.0%	50.0%	71%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
2G	Indirect N2O from NH3 from combustion and industrial processes	N2O	52	56	50.0%	200.0%	206%	0.1%	0.0%	0%	0.0%	0.0%	0.0%
2G	Indirect N2O from NO2 from combustion and industrial processes	N2O	883	637	15.0%	200.0%	201%	0.6%	-0.1%	0%	-0.2%	0.1%	0.3%
3	Indirect CO2 from solvents/product use	CO2	316	144	25.0%	10.0%	27%	0.0%	-0.1%	0%	0.0%	0.0%	0.0%
4A1	CH4 emissions from enteric fermentation in domestic livestock: cattle	CH4	6,767	5,712	5.0%	20.0%	21%	0.5%	-0.5%	3%	-0.1%	0.2%	0.2%
4A8	CH4 emissions from enteric fermentation in domestic livestock: swine	CH4	439	351	5.0%	50.0%	50%	0.1%	0.0%	0%	0.0%	0.0%	0.0%
4A	CH4 emissions from enteric fermentation in domestic livestock: other	CH4	319	286	5.0%	30.0%	30%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
4B	Emissions from manure management	N2O	694	707	10.0%	100.0%	100%	0.3%	0.0%	0%	0.0%	0.0%	0.0%
4B1	Emissions from manure management : cattle	CH4	1,574	1,475	10.0%	100.0%	100%	0.7%	-0.1%	1%	-0.1%	0.1%	0.1%
4B8	Emissions from manure management : swine	CH4	1,141	919	10.0%	100.0%	100%	0.4%	-0.1%	0%	-0.1%	0.1%	0.1%
4B9	Emissions from manure management : poultry	CH4	243	56	10.0%	100.0%	100%	0.0%	-0.1%	0%	-0.1%	0.0%	0.1%
4B	Emissions from manure management : other	CH4	12	16	10.0%	100.0%	100%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
4D1	Direct N2O emissions from agricultural soils	N2O	4,597	4,839	10.0%	60.0%	61%	1.3%	0.1%	2%	0.0%	0.3%	0.3%
4D3	Indirect N2O emissions from nitrogen used in agriculture	N2O	4,861	3,209	50.0%	200.0%	206%	3.0%	-0.8%	1%	-1.6%	1.1%	1.9%
4D2	Animal production on agricultural soils	N2O	1,308	651	10.0%	100.0%	100%	0.3%	-0.3%	0%	-0.3%	0.0%	0.3%
6A1	CH4 emissions from solid waste disposal sites	CH4	12,011	6,521	30.0%	15.0%	34%	1.0%	-2.7%	3%	-0.4%	1.3%	1.4%
6B	Emissions from wastewater handling	CH4	290	225	20.0%	25.0%	32%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
6B	Emissions from wastewater handling	N2O	513	399	20.0%	50.0%	54%	0.1%	-0.1%	0%	0.0%	0.1%	0.1%
6D	OTHER CH4	CH4	1	72	20.0%	25.0%	32%	0.0%	0.0%	0%	0.0%	0.0%	0.0%
3, 6D	OTHER N2O	N2O	250	139	20.0%	50.0%	54%	0.0%	-0.1%	0%	0.0%	0.0%	0.0%

Table A7.3 Emissions (Gg) and uncertainty estimates for the subcategories of Sector 5 LULUCF, as used in the Tier 1 Uncertainty analysis

IPCC	Category	Gas	CO2-eq. 1990	CO2-eq. 2004	AD uncert.	EF uncert.	EM uncertainty estimate
5A1	5A1. Forest Land remaining Forest Land	CO2	-2,505	-2,289	25%	62%	67%
5A2	5A2. Land converted to Forest Land	CO2	-11	-159	25%	58%	63%
5B2	5B2. Land converted to Cropland	CO2	-36	-36	25%	50%	56%
5C1	5C1. Grassland remaining Grassland	CO2	4,246	4,246	25%	50%	56%
5C2	5C2. Land converted to Grassland	CO2	-51	-51	25%	61%	66%
5E2	5E2. Land converted to Settlements	CO2	-152	-152	25%	50%	56%
5F2	5F2. Land converted to Other Land	CO2	717	717	25%	50%	56%
5G	5G. Other (liming of soils)	CO2	183	79	25%	1%	25%
5	TOTAL		2,392	2,356			~100%

ANNEX 8. CRF Summary tables

This annex shows a copy of selected sheets from the 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 2004

Table A8.1 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; **Year: 1990**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**161,781.33**	**1,211.47**	**68.45**	**NA,NE,NO**	**4,432.03**	**C,NA,NE,NO**	**2,264.48**	**C,NA,NE,NO**	**0.01**	**559.33**	**1,137.28**	**465.76**	**190.11**
1. Energy	**151,157.72**	**111.84**	**1.57**							**543.39**	**1,006.10**	**247.01**	**178.88**
A. Fuel Combustion — Reference Approach[2]	155,641.19												
A. Fuel Combustion — Sectoral Approach[2]	149,980.32	32.36	1.57							543.27	1,004.52	198.76	171.36
1. Energy Industries	52,492.33	3.40	0.41							105.54	11.74	2.58	105.84
2. Manufacturing Industries and Construction	33,045.44	2.70	0.11							88.53	153.62	5.05	45.89
3. Transport	26,009.02	7.51	0.88							272.71	753.70	174.26	13.29
4. Other Sectors	37,867.81	18.70	0.14							76.48	85.46	16.87	6.33
5. Other	565.72	0.05	0.03							IE	IE	IE	IE
B. Fugitive Emissions from Fuels	1,177.40	79.48	0.00							0.13	1.58	48.25	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	774.73	78.04	0.00							0.13	1.58	48.25	7.52
2. Industrial Processes	**7,915.33**	**14.13**	**27.44**	**NA,NE,NO**	**4,432.03**	**C,NA,NE,NO**	**2,264.48**	**C,NA,NE,NO**	**0.01**	**12.03**	**129.25**	**87.05**	**7.06**
A. Mineral Products	1,000.43	NO	NO							1.28	3.51	1.03	6.29
B. Chemical Industry	3,701.53	12.13	24.42	NA,NO	NA,NO	NA,NO	NA,NO	NA	NA	9.23	IE,NA,NO	33.11	IE,NA,NO
C. Metal Production	2,908.84	IE,NA,NO	NO				2,246.21		NO	IE,NO	118.79	3.84	IE,NO
D. Other Production[3]	72.54									NO	NO	10.77	NO
E. Production of Halocarbons and SF_6					4,432.03		NO		NO				
F. Consumption of Halocarbons and SF_6				NE,NO	NO	C,NE,NO	18.26	C,NE	0.01				
G. Other	231.99	2.01	3.03	NA,NO	NO	NA,NO	NO	NO	NO	1.51	6.95	38.29	0.77

Table A8.1 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; **Year: 1990 (continued)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs [1]		PFCs [1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	316.43		0.73							NO	NO	129.98	NO
4. Agriculture		499.72	37.05							**NA,NO**	**NA,NO**	**0.16**	**NO**
A. Enteric Fermentation		358.35											
B. Manure Management		141.37	2.24									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils [4]		NE,NO	34.81									0.16	
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	[5] **2,391.84**	**NA,NE,NO**	**NA,NE,NO**							**IE,NE**	**IE,NE**		
A. Forest Land	[5] -2,516.03	NO	NE,NO							IE,NE	IE,NE		
B. Cropland	[5] -35.57	NA,NE	NA,NE							NE	NE		
C. Grassland	[5] 4,194.85	NE	NE							NE	NE		
D. Wetlands	[5] NE	NE	NE							NE	NE		
E. Settlements	[5] -151.54	NE	NE							NE	NE		
F. Other Land	[5] 716.98	NE	NE							NE	NE		
G. Other	[5] 183.15	NE	NE							NE	NE		
6. Waste	IE,NA,NO	585.78	1.66							**3.91**	**1.93**	**1.56**	**4.17**
A. Solid Waste Disposal on Land	[4] NA,NO	571.93								NA,NO	NA,NO	1.45	
B. Waste-water Handling		13.79	1.66							NO	NO	NO	
C. Waste Incineration	[4] 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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
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**												

Table A8.2 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; **Year: 1995**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
		(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**172,826.13**	**1,132.96**	**72.24**	**882.40**	**6,019.54**	**C,NA,NE,NO**	**1,937.82**	**C,NA,NE,NO**	**0.01**	**470.15**	**861.99**	**332.71**	**128.08**
1. Energy		**162,451.50**	**111.18**	**2.26**							**461.38**	**795.05**	**175.88**	**124.77**
A. Fuel Combustion	Reference Approach[2]	166,049.92												
	Sectoral Approach[2]	161,493.33	32.06	2.26							460.85	792.46	140.40	114.58
1. Energy Industries		61,513.04	4.29	0.47							83.92	11.05	3.90	68.89
2. Manufacturing Industries and Construction		28,155.34	2.33	0.07							61.73	155.80	4.83	27.74
3. Transport		29,147.35	5.63	1.54							223.79	544.18	115.98	12.92
4. Other Sectors		42,165.50	19.77	0.14							91.41	81.43	15.68	5.04
5. Other		512.10	0.05	0.03							IE	IE	IE	IE
B. Fugitive Emissions from Fuels		958.16	79.12	IE,NA,NO							0.53	2.59	35.48	10.19
1. Solid Fuels		516.87	1.45	NA,NO							IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NO
2. Oil and Natural Gas		441.29	77.67	IE,NA,NO							0.53	2.59	35.48	10.19
2. Industrial Processes		**7,930.87**	**14.14**	**26.91**	**882.40**	**6,019.54**	**C,NA,NE,NO**	**1,937.82**	**C,NA,NE,NO**	**0.01**	**6.39**	**66.54**	**53.93**	**3.05**
A. Mineral Products		1,481.67	NO	NO							1.31	2.45	0.41	2.73
B. Chemical Industry		3,973.80	12.13	24.25	NA,NO	NA,NO	NA,NO	NA,NO	NA	NA	4.69	IE,NA,NO	17.89	IE,NA,NO
C. Metal Production		2,184.13	IE,NA,NO	NO				1,900.79		NO	0.00	61.32	2.93	IE,NO
D. Other Production[3]		22.40									NO	NO	7.33	NO
E. Production of Halocarbons and SF_6						5,770.76		NO		NO				
F. Consumption of Halocarbons and SF_6					882.40	248.78	C,NE,NO	37.03	C,NE	0.01				
G. Other		268.87	2.01	2.66	NA,NO	NO	NA,NO	NO	NO	NO	0.39	2.76	25.36	0.31

Table A8.2 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; **Year: 1995 (continued)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs [1]		PFCs [1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	242.28		0.64							NO	NO	100.98	NO
4. Agriculture		492.66	40.80							**NA,NO**	**NA,NO**	**0.16**	**NO**
A. Enteric Fermentation		347.92											
B. Manure Management		144.74	2.49									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils [4]		NE,NO	38.31									0.16	
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	[5] **2,201.48**	**NA,NE,NO**	**NA,NE,NO**							**IE,NE**	**IE,NE**		
A. Forest Land	[5] -2,621.45	NO	NE,NO							IE,NE	IE,NE		
B. Cropland	[5] -35.57	NA,NE	NA,NE							NE	NE		
C. Grassland	[5] 4,194.85	NE	NE							NE	NE		
D. Wetlands	[5] NE	NE	NE							NE	NE		
E. Settlements	[5] -151.54	NE	NE							NE	NE		
F. Other Land	[5] 716.98	NE	NE							NE	NE		
G. Other	[5] 98.20	NE	NE							NE	NE		
6. Waste	IE,NA,NO	514.98	1.63							**2.38**	**0.40**	**1.76**	**0.26**
A. Solid Waste Disposal on Land	[4] NA,NO	500.07								NA,NO	NA,NO	1.27	
B. Waste-water Handling		11.48	1.49							NO	NO	NO	
C. Waste Incineration	[4] IE	IE	IE							IE	IE	IE	IE
D. Other	NA	3.43	0.14							2.38	0.40	0.49	0.26
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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Memo Items: [8]													
International Bunkers	**43,011.75**	**1.24**	**0.34**							**NE**	**NE**	**NE**	**NE**
Aviation	7,584.14	0.36	0.06							NE	NE	NE	NE
Marine	35,427.61	0.88	0.28							NE	NE	NE	NE
Multilateral Operations	**IE**	**IE**	**IE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**4,317.42**												

Table A8.3 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; **Year: 2004**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
		(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals		**183,299.86**	**824.00**	**57.25**	**2,390.40**	**1,476.65**	**C,NA,NE,NO**	**284.68**	**C,NA,NE,NO**	**0.01**	**354.78**	**617.22**	**179.96**	**63.56**
1. Energy		**173,852.91**	**64.76**	**2.35**							**352.46**	**555.58**	**91.02**	**62.52**
A. Fuel Combustion	Reference Approach[2]	173,679.30												
	Sectoral Approach[2]	173,218.59	30.14	2.35							352.46	554.72	75.65	62.52
1. Energy Industries		70,617.56	6.23	0.55							56.63	14.35	2.69	41.04
2. Manufacturing Industries and Construction		27,165.67	2.22	0.07							47.94	111.29	3.57	15.43
3. Transport		34,823.86	3.26	1.57							172.35	357.24	55.81	2.16
4. Other Sectors		40,174.83	18.39	0.13							75.54	71.83	13.58	3.89
5. Other		436.67	0.04	0.03							IE	IE	IE	IE
B. Fugitive Emissions from Fuels		634.32	34.63	IE,NA,NO							IE,NA,NE,NO	0.86	15.36	IE,NA,NE,NO
1. Solid Fuels		508.82	1.10	NA,NO							IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NO
2. Oil and Natural Gas		125.50	33.53	IE,NA,NO							NA,NE,NO	0.86	15.36	NA,NE,NO
2. Industrial Processes		**6,947.66**	**14.87**	**22.83**	**2,390.40**	**1,476.65**	**C,NA,NE,NO**	**284.68**	**C,NA,NE,NO**	**0.01**	**1.08**	**61.22**	**27.43**	**0.98**
A. Mineral Products		1,156.84	NO	NO							0.49	1.63	0.26	0.88
B. Chemical Industry		3,657.29	13.10	20.57	NA,NO	NA,NO	NA,NO	NA,NO	NA	NA	IE,NA,NO	IE,NA,NO	9.87	IE,NA,NO
C. Metal Production		1,791.37	IE,NA,NO	NO				105.64		NO	IE,NO	56.00	0.65	IE,NO
D. Other Production[3]		41.17									NO	NO	5.00	NO
E. Production of Halocarbons and SF_6						453.79		NO		NO				
F. Consumption of Halocarbons and SF_6					2,390.40	1,022.86	C,NE,NO	179.04	C,NE	0.01				
G. Other		301.00	1.77	2.26	NA,NO	NO	NA,NO	NO	NO	NO	0.59	3.60	11.65	0.10

Table A8.3 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; **Year: 2004 (continued)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs [1]		PFCs [1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	143.63		0.28							NO	NO	60.46	NO
4. Agriculture		419.70	30.37							**NA,NO**	**NA,NO**	**0.16**	**NO**
A. Enteric Fermentation		302.29											
B. Manure Management		117.41	2.28									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils [4]		NE,NO	28.09									0.16	
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	[5] **2,355.65**	**NA,NE,NO**	**NA,NE,NO**							**IE,NE**	**IE,NE**		
A. Forest Land	[5] -2,448.05	NO	NE,NO							IE,NE	IE,NE		
B. Cropland	[5] -35.57	NA,NE	NA,NE							NE	NE		
C. Grassland	[5] 4,194.85	NE	NE							NE	NE		
D. Wetlands	[5] NE	NE	NE							NE	NE		
E. Settlements	[5] -151.54	NE	NE							NE	NE		
F. Other Land	[5] 716.98	NE	NE							NE	NE		
G. Other	[5] 78.98	NE	NE							NE	NE		
6. Waste	IE,NA,NO	324.66	1.42							**1.24**	**0.41**	**0.89**	**0.06**
A. Solid Waste Disposal on Land	[4] NA,NO	310.55								NA,NO	NA,NO	0.78	
B. Waste-water Handling		10.69	1.29							NO	NO	NO	
C. Waste Incineration	[4] IE	IE	IE							IE	IE	IE	IE
D. Other	NA	3.42	0.14							1.24	0.41	0.11	0.06
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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Memo Items: [8]													
International Bunkers	**57,349.22**	**1.58**	**0.45**							**NE**	**NE**	**NE**	**NE**
Aviation	10,503.13	0.50	0.09							NE	NE	NE	NE
Marine	46,846.10	1.08	0.36							NE	NE	NE	NE
Multilateral Operations	**IE**	**IE**	**IE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**7,606.13**												

A8.2 Recalculation tables for base years 1990 and 2003

For this submission (NIR 2006), The Netherlands uses the CRF reporter software. During the import of the 2005 submission data into the reporter software by the secretariat some errors were introduced. Although these are now corrected, they unfortunately show up as if they were re-calculations. For more information on recalculations, see Chapter 10 'Recalculations' and the sections in Chapter 3-8 on recalculations.

A8.3 CRF Trend Tables 10: greenhouse gas emissions and by source and sink categories.

Table A8.4 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: CO_2***

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	**151,157.72**	**156,124.46**	**154,754.08**	**159,384.45**	**158,594.98**	**162,451.50**	**170,292.13**	**163,191.35**	**165,443.18**	**159,941.13**
A. Fuel Combustion (Sectoral Approach)	149,980.32	154,986.26	153,680.94	158,363.60	157,527.96	161,493.33	169,257.43	162,192.21	164,641.11	159,276.57
1. Energy Industries	52,492.33	53,103.44	53,076.55	55,243.94	58,024.91	61,513.04	62,477.51	63,497.35	65,813.08	61,863.30
2. Manufacturing Industries and Construction	33,045.44	32,483.90	33,065.06	32,281.20	30,699.90	28,155.34	28,833.10	27,317.13	27,556.75	27,326.74
3. Transport	26,009.02	26,282.22	27,545.19	28,156.27	28,624.05	29,147.35	29,909.42	30,305.19	31,044.85	32,007.31
4. Other Sectors	37,867.81	42,578.16	39,441.04	42,143.83	39,693.23	42,165.50	47,529.17	40,587.39	39,706.50	37,429.71
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	1,138.20	1,073.14	1,020.85	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	708.18	641.65	575.12	508.51	441.29	384.13	494.60	309.87	218.94
2. Industrial Processes	**7,915.33**	**8,016.45**	**7,448.89**	**7,210.29**	**7,924.63**	**7,930.87**	**7,222.74**	**7,760.47**	**7,606.26**	**7,586.81**
A. Mineral Products	1,000.43	1,386.54	1,322.60	1,312.50	1,526.65	1,481.67	1,019.27	1,021.54	1,099.33	1,234.11
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	4,090.61	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	22.40	49.37	48.32	41.29	51.39
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	231.99	325.69	352.01	290.22	305.39	268.87	276.02	251.42	265.51	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)	**2,391.84**	**2,304.52**	**2,191.55**	**2,163.81**	**2,162.00**	**2,201.48**	**2,231.83**	**2,415.37**	**2,317.74**	**2,321.62**
A. Forest Land	-2,516.03	-2,566.96	-2,673.99	-2,695.22	-2,658.52	-2,621.45	-2,603.44	-2,419.34	-2,510.97	-2,487.47
B. Cropland	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57
C. Grassland	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54
F. Other Land	716.98	716.98	716.98	716.98	716.98	716.98	716.98	716.98	716.98	716.98
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**
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 emissions including net CO2 from LULUCF(3)	**161,781.33**	**166,684.05**	**164,609.83**	**168,966.12**	**168,895.97**	**172,826.13**	**179,940.68**	**173,541.49**	**175,556.31**	**170,046.42**
Total CO2 emissions excluding net CO2 from LULUCF(3)	**159,389.48**	**164,379.52**	**162,418.28**	**166,802.31**	**166,733.97**	**170,624.65**	**177,708.84**	**171,126.11**	**173,238.58**	**167,724.80**
Memo Items:										
International Bunkers	**38,897.84**	**40,180.27**	**41,266.58**	**43,136.84**	**41,528.32**	**43,011.75**	**44,262.79**	**47,159.68**	**48,414.10**	**50,031.32**
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	35,335.41	35,617.85	36,922.50	34,993.76	35,427.61	36,183.01	38,420.08	38,854.01	40,199.00
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	3,877.95	3,844.89	3,880.96	4,103.79	3,988.10	4,317.42	4,908.26	5,332.48	5,532.42	5,748.32

Table A8.4 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: CO_2*** *(continued)*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**162,054.56**	**168,173.35**	**168,009.67**	**171,532.66**	**173,852.91**	**15.01**
A. Fuel Combustion (Sectoral Approach)	161,365.81	167,591.14	167,401.61	170,922.38	173,218.59	15.49
1. Energy Industries	63,527.49	67,705.26	67,224.76	68,347.34	70,617.56	34.53
2. Manufacturing Industries and Construction	26,794.78	26,095.27	26,815.93	27,414.37	27,165.67	-17.79
3. Transport	32,366.87	32,880.53	33,582.41	34,259.27	34,823.86	33.89
4. Other Sectors	38,093.48	40,436.13	39,279.46	40,464.72	40,174.83	6.09
5. Other	583.19	473.96	499.05	436.67	436.67	-22.81
B. Fugitive Emissions from Fuels	688.75	582.21	608.05	610.28	634.32	-46.13
1. Solid Fuels	421.71	412.17	430.32	464.43	508.82	26.36
2. Oil and Natural Gas	267.04	170.04	177.73	145.85	125.50	-83.80
2. Industrial Processes	**7,352.82**	**6,831.71**	**6,740.18**	**6,855.60**	**6,947.66**	**-12.23**
A. Mineral Products	1,164.38	1,252.93	1,180.96	1,138.31	1,156.84	15.63
B. Chemical Industry	4,076.89	3,503.26	3,400.77	3,412.11	3,657.29	-1.20
C. Metal Production	1,764.79	1,736.94	1,820.90	1,968.35	1,791.37	-38.42
D. Other Production	48.98	42.82	31.79	46.09	41.17	-43.25
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	297.77	295.76	305.75	290.74	301.00	29.75
3. Solvent and Other Product Use	169.23	157.84	159.98	140.07	143.63	-54.61
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)	**2,416.68**	**2,388.47**	**2,382.49**	**2,373.67**	**2,355.65**	**-1.51**
A. Forest Land	-2,405.66	-2,416.26	-2,426.86	-2,437.45	-2,448.05	-2.70
B. Cropland	-35.57	-35.57	-35.57	-35.57	-35.57	0.00
C. Grassland	4,194.85	4,194.85	4,194.85	4,194.85	4,194.85	0.00
D. Wetlands	NE	NE	NE	NE	NE	0.00
E. Settlements	-151.54	-151.54	-151.54	-151.54	-151.54	0.00
F. Other Land	716.98	716.98	716.98	716.98	716.98	0.00
G. Other	97.62	80.01	84.62	86.41	78.98	-56.88
6. Waste	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**0.00**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
B. Waste-water Handling						
C. Waste Incineration	IE	IE	IE	IE	IE	0.00
D. Other	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Other non-specified	NA	NA	NA	NA	NA	0.00
Total CO2 emissions including net CO2 from LULUCF(3)	**171,993.29**	**177,551.36**	**177,292.31**	**180,902.00**	**183,299.86**	**13.30**
Total CO2 emissions excluding net CO2 from LULUCF(3)	**169,576.61**	**175,162.90**	**174,909.82**	**178,528.32**	**180,944.20**	**13.52**
Memo Items:						
International Bunkers	**52,473.98**	**56,561.83**	**56,445.68**	**53,261.69**	**57,349.22**	**47.44**
Aviation	9,749.35	9,538.72	9,981.87	9,817.17	10,503.13	131.32
Marine	42,724.63	47,023.11	46,463.81	43,444.52	46,846.10	36.35
Multilateral Operations	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass	6,189.29	6,522.08	7,104.56	6,761.18	7,606.13	96.14

Table A8.5 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: CH_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)
Total CH_4 emissions	**1,211.47**	**1,224.69**	**1,200.38**	**1,187.27**	**1,147.96**	**1,132.96**	**1,096.51**	**1,048.07**	**1,007.93**	**958.79**
1. Energy	111.84	112.80	111.05	111.71	110.62	111.18	108.45	80.94	80.43	72.53
A. Fuel Combustion (Sectoral Approach)	32.36	33.26	31.66	32.50	31.39	32.06	35.11	31.97	31.02	30.20
1. Energy Industries	3.40	3.79	3.69	4.06	3.96	4.29	4.92	5.24	5.27	5.22
2. Manufacturing Industries and Construction	2.70	2.58	2.60	2.50	2.47	2.33	2.41	2.32	2.33	2.30
3. Transport	7.51	6.58	6.42	6.09	5.80	5.63	5.25	4.96	4.74	4.53
4. Other Sectors	18.70	20.25	18.89	19.80	19.11	19.77	22.47	19.41	18.64	18.08
5. Other	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.07
B. Fugitive Emissions from Fuels	79.48	79.54	79.39	79.21	79.24	79.12	73.35	48.97	49.41	42.33
1. Solid Fuels	1.44	1.44	1.44	1.44	1.45	1.45	1.46	1.45	1.42	1.16
2. Oil and Natural Gas	78.04	78.10	77.95	77.77	77.79	77.67	71.88	47.52	47.99	41.16
2. Industrial Processes	**14.13**	**14.14**	**14.12**	**14.07**	**14.11**	**14.14**	**14.09**	**14.09**	**14.07**	**14.20**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.13	12.15	12.25
C. Metal Production	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
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	2.01	2.02	2.00	1.94	1.98	2.01	1.96	1.96	1.93	1.95
3. Solvent and Other Product Use										
4. Agriculture	**499.72**	**506.27**	**494.93**	**496.72**	**480.13**	**492.66**	**475.91**	**470.64**	**451.14**	**447.71**
A. Enteric Fermentation	358.35	363.95	355.51	357.66	346.74	347.92	333.19	328.35	319.27	318.27
B. Manure Management	141.37	142.32	139.42	139.06	133.39	144.74	142.72	142.29	131.87	129.44
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
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	NO	NO	NO	NO	NO	NO	NO	NO	NO	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	**585.78**	**591.48**	**580.28**	**564.77**	**543.10**	**514.98**	**498.06**	**482.40**	**462.28**	**424.35**
A. Solid Waste Disposal on Land	571.93	572.31	560.46	544.52	526.80	500.07	483.26	467.80	447.78	409.65
B. Waste-water Handling	13.79	18.39	18.33	18.30	13.40	11.48	11.31	11.03	10.97	11.23
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	0.06	0.77	1.48	1.95	2.90	3.43	3.49	3.57	3.53	3.47
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	1.06	1.11	1.15	1.18	1.16	1.24	1.27	1.33	1.39	1.43
Aviation	0.22	0.23	0.27	0.30	0.31	0.36	0.38	0.42	0.45	0.47
Marine	0.84	0.87	0.88	0.88	0.84	0.88	0.89	0.92	0.94	0.96
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

Table A8.5 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: CH_4*** *(continued)*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total CH_4 emissions	**916.69**	**899.25**	**856.77**	**835.56**	**824.00**	**-31.98**
1. Energy	69.96	70.07	67.68	66.90	64.76	-42.09
A. Fuel Combustion (Sectoral Approach)	30.67	31.31	30.70	30.08	30.14	-6.87
1. Energy Industries	5.26	5.61	5.93	5.71	6.23	83.19
2. Manufacturing Industries and Construction	2.28	2.19	2.24	2.23	2.22	-18.00
3. Transport	4.10	3.88	3.72	3.51	3.26	-56.63
4. Other Sectors	18.97	19.58	18.76	18.59	18.39	-1.63
5. Other	0.06	0.05	0.05	0.04	0.04	-19.10
B. Fugitive Emissions from Fuels	39.28	38.77	36.98	36.82	34.63	-56.43
1. Solid Fuels	1.06	1.11	1.06	1.08	1.10	-23.44
2. Oil and Natural Gas	38.22	37.66	35.92	35.74	33.53	-57.04
2. Industrial Processes	**14.32**	**14.24**	**14.69**	**15.04**	**14.87**	**5.21**
A. Mineral Products	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	12.42	12.39	12.89	13.20	13.10	8.06
C. Metal Production	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	1.90	1.85	1.81	1.85	1.77	-11.99
3. Solvent and Other Product Use						
4. Agriculture	**432.52**	**438.45**	**414.87**	**417.70**	**419.70**	**-16.01**
A. Enteric Fermentation	305.27	313.00	294.50	302.43	302.29	-15.64
B. Manure Management	127.25	125.45	120.37	115.27	117.41	-16.95
C. Rice Cultivation	NO	NO	NO	NO	NO	0.00
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	0.00
G. Other	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**	**0.00**
A. Forest Land	NO	NO	NO	NO	NO	0.00
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
C. Grassland	NE	NE	NE	NE	NE	0.00
D. Wetlands	NE	NE	NE	NE	NE	0.00
E. Settlements	NE	NE	NE	NE	NE	0.00
F. Other Land	NE	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	NE	0.00
6. Waste	**399.90**	**376.49**	**359.53**	**335.91**	**324.66**	**-44.58**
A. Solid Waste Disposal on Land	385.72	362.68	345.39	322.62	310.55	-45.70
B. Waste-water Handling	10.50	10.47	10.72	10.06	10.69	-22.47
C. Waste Incineration	IE	IE	IE	IE	IE	0.00
D. Other	3.67	3.34	3.42	3.23	3.42	5,947.27
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
	NA	NA	NA	NA	NA	0.00
Memo Items:						
International Bunkers	1.49	1.58	1.58	1.49	1.58	49.85
Aviation	0.46	0.45	0.47	0.47	0.50	131.32
Marine	1.02	1.12	1.10	1.02	1.08	28.92
Multilateral Operations	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass						

Table A8.6 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: N_2O***

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)
Total N_2O emissions	**68.45**	**69.79**	**72.13**	**74.44**	**71.78**	**72.24**	**71.47**	**70.72**	**69.90**	**67.55**
1. Energy	**1.57**	**1.68**	**1.84**	**2.00**	**2.13**	**2.26**	**2.30**	**2.29**	**2.32**	**2.29**
A. Fuel Combustion (Sectoral Approach)	1.57	1.68	1.84	2.00	2.13	2.26	2.30	2.29	2.32	2.29
1. Energy Industries	0.41	0.38	0.38	0.40	0.44	0.47	0.47	0.46	0.48	0.43
2. Manufacturing Industries and Construction	0.11	0.10	0.10	0.10	0.09	0.07	0.08	0.07	0.07	0.08
3. Transport	0.88	1.02	1.19	1.33	1.43	1.54	1.57	1.60	1.60	1.61
4. Other Sectors	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.14	0.13	0.13
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	**27.44**	**27.69**	**27.86**	**29.54**	**28.23**	**26.91**	**26.79**	**26.65**	**26.51**	**25.65**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	24.42	24.70	24.90	26.70	25.50	24.25	24.20	24.20	24.10	23.23
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	3.03	2.99	2.96	2.84	2.73	2.66	2.59	2.45	2.41	2.42
3. Solvent and Other Product Use	0.73	0.73	0.73	0.70	0.66	0.64	0.62	0.55	0.52	0.50
4. Agriculture	**37.05**	**37.97**	**39.99**	**40.51**	**39.04**	**40.80**	**40.15**	**39.64**	**38.93**	**37.56**
A. Enteric Fermentation										
B. Manure Management	2.24	2.37	2.50	2.52	2.39	2.49	2.45	2.43	2.62	2.66
C. Rice Cultivation										
D. Agricultural Soils	34.81	35.60	37.49	37.99	36.65	38.31	37.70	37.21	36.31	34.90
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	**1.66**	**1.72**	**1.71**	**1.69**	**1.73**	**1.63**	**1.60**	**1.59**	**1.62**	**1.56**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	1.66	1.69	1.65	1.61	1.61	1.49	1.46	1.44	1.48	1.42
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**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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
CO_2 Emissions from Biomass										

Table A8.6 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: N_2O*** *(continued)*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Total N_2O emissions	**64.09**	**60.79**	**57.97**	**56.05**	**57.25**	**-16.36**
1. Energy	**2.23**	**2.26**	**2.29**	**2.28**	**2.35**	**49.47**
A. Fuel Combustion (Sectoral Approach)	2.23	2.26	2.29	2.28	2.35	49.52
1. Energy Industries	0.47	0.51	0.53	0.53	0.55	32.87
2. Manufacturing Industries and Construction	0.07	0.07	0.07	0.07	0.07	-34.08
3. Transport	1.56	1.55	1.56	1.52	1.57	79.33
4. Other Sectors	0.10	0.11	0.10	0.13	0.13	-8.46
5. Other	0.03	0.03	0.03	0.03	0.03	-19.51
B. Fugitive Emissions from Fuels	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	0.00
2. Oil and Natural Gas	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	-100.00
2. Industrial Processes	**25.36**	**23.51**	**22.49**	**21.66**	**22.83**	**-16.83**
A. Mineral Products	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	23.03	21.23	20.23	19.40	20.57	-15.77
C. Metal Production	NO	NO	NO	NO	NO	0.00
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	2.34	2.29	2.26	2.26	2.26	-25.37
3. Solvent and Other Product Use	0.44	0.36	0.29	0.29	0.28	-61.02
4. Agriculture	**34.52**	**33.13**	**31.40**	**30.41**	**30.37**	**-18.03**
A. Enteric Fermentation						
B. Manure Management	2.51	2.46	2.51	2.06	2.28	1.79
C. Rice Cultivation						
D. Agricultural Soils	32.01	30.67	28.89	28.35	28.09	-19.30
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	0.00
G. Other	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**	**0.00**
A. Forest Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
C. Grassland	NE	NE	NE	NE	NE	0.00
D. Wetlands	NE	NE	NE	NE	NE	0.00
E. Settlements	NE	NE	NE	NE	NE	0.00
F. Other Land	NE	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	NE	0.00
6. Waste	**1.53**	**1.53**	**1.51**	**1.41**	**1.42**	**-14.14**
A. Solid Waste Disposal on Land						
B. Waste-water Handling	1.38	1.39	1.37	1.28	1.29	-22.29
C. Waste Incineration	IE	IE	IE	IE	IE	0.00
D. Other	0.15	0.13	0.14	0.13	0.14	5,950.99
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
	NA	NA	NA	NA	NA	0.00
Memo Items:						
International Bunkers	**0.42**	**0.45**	**0.45**	**0.42**	**0.45**	**47.52**
Aviation	0.08	0.08	0.08	0.08	0.09	131.32
Marine	0.33	0.37	0.36	0.34	0.36	35.65
Multilateral Operations	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass						

Table A8.7 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: HFCs, PFCs and SF_6***

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	Base year (1995) (Gg)	1996 (Gg)	1997 (Gg)	1998 (Gg)	1999 (Gg)
Emissions of HFCs[4] - (Gg CO_2 equivalent)	**4,432.03**	**3,451.56**	**4,447.33**	**4,998.04**	**6,480.37**	**6,019.54**	**7,677.81**	**8,300.14**	**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[5] - (Gg CO_2 equivalent)	NO	NO	NO	21.41	117.36	187.62	489.42	1,272.05	1,157.38	974.28
Emissions of PFCs[4] - (Gg CO_2 equivalent)	**2,264.48**	**2,244.88**	**2,042.86**	**2,068.47**	**1,989.67**	**1,937.82**	**2,155.33**	**2,343.91**	**1,829.23**	**1,470.53**
CF_4	0.28	0.28	0.25	0.25	0.24	0.24	0.26	0.28	0.21	0.15
C_2F_6	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NA,NO	NA,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed PFCs[5] - (Gg CO_2 equivalent)	18.26	21.00	24.15	27.77	31.94	37.03	51.10	101.26	113.87	147.10
Emissions of SF_6[4] - (Gg CO_2 equivalent)	**217.32**	**133.91**	**143.09**	**149.90**	**191.20**	**301.26**	**312.40**	**344.85**	**328.84**	**317.03**
SF_6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table A8.7 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: HFCs, PFCs and SF_6*** *(continued)*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[4] - (Gg CO_2 equivalent)	**3,823.57**	**1,469.35**	**1,541.42**	**1,318.75**	**1,476.65**	**-66.68**
HFC-23	0.21	0.04	0.06	0.04	0.03	-92.00
HFC-32	0.00	0.01	0.00	0.01	0.01	100.00
HFC-41	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	0.00
HFC-125	0.06	0.08	0.06	0.07	0.09	100.00
HFC-134	NO	NO	NO	NO	NO	0.00
HFC-134a	0.12	0.16	0.20	0.25	0.31	100.00
HFC-152a	0.02	0.01	0.00	0.00	0.01	100.00
HFC-143	NO	NO	NO	NO	NO	0.00
HFC-143a	0.08	0.05	0.05	0.06	0.07	100.00
HFC-227ea	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	0.00
Unspecified mix of listed HFCs[5] - (Gg CO_2 equivalent)	769.40	408.12	216.39	154.96	198.15	100.00
Emissions of PFCs[4] - (Gg CO_2 equivalent)	**1,580.60**	**1,488.61**	**2,185.52**	**619.53**	**284.68**	**-87.43**
CF_4	0.16	0.15	0.24	0.05	0.01	-95.13
C_2F_6	0.04	0.04	0.06	0.01	0.00	-95.98
C_3F_8	NO	NO	NO	NO	NO	0.00
C_4F_{10}	NO	NO	NO	NO	NO	0.00
c-C_4F_8	NO	NO	NO	NO	NO	0.00
C_5F_{12}	NO	NO	NO	NO	NO	0.00
C_6F_{14}	NO	NO	NO	NO	NO	0.00
Unspecified mix of listed PFCs[5] - (Gg CO_2 equivalent)	193.35	162.71	119.70	180.25	179.04	880.47
Emissions of SF6[4] - (Gg CO_2 equivalent)	**335.15**	**356.25**	**332.31**	**309.24**	**328.36**	**51.09**
SF_6	0.01	0.01	0.01	0.01	0.01	51.09

Table A8.8 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: All gases and by sector CO_2-eq***

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)
CO2 emissions including net CO_2 from LULUCF[3]	161,781.33	166,684.05	164,609.83	168,966.12	168,895.97	172,826.13	179,940.68	173,541.49	175,556.31	170,046.42
CO2 emissions excluding net CO_2 from LULUCF[3]	159,389.48	164,379.52	162,418.28	166,802.31	166,733.97	170,624.65	177,708.84	171,126.11	173,238.58	167,724.80
CH_4	25,440.86	25,718.48	25,207.90	24,932.58	24,107.19	23,792.11	23,026.69	22,009.57	21,166.47	20,134.58
N_2O	21,219.28	21,634.22	22,360.81	23,077.06	22,251.48	22,394.42	22,154.49	21,921.72	21,668.31	20,940.85
HFCs	4,432.03	3,451.56	4,447.33	4,998.04	6,480.37	6,019.54	7,677.81	8,300.14	9,341.37	4,859.17
PFCs	2,264.48	2,244.88	2,042.86	2,068.47	1,989.67	1,937.82	2,155.33	2,343.91	1,829.23	1,470.53
SF_6	217.32	133.91	143.09	149.90	191.20	301.26	312.40	344.85	328.84	317.03
Total (including net CO_2 from LULUCF)[3]	**215,355.30**	**219,867.10**	**218,811.82**	**224,192.17**	**223,915.87**	**227,271.27**	**235,267.39**	**228,461.69**	**229,890.53**	**217,768.58**
Total (excluding net CO_2 from LULUCF)[3], [6]	**212,963.45**	**217,562.58**	**216,620.27**	**222,028.37**	**221,753.87**	**225,069.79**	**233,035.56**	**226,046.31**	**227,572.79**	**215,446.96**

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	153,993.57	159,015.24	157,657.66	162,350.75	161,577.16	165,487.01	173,282.43	165,601.54	167,852.28	162,172.85
2. Industrial Processes	23,633.70	22,726.54	23,014.26	23,879.66	25,632.76	24,829.39	25,969.81	27,305.42	27,617.91	22,484.53
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	21,979.62	22,402.37	22,790.43	22,989.22	22,185.13	22,993.86	22,440.61	22,171.84	21,542.24	21,045.51
5. Land Use, Land-Use Change and Forestry[7]	2,391.84	2,304.52	2,191.55	2,163.81	2,162.00	2,201.48	2,231.83	2,415.37	2,317.74	2,321.62
6. Waste	12,815.39	12,953.78	12,715.28	12,384.63	11,940.02	11,319.67	10,955.61	10,622.36	10,209.92	9,393.59
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[7]	**215,355.30**	**219,867.10**	**218,811.82**	**224,192.17**	**223,915.87**	**227,271.27**	**235,267.39**	**228,461.69**	**229,890.53**	**217,768.58**

Table A8.8 Emissions of greenhouse gases in the Netherlands; ***CRF Trend Table 10: All gases and by sector CO_2-eq*** *(continued)*

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	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)	(%)
CO2 emissions including net CO_2 from LULUCF[3]	171,993.29	177,551.36	177,292.31	180,902.00	183,299.86	13.30
CO2 emissions excluding net CO_2 from LULUCF[3]	169,576.61	175,162.90	174,909.82	178,528.32	180,944.20	13.52
CH_4	19,250.51	18,884.20	17,992.15	17,546.68	17,303.90	-31.98
N_2O	19,866.88	18,844.34	17,970.40	17,374.37	17,747.87	-16.36
HFCs	3,823.57	1,469.35	1,541.42	1,318.75	1,476.65	-66.68
PFCs	1,580.60	1,488.61	2,185.52	619.53	284.68	-87.43
SF_6	335.15	356.25	332.31	309.24	328.36	51.09
Total (including net CO_2 from LULUCF)[3]	**216,850.00**	**218,594.11**	**217,314.11**	**218,070.56**	**220,441.31**	**2.36**
Total (excluding net CO_2 from LULUCF)[3, 6]	**214,433.32**	**216,205.64**	**214,931.62**	**215,696.89**	**218,085.66**	**2.41**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	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)	(%)
1. Energy	164,215.72	170,345.14	170,139.97	173,643.25	175,941.26	14.25
2. Industrial Processes	21,255.75	17,734.10	18,079.94	16,133.27	16,425.55	-30.50
3. Solvent and Other Product Use	306.89	268.54	248.57	230.25	231.23	-57.27
4. Agriculture	19,784.12	19,477.75	18,446.27	18,198.80	18,228.40	-17.07
5. Land Use, Land-Use Change and Forestry[7]	2,416.68	2,388.47	2,382.49	2,373.67	2,355.65	-1.51
6. Waste	8,870.84	8,380.12	8,016.86	7,491.32	7,259.22	-43.36
7. Other	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)[7]	**216,850.00**	**218,594.11**	**217,314.11**	**218,070.56**	**220,441.31**	**2.36**

A8.4 Trend tables for the precursor gases and SO_2

Table A8.9 Emissions of precursor gases in the Netherlands; ***All gases and by sector (Gg)***

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
National Total															
NOx	559.3	460.9	447.1	429.3	412.4	470.2	456.6	417.2	405.6	411.1	396.4	385.2	377.5	375.5	354.8
CO	1137.3	1026.3	981.9	925.3	896.4	862.0	850.8	772.4	759.4	738.7	715.6	680.1	647.5	626.8	617.2
NMVOC	465.8	412.1	388.8	361.2	339.9	332.7	293.3	263.6	262.6	248.7	234.6	212.6	202.0	187.0	180.0
SO2	190.1	140.5	133.5	126.0	118.5	128.1	121.3	102.0	93.7	87.8	71.6	73.4	66.7	62.8	63.6
1. Energy															
NOx	543.4	446.4	434.1	417.6	402.2	461.4	454.2	414.8	400.6	409.5	391.9	380.9	373.9	375.0	352.5
CO	1006.1	911.7	879.4	835.1	818.1	795.0	813.9	732.8	646.8	700.4	609.6	577.4	577.6	583.2	555.6
NMVOC	247.0	205.7	194.9	179.6	170.8	175.9	163.7	145.2	134.9	126.8	121.0	110.3	102.5	97.4	91.0
SO2	178.9	130.9	125.4	119.6	113.6	124.8	117.9	99.0	91.2	85.9	69.7	71.1	64.1	61.9	62.5
2. Industial processes															
NOx	12.0	10.9	9.8	8.6	7.5	6.4	2.3	2.4	5.0	0.8	4.5	3.9	3.1	0.5	1.1
CO	129.3	113.0	101.1	89.2	77.6	66.5	36.9	39.6	112.6	38.0	105.9	102.5	69.6	43.5	61.2
NMVOC	87.0	80.4	73.7	67.1	60.5	53.9	48.9	45.6	46.7	39.3	40.2	33.2	32.2	28.0	27.4
SO2	7.1	6.3	5.5	4.7	3.8	3.0	3.4	3.1	2.5	1.9	1.9	2.2	2.5	0.8	1.0
3. Solvents and Other product use															
NOx	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NMVOC	130.0	124.2	118.4	112.6	106.8	101.0	78.8	71.1	79.3	81.4	72.2	67.9	66.2	60.6	60.5
SO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Agriculture															
NOx	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	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	0.2	0.2	0.2	0.2	0.2
SO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste															
NOx	3.9	3.6	3.3	3.0	2.7	2.4	0.1	0.0	0.1	0.9	0.0	0.4	0.5	0.0	1.2
CO	1.9	1.6	1.3	1.0	0.7	0.4	0.0	0.0	0.0	0.3	0.0	0.1	0.3	0.0	0.4
NMVOC	1.6	1.6	1.7	1.7	1.8	1.8	1.8	1.5	1.5	1.1	1.0	1.0	1.0	0.9	0.9
SO2	4.2	3.4	2.6	1.8	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

ANNEX 9. Chemical compounds, Units, Global Warming Potentials, Other conversion factors and Internet links

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
NO_x	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: Second Assessment Report (SAR), 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:

$C \rightarrow CO_2$:	x 44/12 = 3.67
$C \rightarrow CH_4$:	x 16/12 = 1.33
$C \rightarrow CO$:	x 28/12 = 2.33
$N \rightarrow N_2O$:	x 44/28 = 1.57
$N \rightarrow NO$:	x 30/14 = 2.14
$N \rightarrow NO_2$:	x 46/14 = 3.29
$N \rightarrow NH_3$:	x 17/14 = 1.21
$N \rightarrow HNO_3$:	x 63/14 = 4.50
$S \rightarrow SO_2$:	x 64/32 = 2.00

From full molecular mass to element basis:

$CO_2 \rightarrow C$:	x 12/44 = 0.27
$CH_4 \rightarrow C$:	x 12/16 = 0.75
$CO \rightarrow C$:	x 12/28 = 0.43
$N_2O \rightarrow N$:	x 28/44 = 0.64
$NO \rightarrow N$:	x 14/30 = 0.47
$NO_2 \rightarrow N$:	x 14/46 = 0.30
$NH_3 \rightarrow N$:	x 14/17 = 0.82
$HNO_3 \rightarrow N$:	x 14/63 = 0.22
$SO_2 \rightarrow S$:	x 32/64 = 0.50

ANNEX 10. List of abbreviations

AD	Activity Data
AOO	Waste Co-ordination Platform (in Dutch: *Afval Overleg Orgaan*, AOO)
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
CCDM	Co-ordination Committee for Monitoring of Target Groups
CDM	Clean Development Mechanism (one of three so-called mechanisms of the Kyoto Protocol)
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 a NIR)
CRT	Continuous Regeneration Trap
DLO	Legal name of Wageningen University and Research Centre (Wageningen UR)
dm	dry matter
DOC	Degradable Organic Carbon
EC-LNV	National Reference Centre for Agriculture
ECE	Economic Commission for Europe (UN)
EEA	European Environment Agency
EF	Emission Factor
EGR	Exhaust Gas Recirculation
EIT	Economies-In-Transition (country group comprising the former SU and Eastern Europe)
EMEP	European programme for Monitoring and Evaluation of long-range transmission of air Pollutants
ENINA	Task Group Energy, Industry and Waste Handling
EPA	US Environmental Protection Agency
ER	Emission Registration
ER-I	Emission Registration-Individual firms
ET	Emissions Trading
ETC/ACC	European Topic Centre on Air and Climate Change
EU	European Union
EZ	Ministry of Economic Affairs
FAO	Food and Agricultural Organisation (UN)
F-gases	Group of fluorinated compounds comprising HFCs, PFCs and SF_6
FOI	Facilitating Organisation for Industry
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)
IEF	Implied Emission Factor
IPCC	Intergovernmental Panel on Climate Change

KNMI	Royal Netherlands Meteorological Institute
LEI	Agricultural Economics Institute
LHV	Lower Heating Value
LNV	Ministry of Agriculture, Nature Conservation and Fishery
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 Office of RIVM (in Dutch: *Milieu- en Natuur Planbureau*)
MSW	Municipal Solid Waste
MW	Mega Watt
NA	Not Available; Not Applicable (notation key in CRF); also: National Approach
NAM	Nederlandse Aardolie Maatschappij
ND	No Data
NE	Not Estimated (notation key in CRF)
NEAT	Non-Energy CO_2 emissions Accounting Tables (model of NEU-CO_2 Group)
NEH	Netherlands Energy Statistics
NIR	National Inventory Report (annual greenhouse gas inventory report to the UNFCCC)
NLR	National Aerospace Laboratory
NOGEPA	Netherlands Oil and Gas Exploration and Production Association
ODU	Oxidised During Use (of direct non-energy use of fuels or of petrochemical product)
OECD	Organisation for Economic Cooperation and Development
OF	Oxygen Furnace (gas)
PER	Pollutant Emission Register
RA	Reference Approach (vs. Sectoral or National Approach)
QA	Quality Assurance
QC	Quality Control
RIVM	National Institute for Public Health and the Environment
RIZA	National Institute of Water Management and Waste Treatment
ROB	Reduction Programme non-CO_2 Greenhouse Gases
SA	Sectoral Approach; also: National Approach (vs. Reference Approach)
SCR	Selective Catalytic Reduction
SBSTA	Subsidiary Body for Scientific and Technological Advice (of Parties to the UNFCCC)
SW	Streefwaarde (Dutch for 'target value')
SWDS	Solid Waste Disposal Site
TNO	Netherlands Organisation for Applied Scientific Research
TBFRA	Temperate and Boreal Forest Resources Assessment (ECE-FAO)
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nation's Framework Convention on Climate Change
VROM	Ministry of Housing, Spatial Planning and the Environment
V&W	Ministry of Transport, Public Works and Water Management
WEB	Working Group Emission Monitoring of Greenhouse Gases
WEM	Working Group Emission Monitoring
WUR	Wageningen University and Research Centre (or: Wageningen UR)
WWTP	Waste Water Treatment Plant