Greenhouse Gas Emissions in the Netherlands 1990-2006

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National Inventory Report 2008

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MNP report 500080009

This investigation has been performed by order and for the account of the Directorate-General for Environmental Protection, Climate Change and Industry Division, of the Netherlands Ministry of Spatial Planning, Housing and the Environment, within the framework of project 500080, 'Netherlands Pollutant Emission Register'.

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Report prepared for submission in accordance with the Kyoto Protocol and the UN Framework Convention on Climate Change (UNFCCC) , as well as the European Union's Greenhouse Gas Monitoring Mechanism [Including electronic Excel spreadsheet files containing the Common Reporting Format (CRF) data for 1990 to 2006]

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Acknowledgements

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 Release & Transfer Register (PRTR), also called the Emission Registration (ER) system, which contains emissions data on about 350 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 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), Mrs Marian van Schijndel and Ms Sietske van der Sluis (agriculture). In addition, Mr Bas Guis of CBS has provided pivotal information on CO_2 related to energy use. This group has also provided activity data and additional information for the CRF files in cases where these were not included in the data sheets submitted by the ER Task Forces. We are particularly grateful to Mr Jan Jonker, Mr Jack Pesik, Mr Dirk Wever and Mr Jeroen Peters, for their contribution to data processing and quality control.

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

Rapport in het kort

Broeikasgasemissies in Nederland 1990-2006

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 2007 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 1990-2006;
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van het IPCC-rapport over Good Practice guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- een overzicht van het kwaliteitssysteem en de validatie van de emissiecijfers voor de Nederlandse Emissieregistratie.

Geconcludeerd wordt dat de emissies van de zes broeikasgassen, uitgedrukt in CO_2-equivalenten, in 2006 in totaal met bijna 3% gedaald zijn ten opzichte van het basisjaar [1990 voor CO_2, CH_4, N_2O en 1995 voor HFK's, PFK's en SF_6 (F-gassen); exclusief de bos- en landgebruik (LULUCF)]. Emissie van CO_2 exclusief LULUCF is in de periode 1990-2006 met 8% gestegen, terwijl de emissies van CH_4 en N_2O met respectievelijk 36% en 15% zijn gedaald over dezelfde periode. De emissies van F-gassen zijn in de periode 1995-2006 met gemiddeld 74% afgenomen. De emissies van HFK's en PFK's daalden in die periode met respectievelijk 73% en 84%. De SF_6 emissies daalden met 29%.

Ten opzichte van 2005 zijn de totale broeikasgasemissies gedaald met ca. 2%, voornamelijk als gevolg van lagere emissies in de energiesector (meer import van elektriciteit) en de doorgaande daling van CH_4 emissie in de sector afvalverwerking.

Trefwoorden: broeikasgassen, emissies, trends, methodiek, klimaat

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Samenvatting

Inleiding

Het National Inventory Report (NIR) 2008 bevat de rapportage van broeikasgasemissies (CO_2, N_2O, CH_4 en de F-gassen) over de periode 1990 tot en met 2006.

De emissiecijfers in de NIR 2008 zijn berekend volgens de protocollen behorend bij het 'National System' dat is voorgeschreven in het Kyoto Protocol. In de protocollen zijn de methoden vastgelegd voor zowel het basisjaar (1990 voor CO_2, CH_4 en N_2O en 1995 voor de F-gassen) als voor de emissies in de periode tot en met 2012. De protocollen staan op de website www.broeikasgassen.nl.

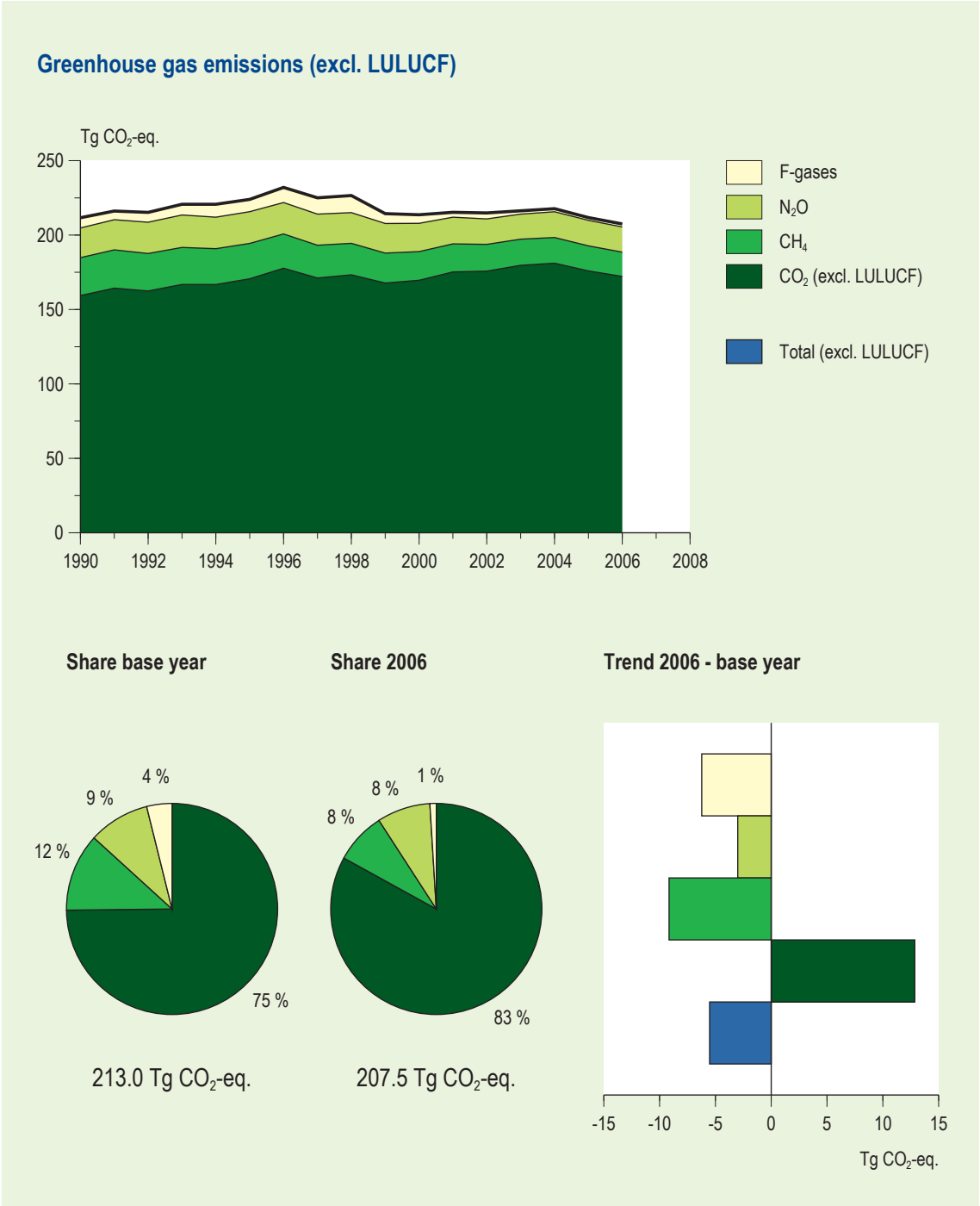
National Inventory Report (NIR)

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 2008 van het Klimaatverdrag van de Verenigde Naties (UNFCCC) het Kyotoprotocol en het Bewakingsmechanisme Broeikasgassen van de Europese Unie. Dit rapport bevat de volgende informatie:

- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2006
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van het IPCC-rapport over Good Practice guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- een overzicht van het kwaliteitssysteem en de validatie van de emissiecijfers voor de Nederlandse Emissieregistratie;
- de wijzigingen die in de methoden voor het berekenen van broeikasgasemissies zijn aangebracht na de review van het Nationaal Systeem broeikasgassen vanuit het Klimaatverdrag. Op basis van de methoden die in de NIR en de Nederlands protocollen broeikasgassen zijn vastgelegd is de basisjaaremissie bepaald, alsmede de hoeveelheid broeikasgassen die Nederland tussen 2008 en 2012 (volgens het Kyotoprotocol) mag uitstoten.

Een aparte annex bij dit rapport bevat 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 bijlagen bij dit rapport zijn de samenvattende emissie - en trendtabellen '7A' en 10 op basis van het CRF opgenomen voor 1990-2006. Daarnaast bevatten de bijlagen ondermeer een overzicht van sleutelbronnen en onzekerheden.

De NIR gaat niet specifiek in op de invloed van het gevoerde overheidsbeleid met betrekking tot emissies van broeikasgassen; meer informatie hierover is te vinden in de jaarlijkse Milieubalans en de vierde Nationale Communicatie onder het Klimaatverdrag, die begin 2006 is verschenen.



Figuur ES.1 Broeikasgassen: emissieniveaus, bijdragen per gas en emissietrends, 1990-2006

Ontwikkeling van de broeikasgasemissies

De emissieontwikkeling in Nederland wordt beschreven en toegelicht in dit National Inventory Report (NIR 2008). Figuur ES.1 geeft het emissieverloop over de periode 1990-2006 weer. De totale emissies bedroegen in 2006 circa 207,5 Tg (Mton ofwel miljard kg) CO_2-equivalenten en waren daarmee bijna drie procent lager (Box ES.1) dan de emissies in het basisjaar (213,0 Tg CO_2-eq.). De hier gepresenteerde emissies zijn exclusief de emissies van landgebruik en bossen (LULUCF); deze emissies tellen pas mee vanaf het emissiejaar 2008 (waarover wordt gerapporteerd in 2010) onder

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 broeikasgasemissies op circa 5%. Dit is geschat op basis van informatie van emissie-experts in een eenvoudige analyse van de onzekerheid (volgens IPCC Tier 1). De totale uitstoot van broeikasgassen ligt daarmee met 95% betrouwbaarheid tussen de 197 en 218 Tg (Mton). De onzekerheid in de emissietrend tussen het basisjaar (1990/1995) en 2006 is geschat op circa 3%-punt; dat wil zeggen dat de emissietrend met 95% betrouwbaarheid ligt tussen de -6 tot +0%.

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

het Kyoto Protocol. De emissie van CO_2 is sinds 1990 met circa 8% toegenomen, terwijl de emissies van de andere broeikasgassen met circa 35% zijn afgenomen ten opzichte van het basisjaar.

De daling in 2006 is vooral toe te schrijven aan de vermindering van de CO_2-emissie. In 2006 bedroeg de CO_2-emissie 172 miljard kg. Dit is veel minder dan in 2004 en 2005, toen de uitstoot respectievelijk 181 en 176 miljard kg bedroeg. Maar ook de uitstoot van de overige broeikasgassen zoals methaan, lachgas en de fluorgassen, nam verder af. De belangrijkste daling van de uitstoot van koolstofdioxide deed zich voor bij de productie van elektriciteit. Hoewel er meer elektriciteit werd verbruikt, nam de productie van elektriciteit in Nederland zowel in 2005 als in 2006 af. Daardoor verminderde vanaf 2004 de CO_2-emissie met bijna 7,4 miljard kg. Om aan de vraag naar elektriciteit te kunnen voldoen, werd in 2006 18 procent van de verbruikte elektriciteit uit het buitenland geïmporteerd.

Daarnaast daalde de CO_2-uitstoot doordat het aandeel duurzame energie in het Nederlandse energieverbruik toenam tot 2,7 procent in 2006. Verder droegen ook de relatief zachte winters in 2005 en 2006 bij aan de lagere uitstoot: hierdoor hoefde er minder aardgas te worden gebruikt voor de verwarming van huizen en werkplekken.

Of er sprake is van een trendbreuk, is op basis van deze waarnemingen niet te zeggen.

Methoden

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

Belangrijkste methodische wijzigingen ten opzichte van de NIR 2007

Naar aanleiding van de review van het nationaal systeem broeikasgassen is een aantal berekeningsmethoden aangepast. Het betreft de volgende wijzigingen:

1. N_2O Public Electricity and Heat Production (cat. 1A1).
   In overleg tussen deskundigen is de emissiefactor (EF) aangepast. Dit leidt tot een herberekening van de gehele reeks, met een toename van de N_2O emissies in het basisjaar met 11,48 Gg CO_2-eq;
2. glas productie (cat. 2A7.1)
   Betere (bedrijfs)meetgegevens – er is drie jaar gemeten – hebben geleid tot een bijstelling van de EF. Dit leidt tot een bijstelling van de gehele reeks. Voor de basisjaaremissies betreft het een daling van 33,65 Gg CO_2-eq.;
3. caprolactam emissie (cat. 2B5)
   Op basis van betere inzichten in de productie en meetgegevens over 2003 en 2004 is de gehele tijdreeks vanaf 1990 gereconstrueerd. De basisjaaremissies dalen hierdoor met 473,57 Gg CO_2-eq.;
4. indirecte N_2O emissies (cat. 2G)
   Deze bron wordt als gevolg van de review niet langer meegenomen. De basisjaaremissie wordt hierdoor naar beneden bijgesteld met omgerekend 935,04 Gg CO_2.eq.;
5. landbouw, N_2O (cat. 4A en 4D).
   Voor de categorie 'Manure Management' is de methode beter in overeenstemming gebracht met de IPCC Good Practice guidance. Voorheen werd de NH3 emissie in de berekening verdisconteerd. Ook zijn de indirecte N_2O emissies van landbouwbodems herberekend. Effect op de basisjaaremissies is een stijging van respectievelijk 118,32 en 2,98 Gg CO_2-eq;
6. sinks
   Een wijziging in de methodiek (validatie van landgebruikverandering bos) en het herstellen van een vergissing in een correctiefactor leiden tot een herberekening (stijging) van sinks emissies in 1990 (categorie 5 van het CRF) met 275,45 Gg CO_2-eq. (Hiervan is 39 Gg CO_2 eq. opgenomen in de berekening van de basisjaaremissies onder het Kyoto Protocol).

Overige wijzigingen naar aanleiding van de review van het 'Nationaal Systeem'

Nederland gaat in de voorliggende NIR 2008 als volgt om met de bevindingen/aanbevelingen van het review team dat het nationaal systeem broeikasgassen in 2007 reviewde:

1. Hoofdstuk 1 bevat een overzicht van de bevindingen van kwaliteitscontroles op het CRF tijdens de zogenoemde 'trendanalyse';
2. Inhoudelijke aanbevelingen, gericht op het vergroten van de transparantie van de NIR, worden overgenomen. Dit betreft bijvoorbeeld het gebruik van biobrandstoffen, diverse industriële procesemissies en de afwijkende aanpak van Nederland voor het berekenen van methaanemissies uit de landbouwsector;
3. Nederland gaat in deze NIR slechts beperkt in op de adjustment die door het reviewteam is toegepast op de berekening van de LULUCF emissies voor het basisjaar 1990. Waar nodig zullen de methoden voor het berekenen van de LULUCF categorie in 2008 / 2009 worden aangepast;
4. Een aanbeveling van het reviewteam om delen van de protocollen op te nemen in de NIR wordt in deze NIR 2008 ook niet opgevolgd. De komende tijd zal worden bezien welke informatie in de protocollen; en welke informatie in de NIR wordt opgenomen.
5. Een aanbeveling van het reviewteam om niet alleen de emissiedata, maar ook de hieraan ten grondslag liggende berekeningen centraal te borgen, is (nog) niet opgevolgd.

Executive Summary

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

This report represents the 2008 Netherlands' annual inventory submission under the Kyoto Protocol and the United Nations Framework Convention on Climate Change (UNFCCC), as well as the European Union's Greenhouse Gas Monitoring Mechanism. It has been prepared following the relevant 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) 2008 therefore provides explanations of the trends in greenhouse gas emissions, activity data and (implied) emission factors for the period 1990-2006. It also summarises descriptions of methods and data sources of Tier 1 assessments of the uncertainty in annual emissions and in emission trends; it presents an assessment of key sources following the Tier 1 and Tier 2 approaches of the IPCC Good Practice Guidance; and describes Quality Assurance and Quality Control activities. This report provides no specific information on the effectiveness of government policies for reducing greenhouse gas emissions. This information can be found in the annual Environmental Balance (in Dutch: 'Milieubalans') prepared by the Netherlands' Environmental Assessment Agency (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 2008** is prepared as a commitment under the UNFCCC, it is also an important report in the context of the Kyoto Protocol. Because the Protocol has entered into force, ratifying Parties will have to start fulfilling commitments under the Protocol. One of the commitments is the development of a National System for greenhouse gas emissions (art. 5.1 of the Protocol). This National System shall comply with the IPCC guidelines as mentioned earlier. This NIR 2008 is based upon the methodologies included in the National System of the Netherlands under article 5.1 of the Protocol, as developed in the period 2000-2005 and reviewed by an Expert Review Team of the UNFCCC in April 2008.

Key categories

For identification of so-called 'key categories' according to the IPCC Good Practice approach the national emissions are allocated according to the IPCC potential key category list wherever possible. The IPCC Tier 1 method consists of ranking this list of source category-gas combinations, for the contribution to both the national total annual emissions and the national total trend. The results of these listings are presented in Annex 1: the largest sources, the total of which ads up to 95% of the national total are 32 sources for annual level assessment and 31 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, the IPCC Tier 2 method for identification of key sources is used, which requires the incorporation of the uncertainty to each of these sources before ordering the list of shares. The result is a list of 41 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, four key categories are found in the LULUCF sector (sector 5), after inclusion of 9 LULUCF subcategories in the key category analysis.

Institutional arrangements for inventory preparation

The greenhouse gas inventory of the Netherlands is based on the national Pollutant Release & Transfer Register (PRTR). The general process of inventory preparation exists many years and is organised as a project with an annual cycle. In 2000, an improvement programme was initiated (under the lead of SenterNovem) to transform the general process of the greenhouse gas inventory of the PRTR into a National System, according to the requirements under article 5.1 of the Kyoto Protocol.

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

Monitoring protocols

As part of the improvement programme, the methodologies for calculating greenhouse gas emission in the Netherlands were reassessed and compared with UNFCCC and IPCC requirements. For the key sources and for sinks, the methodologies and processes are elaborated, re-assessed and revised where needed. The final revision took place after review of the National System (includ-

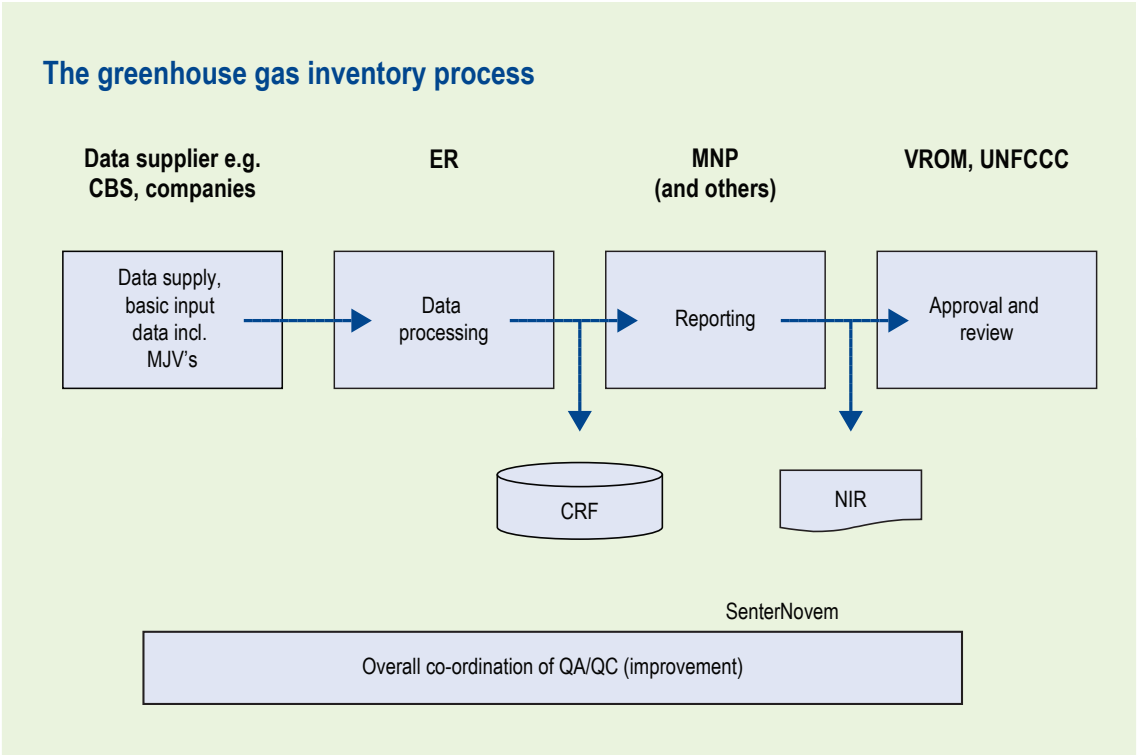


Figure ES.2 Main elements in the greenhouse gas inventory compilation process

ing the protocols). The present CRF/NIR is based on methodologies approved during/after the review of the National System and the calculation of the Assigned Amount of the Netherlands. Monitoring protocols describing methodologies, data sources and the rationale for their selection are available at www.greenhousegases.nl.

Organisation of the report

This report is in line with the prescribed format for the NIR, starting with an introductory Chapter 1, containing background information on the Netherlands' process of inventory preparation and reporting; key categories and their uncertainties; a description of methods, data sources and emission factors, and a description of the quality assurance system, along with verification activities applied to the data. Chapter 2 provides a summary of trends for aggregated greenhouse gas emissions by gas and by main source. Chapters 3 to 9 present detailed explanations for the emissions in different sectors. Chapter 10 presents information on recalculations, improvements and response to issues raised in external reviews on the NIR 2006 and 2007 (including the initial review) and on the draft version of the NIR 2008. In addition, the report provides more detailed information on key categories, methodologies, other relevant reports and summary emission tables selected from the CRF files (IPCC Tables 7A and 10) in 10 Annexes.

ES.2 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 2006, total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands are estimated at 207.5 Tg CO_2-equivalents (CO_2-eq.). This is almost three percent below the emissions in the base year (213.0 Tg CO_2-eq.). In the Netherlands the base year emissions are 1990 for CO_2, CH_4 and N_2O and 1995 for fluorinated gases. CO_2 emissions (excluding LULUCF) increased by about 8% from 1990 to 2006, mainly due to the increase in the emissions in the 1A1a Public electricity sector (+26%) and 1A3 Transport sector (+37%). CH_4 emissions decreased by 37% in 2006 compared to the 1990 level, mainly due to decrease in the waste sector (-54%), the agricultural sector (-17%) and fugitive emissions in the energy sector (-58%). N_2O emissions decreased by about 15% in 2006 compared to 1990, mainly due to the decrease in the emissions from agriculture (-18%) and from industrial processes (-19%), 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 2006 by about 75% and 87%, respectively, while SF_6 emissions increased by 4%. Total emissions of all F-gases decreased by about 75% compared to the 1995 level (chosen as the base year).

Between 2005 and 2006, total greenhouse gas emissions dropped by about 2% (-4.3 Tg CO_2-eq.). CO_2 emissions dropped by 3.7 Tg mainly due to the increased import of electricity. Furthermore, CH_4 emissions from solid waste disposal on land (landfills) showed an ongoing decrease (-0.4 Tg CO_2-eq.).

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

Tables ES.1 and ES.2 provide an overview of the emission trends (in CO_2-equivalents) per gas and per IPCC source category. The Energy sector (category 1) is by far the largest contributor to national total greenhouse gas emissions. The emissions of this sector increased substantially compared to 1990. In contrast, emissions of the other sectors decreased compared to the base year, the largest being those of Industrial Processes, Waste and Agriculture.

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

	CO_2 incl. LULUCF	CO_2 excl. LULUCF	CH_4	N_2O	HFCs	PFCs	SF_6	Total (incl LULUCF)	Total (excl LULUCF) 1)
Base yr	162.0	159.4	25.4	19.9	6.0	1.9	0.3	215.7	213.0
1990	162.0	159.4	25.4	19.9	4.4	2.3	0.2	214.3	211.7
1991	166.9	164.4	25.7	20.3	3.5	2.2	0.1	218.7	216.2
1992	164.9	162.4	25.2	21.0	4.4	2.0	0.1	217.7	215.2
1993	169.2	166.8	24.9	21.8	5.0	2.1	0.1	223.1	220.7
1994	169.2	166.8	24.1	21.2	6.5	2.0	0.2	223.1	220.7
1995	173.1	170.6	23.8	21.3	6.0	1.9	0.3	226.4	224.0
1996	180.2	177.7	23.0	21.1	7.7	2.2	0.3	234.5	232.0
1997	173.8	171.2	22.0	20.9	8.3	2.3	0.3	227.7	225.0
1998	175.9	173.3	21.1	20.7	9.3	1.8	0.3	229.2	226.6
1999	170.4	167.8	20.1	19.9	4.9	1.5	0.3	217.0	214.4
2000	172.3	169.6	19.2	19.0	3.8	1.6	0.3	216.3	213.6
2001	177.9	175.2	18.8	17.9	1.5	1.5	0.3	217.9	215.3
2002	178.4	175.8	18.0	17.1	1.5	2.2	0.3	217.5	214.9
2003	182.3	179.7	17.5	16.8	1.4	0.6	0.2	218.9	216.3
2004	183.7	181.1	17.3	17.3	1.5	0.3	0.3	220.3	217.7
2005	178.5	175.9	17.3	17.1	1.4	0.3	0.2	214.3	211.8
2006	174.8	172.2	16.3	16.9	1.6	0.3	0.2	210.1	207.5

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

	1. Energy	2. Ind. Proc.	3. Solvents	4. Agriculture	5. LULUCF	6. Waste	7. Other	Total (in. LULUCF)	Total (ex. LULUCF)
Base yr	154.0	22.2	0.5	22.1	2.7	12.8	NA	215.7	213.0
1990	154.0	22.2	0.5	22.1	2.7	12.8	NA	214.3	211.7
1991	159.0	21.2	0.5	22.5	2.6	13.0	NA	218.7	216.2
1992	157.7	21.5	0.4	22.9	2.5	12.7	NA	217.7	215.2
1993	162.4	22.4	0.4	23.1	2.4	12.4	NA	223.1	220.7
1994	161.6	24.3	0.4	22.3	2.4	11.9	NA	223.1	220.7
1995	165.5	23.6	0.4	23.1	2.5	11.3	NA	226.4	224.0
1996	173.3	24.8	0.4	22.6	2.5	11.0	NA	234.5	232.0
1997	165.6	26.1	0.3	22.3	2.7	10.6	NA	227.7	225.0
1998	167.9	26.5	0.4	21.7	2.6	10.2	NA	229.2	226.6
1999	162.2	21.2	0.4	21.2	2.6	9.4	NA	217.0	214.4
2000	164.3	20.2	0.3	19.9	2.7	8.9	NA	216.3	213.6
2001	170.4	16.7	0.3	19.6	2.6	8.4	NA	217.9	215.3
2002	171.0	17.0	0.2	18.6	2.6	8.0	NA	217.5	214.9
2003	174.8	15.5	0.2	18.3	2.6	7.5	NA	218.9	216.3
2004	176.1	15.9	0.2	18.3	2.6	7.2	NA	220.3	217.7
2005	171.0	15.5	0.2	18.3	2.6	6.8	NA	214.3	211.8
2006	167.1	15.7	0.2	18.2	2.6	6.3	NA	210.1	207.5

Sectors showing the largest growth in CO_2-equivalent emissions since 1990 are Transport (1A3) and Energy industries (1A1) (+37% and +18%, respectively). Note that half of the marked increase in the Public electricity sector of almost 30% between 1990 and 1998 is caused by a shift of cogeneration plants from Manufacturing industries to the Public electricity and heat production sector due to a change of ownership (joint-ventures), simultaneously causing a 15% decrease in industry emissions in the early 1990's (1A2).

ES.4 Other information

General uncertainty evaluation

The results of the uncertainty estimation according to the IPCC Tier 1 uncertainty approach are summarised in Annex 1 of this report. The Tier 1 estimation of *annual uncertainty* in CO_2-eq. emissions results in an overall uncertainty of 4%, based on calculated uncertainties of 2%, 17%, 43% and 32% 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 1990-2005 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in the total CO_2-eq. emissions (including LULUCF) for 1990-2006 (1995 for F-gases) of ±3% points. This means that the decrease in total CO_2-eq. emissions between 1990 and 2006, which is calculated to be 2%, will be between -5% and +1%. 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%, ±10%, ±16% and ±8% points, respectively. More details on the level and trend uncertainty assessment can be found in Annex 7.

Completeness of the national inventory

The Netherlands greenhouse gas emission inventory includes all sources identified by the Revised 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 negligible amounts have been found. Since no regular monitoring data are available, these sources are not included. Based on recommendations by the ERT, justification for missing sources will be improved in future.

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 2008 is based upon the envisaged National System of the Netherlands under article 5.1 of the Kyoto Protocol, as developed in the past few years and finalised by December 2005. In past years the results of various improvement actions have been implemented in the methodologies and processes of the preparation of the greenhouse gas inventory of the Netherlands. Compared to the NIR/CRF 2007 and based on the results of the review of the National System by an Expert Review Team of the UNFCCC, some recalculations were undertaken and included in a resubmission of the CRF 2007 (version 1.4, submitted by 1 June 2007) and the CRF 2008. The methodological changes are documented in Chapters 3-8.

Compared to the NIR/CRF 2007, the following methodological changes were made in the greenhouse gas inventory for the base year:

- Recalculation of N_2O emissions from waste combustion, Category 1A1, +11.48 Gg CO_2-eq in 1990;
- Recalculation of CO_2 from glass production, Category 2A -33.65 Gg CO_2-eq in 1990;
- Recalculation of N_2O from caprolactam production; Category 2B -473.57 Gg CO_2-eq in 1990;
- Removal of Indirect N_2O emissions from category 2G, -935.04 Gg CO_2-eq. in 1990.
- Recalculation of N_2O from manure management, adjustment for NH_3 volatilization is removed, Category 4B +118.32 Gg CO_2-eq. in 1990.
- Recalculation of indirect N_2O from agricultural soils, Category 4D +2.98 Gg CO_2-eq. in 1990.
- Recalculation of CO_2 emissions from the LULUCF sector, Category 5A +5C+5F total +275.45 Gg CO_2-eq. in 1990 (note that 39 Gg is included in the calculation of the Assigned Amount).

Table ES.3 provides the results of recalculations in the NIR 2008 compared to the NIR 2007.

Based on the results of the review of the National System, also some more general improvements were considered (to some extent included in this NIR 2008):

- Description of QC activities (summarized in Chapter 1);
- Improved transparency with respect to some sub-sectors, including biofuel-use, industrial processes and the Netherlands' approach for calculating CH_4 emissions from the agricultural sector;
- Improved methodologies and documentation for LULUCF sector (to be included in upcoming NIR reports);
- Improved consistency between NIR report and monitoring protocols (for instance by including descriptions of methodologies in the NIR) – to be further considered for upcoming NIR reports;
- The ERT recommended to further centralize intermediate calculations (and data). This recommendation will also be considered for upcoming CRF/ NIR reports.

Table ES.3 Differences between NIR 2007 and NIR 2008 due to recalculations (Unit: Tg CO_2-eq., F-gases: Gg CO_2-eq)

Gas	Source	1990	1995	2000	2001	2002	2003	2004	2005
CO_2	NIR07	161.8	172.8	172.0	177.6	178.1	182.0	183.6	178.2
Incl. LUCF	NIR08	162.0	173.1	172.3	177.9	178.4	182.3	183.7	178.5
	Diff.	0.2	0.3	0.3	0.3	0.3	0.3	0.0	0.3
CO_2	NIR07	159.4	170.6	169.6	175.2	175.7	179.6	181.3	175.9
Excl. LUCF	NIR08	159.4	170.6	169.6	175.2	175.8	179.7	181.1	181.1
	Diff.	0.0	0.0	0.1	0.1	0.1	0.1	-0.2	5.2
CH_4	NIR07	25.4	23.8	19.3	18.9	18.0	17.5	17.3	16.7
	NIR08	25.4	23.8	19.2	18.8	18.0	17.5	17.3	16.8
	Diff.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
N_2O	NIR07	21.2	22.4	19.9	18.8	18.0	17.4	17.7	17.6
	NIR08	19.9	21.3	19.0	17.9	17.1	16.8	17.3	17.1
	Diff.	-1.3	-1.1	-0.8	-0.9	-0.9	-0.6	-0.4	-0.4
PFCs	NIR07	2,264	1,938	1,581	1,489	2,186	620	285	265
Gg	NIR08	2,264	1,938	1,582	1,489	2,187	621	286	266
	Diff.	0.0	0.0	0.9	0.8	1.5	1.0	1.0	0.8
HFCs	NIR07	4,432	6,020	3,824	1,469	1,541	1,380	1,515	1,354
Gg	NIR08	4,432	6,020	3,824	1,469	1,541	1,379	1,511	1,353
	Diff.	0.0	0.0	0.0	0.0	0.0	-1.0	-4.1	-0.8
SF_6	NIR07	217	301	335	356	332	309	328	337
Gg	NIR08	217	301	320	325	286	248	251	250
	Diff.	0.0	0.0	-15.3	-30.8	-46.2	-61.6	-77.1	-87.4
Total	NIR07	213.0	225.1	214.4	216.2	215.7	216.8	218.4	212.1
Incl. LUCF	NIR08	214.3	226.4	216.3	217.9	217.5	218.9	220.3	214.3
	Diff.	1.4	1.4	1.9	1.7	1.8	2.1	1.9	2.2
Total	NIR07	215.4	227.3	216.8	218.6	218.1	219.2	220.8	214.5
Excl. LUCF	NIR08	211.7	224.0	213.6	215.3	214.9	216.3	217.7	211.8
	Diff.	-3.7	-3.3	-3.2	-3.3	-3.3	-2.9	-3.1	-2.7

Note: base year values are indicated in bold. Differences in totals are caused by rounding

[1] erroneously, different values are provided in the summary tables in the NIR 2007

Improving the QA/QC system

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

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

Emission trends for indirect greenhouse gases and SO_2

Compared to 1990, the CO and NMVOC emissions were reduced in 2006 by 49% and 64%, respectively. For SO_2 this is 66%, and for NO_x, the 2006 emissions are 42% lower than the 1990 level. Table ES.4 provides trend data.

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

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

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 only been performed for 1990, 1995, 2000, 2004, 2005 and 2006 for all sources. For that reason the precursor gas emissions in other years are interpolated (not the whole time series is presented in table ES.4).

1 Introduction

1.1 Background information on greenhouse gas inventories and climate change

1.1.1 General issues

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

This report documents the 2008 annual inventory for the Netherlands under the Kyoto Protocol and the UNFCCC. 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, the reader is referred to the annual Environmental Balance (MNP 2007, 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 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' Pollutant Release and Transfer Register, PRTR, which is also compiled by the Environmental Assessment Agency. The greenhouse gas inventory and the PRTR share the same underlying data, which ensures consistency between the inventories and the internationally reported data. Several institutes are involved in the process of compiling the greenhouse gas inventory (see also section 1.3).

The 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 well as sulphur oxides (SO_x).

This report provides explanations of the trends in greenhouse gas emissions per gas and per sector for the 1990–2006 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 protocols were revised after the review of the National System in April 2007. The monitoring protocols and the general description of the National System are available on the website www.greenhousegases.nl. The emissions reported in the NIR 2008 are based on these methodologies, which have been incorporated in the National System for greenhouse gases.

In 2007 the UN performed an in-country review of the NIR 2006 and the initial review under the Kyoto Protocol. The review concluded that the Netherlands' national system has been established in accordance with the guidelines and that it meets the requirements. The national system remained unchanged. As a result of the review of the NIR 2006 by the UNFCCC a number of changes have been implemented in the NIR 2008 relative to the NIR of 2007. An overview of these changes is provided in section 10.1.

The structure of this report complies with the format required by THE UNFCCC (FCCC/SBTSA/2004/8). An annex to this report describes the supplementary information, required under article 7 of the Kyoto Protocol. 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.

1.1.2 CRF files: greenhouse gas emissions and background data

The Common Reporting Format (CRF) spreadsheet files accompany this report as electronic annexes (The CRF files are compressed into four zip files for this submission: crf-nld-2008-v-1-2-90-93.zip; crf-nld-2008-v-1-2-94-97.zip; crf-nld-2008-v-1-2-98-01.zip; crf-nld-2008-v-1-2-02-06.zip. The CRF files contain detailed information on greenhouse gas emissions, activity data and (implied) emission factors specified by sector, source category and greenhouse gas. *Please note that the results of the key category analysis are included in the year 2004 instead of 2006 due to a minor bug in the CRF reporter*. The complete set of CRF files as well as this report comprise the National Inventory Report (NIR) and are published on the website www.greenhousegases.nl.

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

- IPCC summary Table 7A for 1990, 1995, 2000, 2005 and 2006 (CRF Summaries 1);
- trend Table 10 for each gas individually, and for all gases and sources in CO_2-equivalents.

Section 10.4 provides details on the extent to which the CRF data files for 1990–2006 have been completed.

1.1.3 Geographical coverage of the Netherlands' inventory

The reported emissions have to be allocated to the *legal territory* of the Netherlands. This includes a 12-mile zone from the coastline and also inland water bodies. It excludes Aruba and the Netherlands Antilles, which are self-governing dependencies of the Royal Kingdom of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental

shelf are included as are emissions from all electricity-generating activities in the Netherlands, including the electricity fraction that is exported. The Netherlands imported about 10% of its electricity up to 1999, but following the 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) has been contracted by the Ministry of VROM to compile and maintain the pollutants emission register/inventory (PRTR system) and to co-ordinate the preparation of the NIR and filling the CRF.

1.2.2 Responsibility for 'the National System'

In August 2004, the Ministry of VROM assigned SenterNovem executive tasks bearing on the National Inventory Entity (NIE), the single national entity required under the Kyoto Protocol. In December 2005, SenterNovem was designated by law as the NIE. In addition to co-ordinating the establishment of a National System, the tasks of SenterNovem include the overall co-ordination of (improved) QA/QC 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. (2005c).

1.2.3 Responsibility for emission estimates

A Pollutant Emission Register (PRTR) has been in operation in the Netherlands since 1974. This system encompasses the process of data collection, data processing and the registering and reporting of emission data for some 170 policy-relevant compounds and compound groups that are present in the air, water and soil. The emission data 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 PRTR 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 PRTR 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 PRTR by performing calculations or submitting activity data (see following section), these include: CBS (Statistics Netherlands), TNO (Netherlands Organisation for Applied Scientific Research), SenterNovem, 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 PRTR project. Most institutes involved in the PRTR also contribute to the NIR (including CBS and TNO, among others). In addition, SenterNovem is involved in its role as NIE.

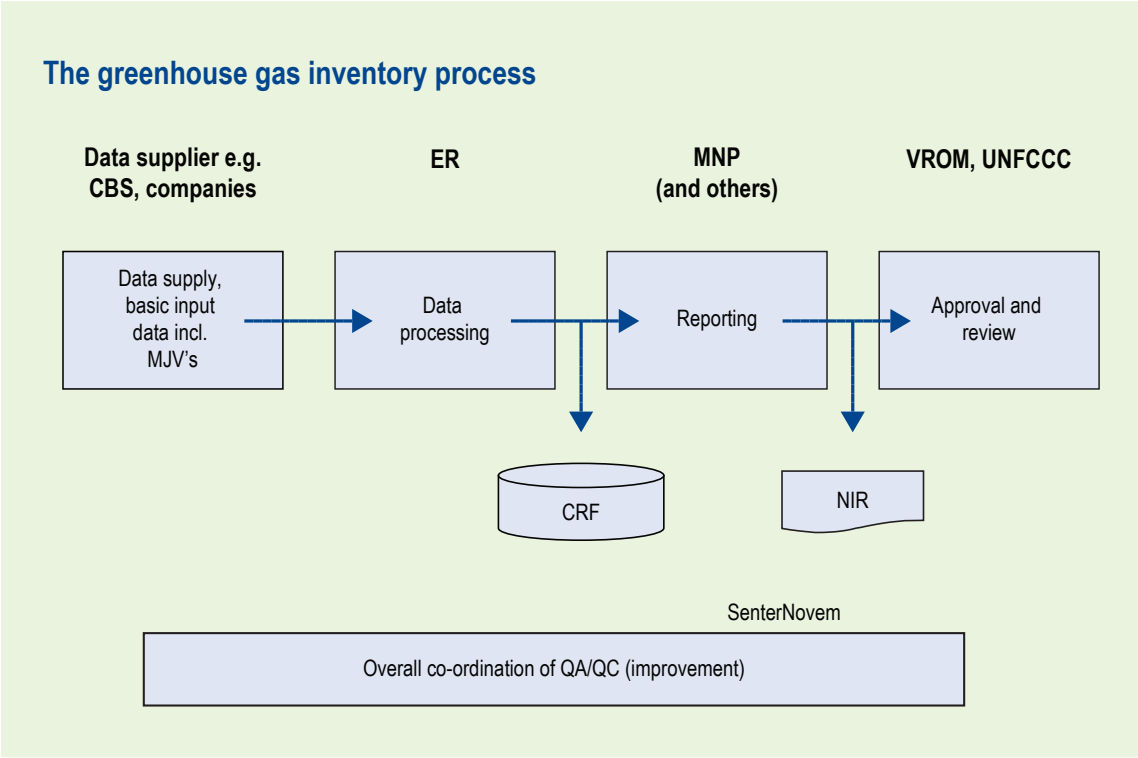


Figure 1.1 Main elements in the greenhouse gas inventory process

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.

1.3.2 Data supply and collection

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

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

nies). A number of companies with large combustion plants are also required to report information under the so-called BEES/A regulation. Some companies provide data voluntarily, within the framework of environmental covenants. The data in these MJVs are used for verifying the calculated CO_2 emissions from energy statistics for industry, energy 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 CO_2 emission estimates for specific sectors.
Besides, the MJVs from individual companies provide essential information for calculating the emissions of substances other than CO_2 . The calculations of industrial process emissions of non-CO_2 greenhouse gases (e.g. N_2O, HFC-23 and PFCs released as by-products) are mainly based on information from these MJVs, as are the calculated emissions from precursor gases (CO, NOx, NMVOC) and SO_2. As reported in previous NIRs, only those MJVs with high-quality and transparent data are used as a basis for calculating total source emissions in the Netherlands.

- *Additional greenhouse-gas-related data*
  Additional greenhouse-gas-related data are provided by other institutes and consultants that are specifically contracted to provide information on sectors not sufficiently covered by the above-mentioned data sources. For greenhouse gases, contracts and financial arrangements are made (by 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 PRTR.

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 2006, in addition to the MNP, these included TNO, CBS, RIZA, FO-I (the Facilitating Organisation for Industry, which co-ordinates 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.

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

Greenhouse gas source and sink	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
Categories	Method applied	Em. factor	Method applied	Em. factor	Method applied	Em. factor	Method applied	Em. factor	Method applied	Em. factor	Method applied	Em. factor
1. Energy	CS,T2,T3	CS,D,PS	CS,T1,T1b, T2,T3	CS,D,PS	CS,T1, T2	CS,D, PS						
A. Fuel Combustion	CS,T2	CS,D	CS,T1, T2,T3	CS,D	CS,T1, T2	CS,D						
1. Energy Industries	T2	CS	T2	CS	T1,T2	CS,D						
2. Manufacturing Industries and Construction	T2	CS	T2	CS	T1	CS,D						
3. Transport	CS,T2	CS	CS,T2,T3	CS,D	CS,T2	CS,D						
4. Other Sectors	T2	CS,D	T1,T2	CS,D	T1	D						
5. Other	T2	D	T2	CS	T2	CS						
B. Fugitive Emissions from Fuels	T2,T3	CS,PS	T1b,T2,T3	CS,D,PS	T2	PS						
1. Solid Fuels	T2	CS	T1b	D	NA	NA						
2. Oil and Natural Gas	T2,T3	CS,PS	T1b,T2,T3	CS,D,PS	T2	PS						
2. Industrial Processes	CS,T1,T1a, T1b,T2	CS,D,PS	CS,T1,T2	CS,D	CS,T2	CS,PS	T2	PS	CS,T1, T2	PS	CS,T2	D,PS
A. Mineral Products	CS	CS,D,PS	NA	NA	NA	NA						
B. Chemical Industry	CS,T1,T1b	CS,D,PS	T1,T2	D	T2	PS					NA	NA
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 SF6							T2	PS	T1	PS	NA	NA
F. Consumption of Halocarbons and SF6									CS,T2	PS	CS,T2	D,PS
G. Other	CS,T1b	CS,D	CS	CS	CS	CS			NA	NA	NA	NA
3. Solvent and Other Product Use	CS	CS			CS	CS						
4. Agriculture			T1,T2	CS,D	T1,T1b, T2,T3	CS,D						
A. Enteric Fermentation			T1,T2	CS,D								
B. Manure Management			T2	CS	T2	D						
C. Rice Cultivation			NA	NA								
D. Agricultural Soils			NA	NA	T1,T1b, T2,T3	CS,D						
E. Prescribed Burning of Savannas			NA	NA	NA	NA						
F. Field Burning of Agricultural Residues			NA	NA	NA	NA						
G. Other			NA	NA	NA	NA						
5. Land Use, Land-Use Change and Forestry	CS,D,T2	CS,D	NA	NA	NA	NA						
A. Forest Land	CS,T2	CS	NA	NA	NA	NA						
B. Cropland			NA	NA	NA	NA						
C. Grassland			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	D	D	NA	NA	NA	NA						
6. Waste	NA	NA	T2	CS	T2	CS,D						
A. Solid Waste Disposal on Land	NA	NA	T2	CS								
B. Waste-water Handling			T2	CS	T2	D						
C. Waste Incineration	NA	NA	NA	NA	NA	NA						
D. Other	NA	NA	T2	CS	T2	CS						
7. Other (as specified in Summary 1.A)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Explanation of notation keys used:

Method applied: D, IPCC default; RA, reference approach; T, IPCC Tier; C, CORINAIR; CS, country-specific; M, model.

Emission factor used: D, IPCC default; C, CORINAIR; CS, country-specific; PS, plant-specific; M, model.

Other keys: NA, not applicable, NO, not occurring; NE, not estimated; IE, included elsewhere.

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

1.4 Brief description of methodologies and data sources used

1.4.1 Methodologies

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

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

1.4.2 Data sources

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

- fossil fuel data: (1) national energy statistics from CBS (National Energy Statistics; Energy Monitor); (2) natural gas and diesel consumption in the agricultural sector (Agricultural Economics Institute, LEI);
- residential biofuel data: (1) annual survey of residential woodstove and fireplace penetration from the Association for Comfortable Living (Vereniging Comfortabel Wonen); (2) a 1996 survey on wood consumption by owners of residential woodstoves and fireplaces from the Stove and Stack Association (Vereniging van Haard en Rookkanaal, VHR);
- transport statistics: monthly statistics for traffic and transportation;
- industrial production statistics: (1) annual inventory reports from individual companies; (2) national statistics;
- consumption of HFCs: annual reports from the accountancy firm, PriceWaterhouseCoopers (only HFC data are used due to inconsistencies for PFCs and SF_6 with emissions reported elsewhere);
- consumption/emissions of PFCs and SF_6: reported by individual firms;
- 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 agricultural database, plus data from the annual agricultural census;
- manure production and handling: from the CBS/LEI national statistics;
- fertiliser statistics: from the LEI 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;
- CH_4 recovery from landfills: Association of Waste Handling Companies (VVAV).

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

1.5 A brief description of the key categories

The analysis of key sources is performed in accordance with the IPCC Good Practice Guidance (IPCC, 2001). 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.

A detailed description of the key source analysis is provided in Annex 1 of this report. This analysis is based on emission figures in CRF version 1.2, submitted to the EU in March 2008. Per sector, the key sources are also listed in the first Section of each of the Chapters 3–8.

Compared to the key source analysis for the NIR 2007, the key categories change as follows:
- CO_2 emissions from 1A3 mobile combustion: water-borne navigation: now key;
- N_2O emissions from 1A3 Mobile combustion: road vehicles: now key;
- CO_2 emissions from 2A7 Other minerals: now key;
- Indirect N_2O emissions in category 2G: now non-key. This emission source has been removed as a result of the in-country review of the NIR 2006 in April 2007.
- CO_2 emissions from 5A2 Land converted to Forest Land: now key.

1.6 Information on the QA/QC plan

As one of the results of a comprehensive *inventory improvement programme*, a National System fully in line with the Kyoto requirements was finalised and established by the end of 2005. As part of this system also an Act on Monitoring of Greenhouse Gases has become effective in December 2005. This Act determines the establishment of the National System for monitoring of greenhouse gases and empowers the Minister of Housing, Spatial Planning and the Envi-

ronment (VROM) to appoint an authority responsible for the National System and the National Inventory. The Act also determines that the National Inventory be based on methodologies and processes as laid down in the monitoring protocols. With a regulation following to that the Minister has appointed SenterNovem as NIE (national inventory entity) and published a list of the protocols. Adjustments to the protocols will require official publication of the new protocols and announcement of publication in the official Government Gazette (Staatscourant).

As part of its National System, the Netherlands has developed and implemented a QA/QC programme. This programme is yearly assessed and updated, if needed. The key elements of the current programme (SenterNovem, 2007) are briefly summarised in this chapter, notably those related to the current NIR.

1.6.1 QA/QC activities for the CRF/NIR 2008

- The Monitoring protocols were elaborated and implemented in order to improve the transparency of the inventory (including methodologies, procedures, tasks, roles and responsibilities with regard to inventories of greenhouse gases). Transparent descriptions and procedures of these different aspects are described in the protocols for each gas and sector and in process descriptions for other relevant tasks in the National System. The protocols are assessed annually and updated if needed. During the review of the National System and the NIR2006, some remarks and recommendations were made by the Expert Review Team concerning QA/QC and the documentation in the NIR:
- Inconsistencies in the key category analysis between CRF and NIR were analyzed and removed. The key category analysis is updated in the NIR (Annex I) as well as the CRF files;
- The ERT recommended providing more information in the NIR report and protocols, that was until now only included in background information. The Netherlands will reconsider what information to include in the NIR, what information in protocols and what information in background documents;
- The ERT recommended providing more specific information on sector specific QC activities. A start has been made in this NIR, however this will be further expanded in the NIR 2009;
- Finally, the Netherlands continues its efforts to include the correct notation keys in the CRF files;

Box 1.1. Trend verification workshops.

Several weeks in advance of a trend analysis meeting, a snapshot from the database is made available by MNP in a webbased application (so-called Emission Explorer, EmEx) for checks by the involved institutes and experts (PRTR task forces). In this way the task forces can check for level errors and consistency in the algorithm/method used for calculations throughout the time series. The task forces perform checks for 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 to discussion at the trend analysis workshop and subsequently documented.

Furthermore, TNO 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 2006 were checked in two ways: (1) emissions from 1990 – 2005 should (with some exeptions) be identical to those reported last year; (2) the data for 2006 were compared with the trend development for each gas since 1990. 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 next year's inventory.

- For the NIR 2008 changes were incorporated to and references were updated in the National System website (www.greenhousegases.nl), providing additional information on the protocols and relevant background documents;
- *General* QC *checks* are performed. To facilitate these general QC checks, a checklist was developed and implemented. A number of general QC checks have been introduced as part of the annual work plan of the PRTR respectively of the monitoring protocols. The QC checks included in the work plan, aim at covering issues as consistency, completeness and correctness of the CRF data, among others.
  The general QC for the present inventory is largely performed in the PRTR, as an integrated part of the working processes. The PRTR task forces fill in a standard-format database with emission data for 1990–2006. After a first check of the emission files by MNP and TNO for completeness, the (corrected) data are available for the specific task force for checking consistency checks and trend analysis (comparability, accuracy). The task forces have access to information about the relevant emissions in the database. Several weeks before the dataset is fixed, a trend verification workshop is organised by MNP (see Box 1.1).
- *Quality Assurance* for the current NIR includes the following activities:
- A peer and public review on the basis of the draft NIR in January/February 2008. Results of this review are summarised in Chapter 10 and have been dealt with as far as possible in the present NIR.
- In preparing this NIR, the results of former UNFCCC reviews, including the results of the In Country Review (initial review) of the National System in April 2007 and the Synthesis and Assessment Report of NIR 2007 – have been taken into account in Chapters 3–8 to the extent possible.
- As part of the evaluation process of the previous cycle, internal audits were performed through SenterNovem on the use of the protocols and the implementation of QC checks. These audits showed that the monitoring protocols could be well implemented and did not provide major problems. Also the designed QC procedures were basically considered appropriate and well workable. Some recommended small improvements were implemented (e.g. additional sample checks).

The trend verification workshop held on 22 February 2008, showed a.o. the following results:

General issues:

- Further guidance is needed for dealing with improved methodologies. Based on IPCC Good Practice guidance, Parties shall continue improving methodologies. For the Kyoto mechanisms (emissions trading) however, it seems important to apply the methodologies for calculating the Assigned Amount throughout the whole commitment period (time series consistency). The PRTR project leader will notify the ministry of Environment of this possible discrepancy, in order to get guidance from the policy perspective;

Issues per source category:

- cat. 1A1a: reconsider the whole time series (CO_2, N_2O) waste incineration for 'biomass' and 'other fuel'. Also clarify increase of N_2O emissions since 2004;
- cat. 1A2c: trend in natural gas? One big company in the Netherlands shut down;
- cat. 1A2d: re-allocation of CO_2 from 'biomass' to 'other industries' (1A2f) instead of 'pulp and paper';
- cat. 1A3d3: improved activity data for inland shipping (CO_2) available (since 1991) and applied. To be justified in the NIR report;
- cat. 1A4a: improved activity data available for natural gas use in greenhouses;

- cat. 1A4c: improved activity data for biomass available. Trend 2006: more biomass applied in the agricultural sector;
- cat. 1B2: results of the review still to be included in CRF and PRTR database;
- cat. 2A4: Activity data doubled for 2006;
- cat. 2A7: results of the review still to be included in CRF and PRTR database;
- cat.4: check consistency of CH_4 emissions in the CRF and PRTR database;
- cat 4: total N_2O emissions lower in 2006. Check activity data;

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 PRTR and the National System, taking into account the ISO 9001:2000 certification of MNP and the international QA/QC requirements (IPCC 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, 2007, updated version of the 2005 programme) 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 be updated annually as part of a yearly 'evaluation and improvement cycle' for the inventory and National System and held available for review.
- *The annual activity programme* of the PRTR (MNP, 2007) that is part of the requirements under the MNP ISO 9001:2000 certification. The work plan describes tasks and responsibilities of the parties involved in the PRTR process, products , 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).
- The responsibility for the quality of data in annual environmental reports (MJVs) lies with the companies themselves, while validation of the data is the responsibility of the competent authorities. It is the responsibility of the institutes involved in the PRTR to judge whether or not to use the validated data of individual companies to assess the national total emissions (CO_2 emissions, however, are based on energy statistics and standard emission factors, and only qualified specific emission factor from environmental reports are used).
- *Agreements/covenants* between MNP and other institutes, involved in the annual PRTR process. The general agreement is that by accepting the annual work plan, the involved institutes commit themselves to deliver capacity for the products specified in that work plan. The role and responsibility of each institute have been described (and agreed upon) within the framework of the PRTR work plan.
- *Specific procedures* that have been established to 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 PRTR work plan:
  - QC on data input and data processing, as part of the annual process towards trend analysis and fixation of the database following approval of the involved institutions.
  - Documentation of consistency, completeness and correctness of the CRF data (see also 1.6.1). Documentation is 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 (assigned as NIE) and institutions not basically involved in the PRTR process.
  - 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.

  - Audits: in the context of the annual work plan, it has been agreed upon that the involved institutions of the PRTR inform MNP on possible internal audits. In 2007 for instance, an audit on the Annual Environmental Report application and procedures was performed. As outcome of this audit, no major revisions of the system or approach seem necessary. Furthermore, SenterNovem is assigned the task of organising audits, if needed, of relevant processes or organisational issues within the National System. In 2007 such an audit was performed for the NIR process, as well as for the activities of the Agriculture Task Force under the PRTR (see the previous section).
  - Archiving and documentation: internal procedures are agreed upon (amongst others in the PRTR annual activity programme) for general data collection and the storage of fixed datasets in the MNP database, including the documentation/archiving of QC checks. The improved monitoring protocols have been documented and will be published on the website www.greenhousegases.nl. To improve transparency, the implemented checklists for QC checks have been documented and archived. As part of the QA/QC plan the documentation and archiving system has been further upgraded. SenterNovem (NIE) maintains the national system website and a central archive of relevant national system documents.
  - Each institution is responsible for QA/QC aspects related to reports based on the annually fixed database.
- *Evaluation and improvement*: those persons involved in the annual inventory tasks are invited once yearly to evaluate the process. In this evaluation, the results of any internal and external review and evaluation are taken into account. The results are used for the annual update of the QA/QC 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. These uncertainty estimates have also been used for a first Tier 2 analysis to assess error propagation and to identify key sources as defined in the IPCC Good Practice Guidance (IPCC, 2001).

1.7.1 Data

The following information sources were used for estimating the uncertainty in activity data and emission factors (Olivier, 2008):

- estimates used for reporting uncertainty in greenhouse gas emissions in the Netherlands that were discussed at a national workshop in 1999 (Van Amstel et al., 2000a);
- default uncertainty estimates provided in the IPCC Good Practice Guidance report (IPCC 2000);
- RIVM fact sheets on calculation methodology and data uncertainty (RIVM, 1999);
- other recent information on the quality of data (Boonekamp et al., 2001);

- A comparison with uncertainty ranges reported by other European countries have led to a number of improvements in (and increased underpinning of) the Netherlands' assumptions for the present Tier 1 (Ramirez et al., 2006).

These data sources were supplemented with expert judgements from MNP and CBS emission experts (also for new key sources). This was followed by an estimation of the uncertainty in the emissions in 1990 and 2006 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-eq. emissions results in an overall uncertainty of about 4% in 2006, based on calculated uncertainties of 2%, 17%, 43% and 32% 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 2.5%.

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

Table 1.3 shows the top ten sources contributing most to total *annual uncertainty* in 2006, after ranking the sources according to their calculated contribution to the uncertainty in total national emissions (using the column 'Combined Uncertainty as a percentage of total national emissions in 2006' in Table A7.1).

Table 1.2 Uncertainty of total annual emissions

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

Table 1.3 Top ten sources contributing most to total annual uncertainty in 2006

IPCC category	Category	Gas	Combined uncertainty as a percentage of total national emissions in 2006
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3.1%*)
4D1	Direct N_2O emissions from agricultural soils	N_2O	1.4%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	1.0%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	0.9%
4B1	Emissions from manure management : cattle	CH_4	0.7%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	0.6%
2B2	Nitric acid production	N_2O	0.6%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	0.5%
4B8	Emissions from manure management : swine	CH_4	0.4%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	0.4%

*) calculated uncertainties, for ranking purposes not rounded off

Table 1.4 Top ten sources contributing most to trend uncertainty in the national total

IPCC cat.	Category	Gas	Uncertainty introduced into the trend in total national emissions
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1.8%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	1.4%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	1.2%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	0.7%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	0.6%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	0.6%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	0.5%
2B2	Nitric acid production	N_2O	0.4%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	0.3%
4D1	Direct N_2O emissions from agricultural soils	N_2O	0.3%

Table A7.1 of Annex 7 summarises the estimate of the *trend uncertainty* 1990–2006 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 1990–2006 (1995 for F-gases) of ±3% points. This means that the increase in total CO_2-eq. emissions between 1990 and 2006, which is calculated to be -3%, will be between -6% and +0%.

Per individual gas, the *trend uncertainty* in total emissions of CO_2, CH_4, N_2O and the total group of F-gases has been calculated to be ±3%, ±10%, ±16% and ±8% points, respectively. More details on the level and trend uncertainty assessment can be found in Annex 7. Table 1.4 shows the top ten sources contributing most to *trend uncertainty* (calculated) in the national total (using the column 'Uncertainty introduced into the trend in total national emissions' in Table A7.1).

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.

Furthermore, in 2006 a Tier 2 uncertainty assessment was carried out (Ramirez et al., 2006). This study used the same uncertainty assumption as the Tier 1 study but accounted for correlations and non-Gaussian distributions. Results reveal that the Tier 2 uncertainty in total Netherlands CO_2-equivalent emissions is in the same order of magnitude as that in the Tier 1 results, although a higher trend uncertainty is found (see Tables 1.5 and 1.6). 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.

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

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

Greenhouse gas	Tier 1 annual uncertainty [1]	Tier 2 annual uncertainty [2]
Carbon dioxide	1.9%	1.5%
Methane	18%	15.1%
Nitrous oxide	45%	42.0%
F-gases	27%	28.1%
Total	4.3%	3.9%

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

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

Greenhouse gas	Emission trend 1990-2004	Tier 1 trend uncertainty [1]	Tier 2 trend uncertainty [2]
Carbon dioxide	+13%	2.7%	2.1%
Methane	-32%	11.3%	14.6%
Nitrous oxide	-16%	15.0%	27.9%
F-gases	-75%	7.0%	9.1%
Total	+1.6%	3.2%	4.5%

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

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 et al. (2003). In 2006, the research programme '*Climate changes spatial planning'* started aiming to strenghten the knowledge on the relation between greenhouse gas emissions and land-use and spatial planning.

1.8 General assessment of the completeness

At present, the greenhouse gas emission inventory for the Netherlands includes all of the sources identified by the Revised IPCC Guidelines (IPCC, 1997), with the exception of a number of (very) minor sources. Annex 5 presents the results of the completeness checks of this submission of the NIR and the CRF. Based on recommendations by the ERT, completeness will be re-evaluated in the next few years.

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 1990–2006, by greenhouse gas and by sector. Detailed explanations of these trends are provided in Chapters 3-8. In 2006 total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands are estimated at 207.4 Tg CO_2-eq., which is 2% lower than the 213.0 Tg CO_2-eq. reported in the base year (1990; 1995 is the base year for fluorinated gases).

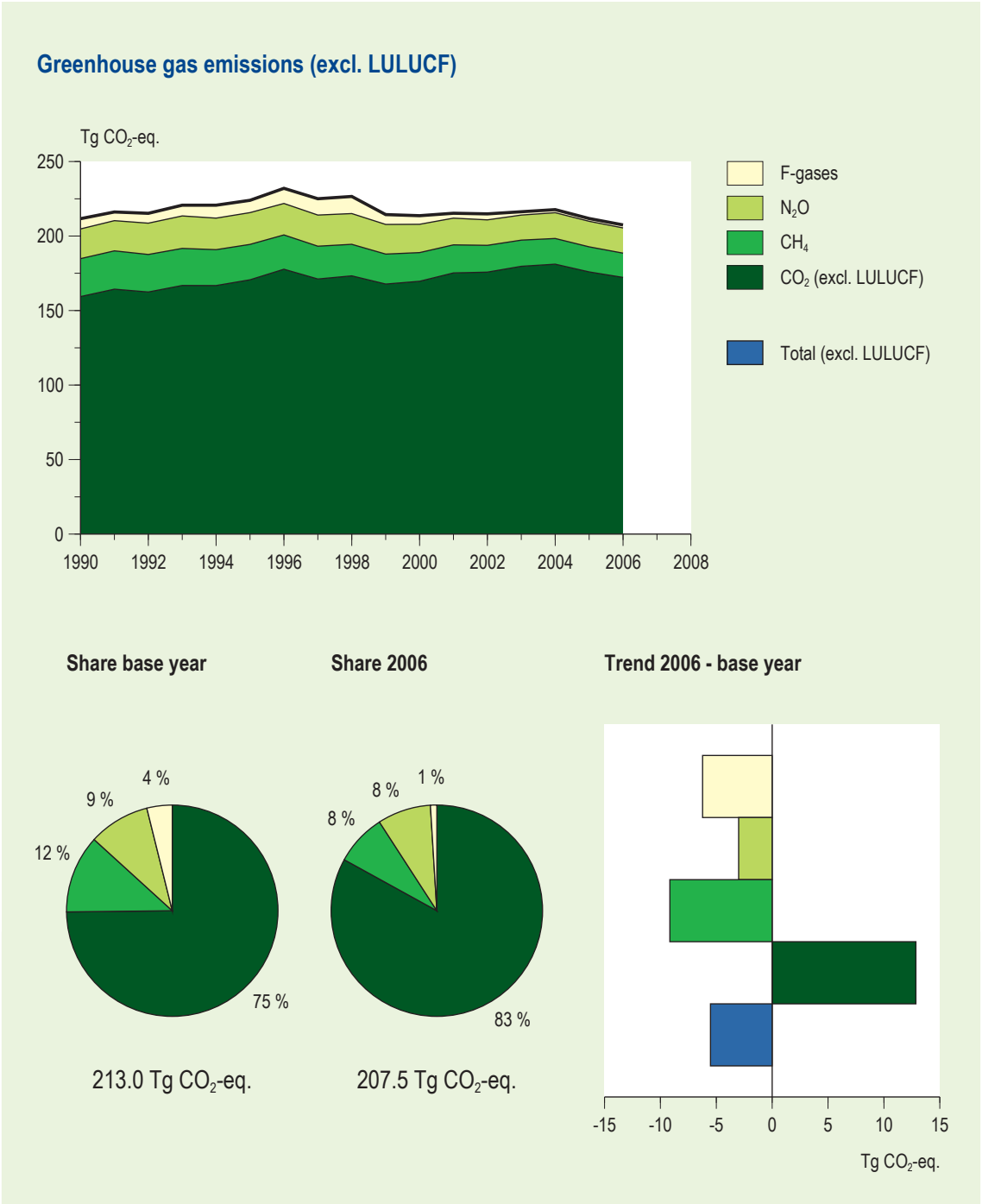


Figure 2.1 Greenhouse gases: trends, emission levels and share of gases, 1990–2006

Figure 2.1 shows the trends and relative contributions of the different gases to the aggregated national greenhouse gas emissions. In the period 1990–2006 emissions of CO_2 increased by 8% (excluding LULUCF), while emissions of non-CO_2 greenhouse gases decreased by 35% compared with the base year emissions. Of the non-CO_2 greenhouse gases, CH_4, N_2O and the F-gases individually decreased 36%, 15% , 75%, respectively.

Emissions of LULUCF related sources decreased 3.5%, from 2.7 Tg in 1990 to 2.6 Tg CO_2-eq. in 2006. In the period 1990–2006 emissions of CO_2 increased by 8% (excluding LULUCF), while emissions of non-CO_2 greenhouse gases decreased by 35% compared with the base year emissions. Of the non-CO_2 greenhouse gases, CH_4, N_2O and the F-gases individually decreased 36%, 15% , 75%, respectively. Emissions of LULUCF related sources decreased 3.5%, from 2.7 Tg in 1990 to 2.6 Tg CO_2-eq. in 2006.

Between 2005 and 2006, total greenhouse gas emissions (excl. LULUCF) dropped by about 2% (-4.3 Tg CO_2-eq.). This decrease was largely due to a reduction of CO_2 emissions (-3.7 Tg CO_2) and a further decrease of CH_4 emissions (-0.6 Tg CO_2-eq.).

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 1990–2006 the national CO_2 emissions increased by 8% (from 159.4 to 172.2 Tg). The Energy sector is by far the largest contributor to CO_2 emissions in the Netherlands (96%), with the categories 1A1 'Energy industries' (36%) and 1A4 'Other Sectors' (22%) as largest contributors in 2006.

The relatively high level of CO_2 emissions in 1996 is mainly explained by a very cold winter, which caused increased energy use for space heating in the residential sector. The resulting emissions are included in the category 1A4 'Other sectors'. The relatively low level of CO_2 emissions in the category 1A1 'Energy industries' in 1999 is explained by the marked increase in imported electricity and a shift from the use of coal to residual chemical gas and natural gas in 1999; the share of imported electricity almost doubled. However, this increased import of electricity led to only a temporary decrease in the CO_2 emissions. In the period 2000-2004, the pre-1999 annual increase in CO_2 emissions from this category – about 1–2% – was observed again. In 2005 and 2006, the import of electricity has increased again considerably.
In 2006, total CO_2 emissions dropped by 2% (-3.7 Tg) compared to 2005. The CO_2 emissions decreased due to the increased use of biomass fuel for electricity generation, less energy use by households and the commercial/institutional sector for heating during a relatively warm winter, and by increased import of electricity.

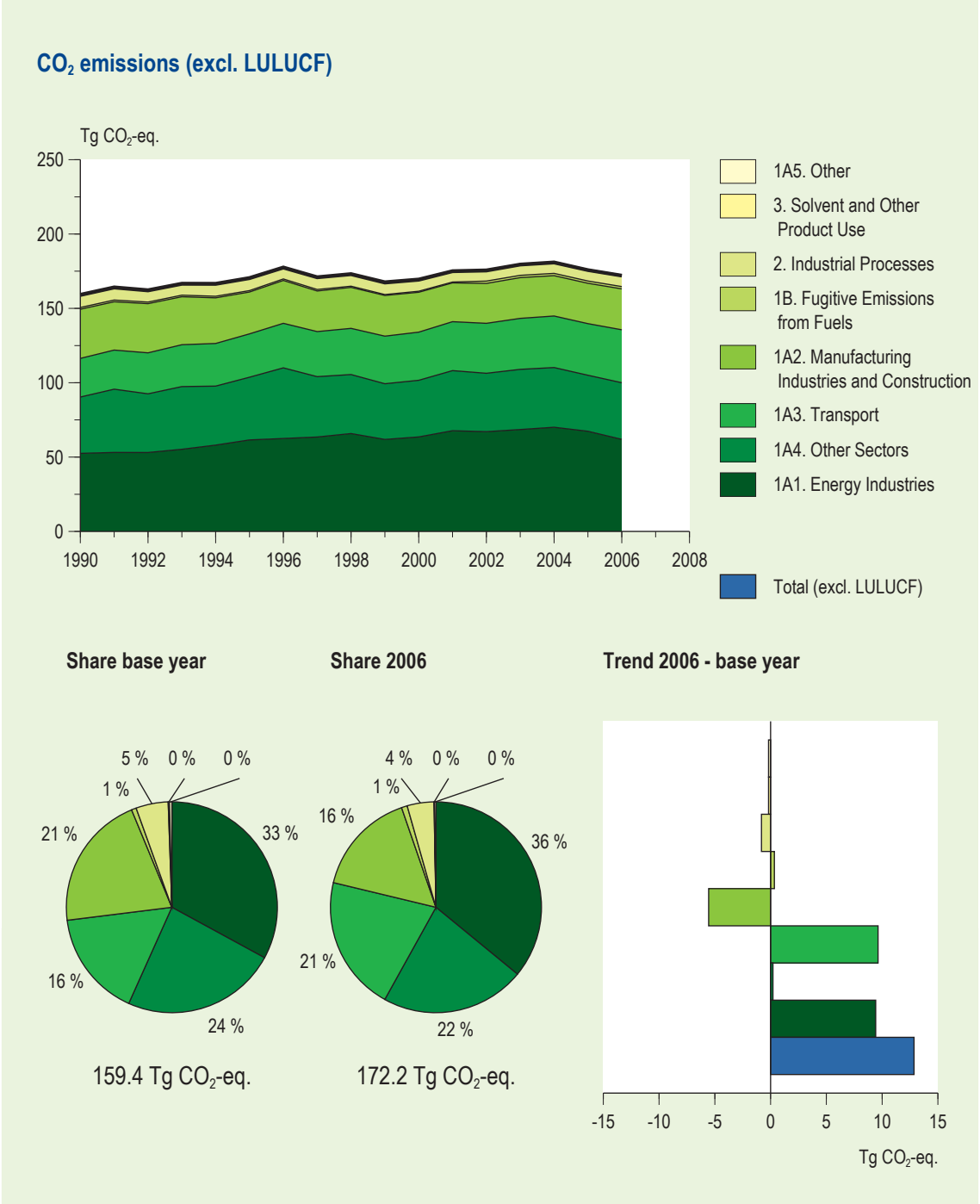


Figure 2.2 CO_2: trend, emission levels and share of sectors, 1990–2006

2.2.2 Methane

Figure 2.3 presents the contribution of the most important IPCC sectors to the trend in total CH_4 emissions. The national CH_4 emissions decreased by 36%, from 1,211 Gg in 1990 to 775 Gg in 2006 (25.4 to 16.3 Tg CO_2-eq.). The Agriculture and Waste sector (54 % and 36%) are the largest contributors in 2006.
Compared to 2005, national CH_4 emissions dropped by 3% in 2006 (-0.7 Tg CO_2-eq.), due to the further decrease of CH_4 emissions mainly in category 6A: 'Solid waste disposal on land'.

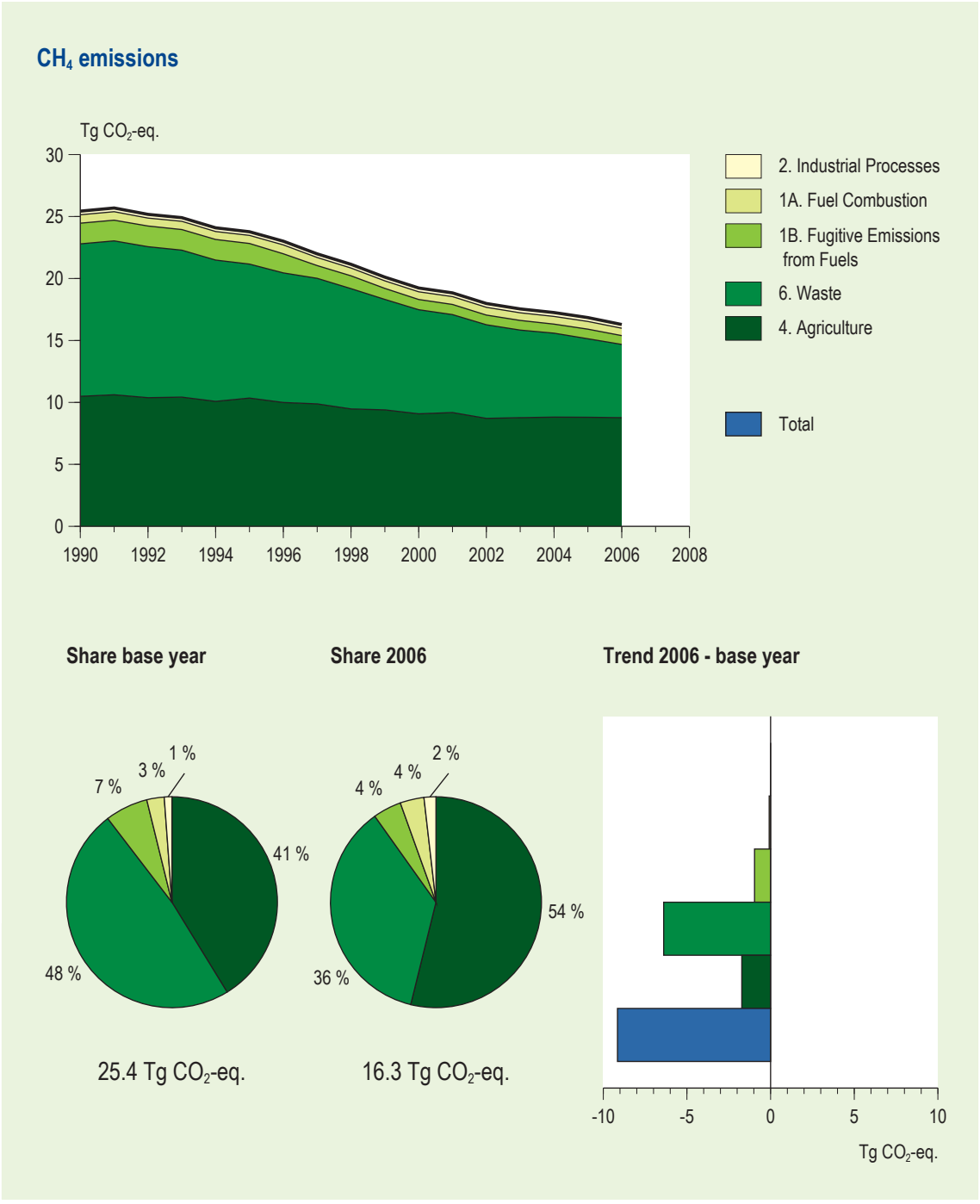


Figure 2.3 CH_4: trend, emission levels and share of sectors, 1990-2006

2.2.3 Nitrous oxide

Figure 2.4 presents the contribution of the most important IPCC sectors to the trend in national total N_2O emissions. The total national inventory of N_2O emissions decreased by about 15%, from 64.3 Gg in 1990 to 54.7 Gg in 2006 (from 19.9 to 16.9 Tg CO_2-eq.). Sectors contributing the most to this decrease in N_2O emissions are sectors 'Agriculture' (–18%) and 'Industrial Processes' (–13%). During the same period N_2O emissions from fossil fuel combustion increased. This latter trend can be largely clarified by increased emissions from Transport. Compared to 2005, the total N_2O emissions decreased by 1% in 2006 (-0,2 Tg CO_2-eq.).

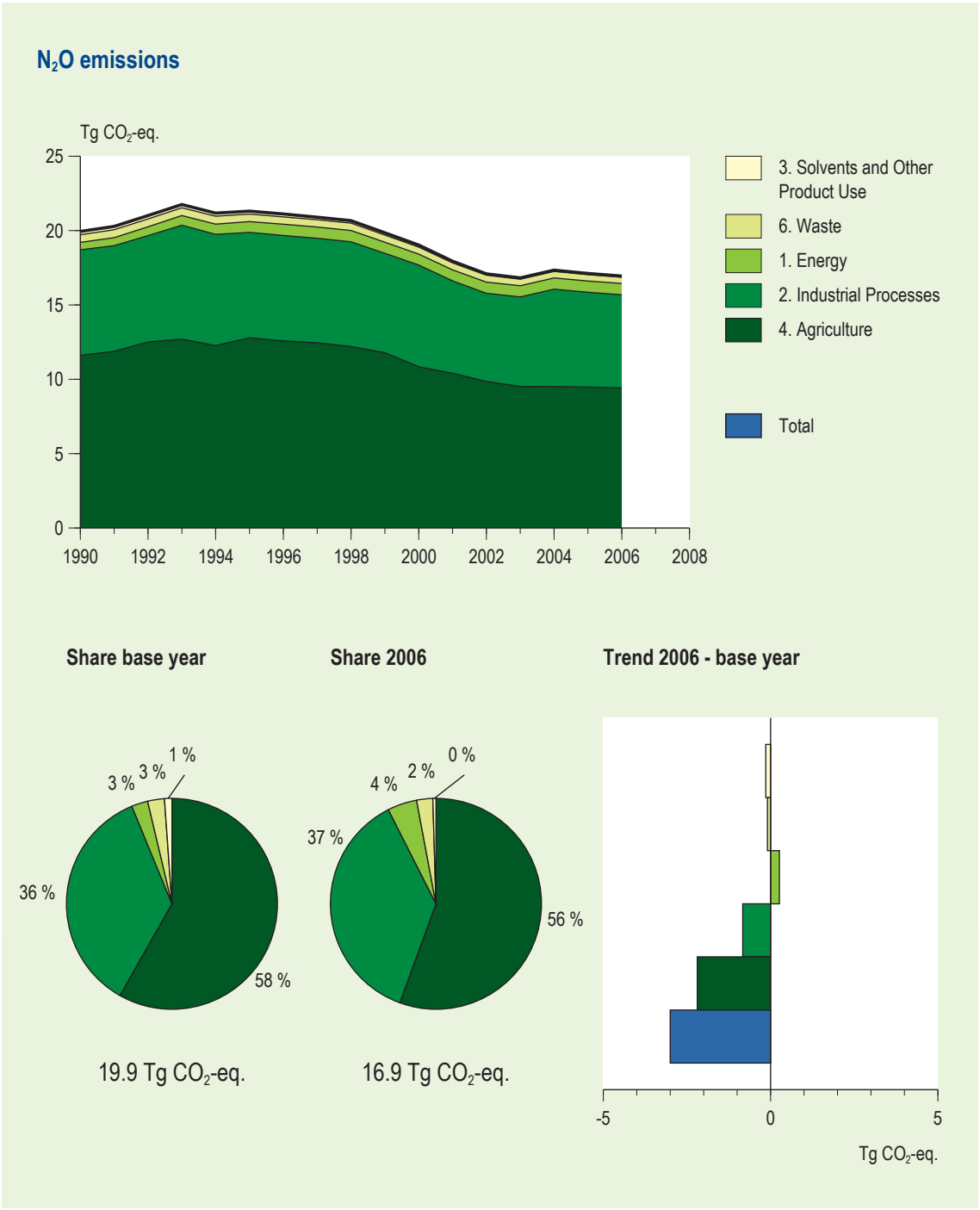


Figure 2.4 N_2O: trend, emission levels and share of sectors, 1990–2006

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 76% between 1995 and 2006, from 8.3 Tg CO_2-eq. in 1995 (base year for F-gases) to 2.0 Tg CO_2-eq. in 2006. Emissions of HFCs and PFCs decreased by approximately 74% and 87%, respectively, during this same period, while SF_6 emissions decreased by 29%.

The aggregated emissions of F-gases increased by 9 % from 2005 to 2006: HFC emissions showed a small increase of 15%. PFC and SF_6 emissions showed a continued decrease.

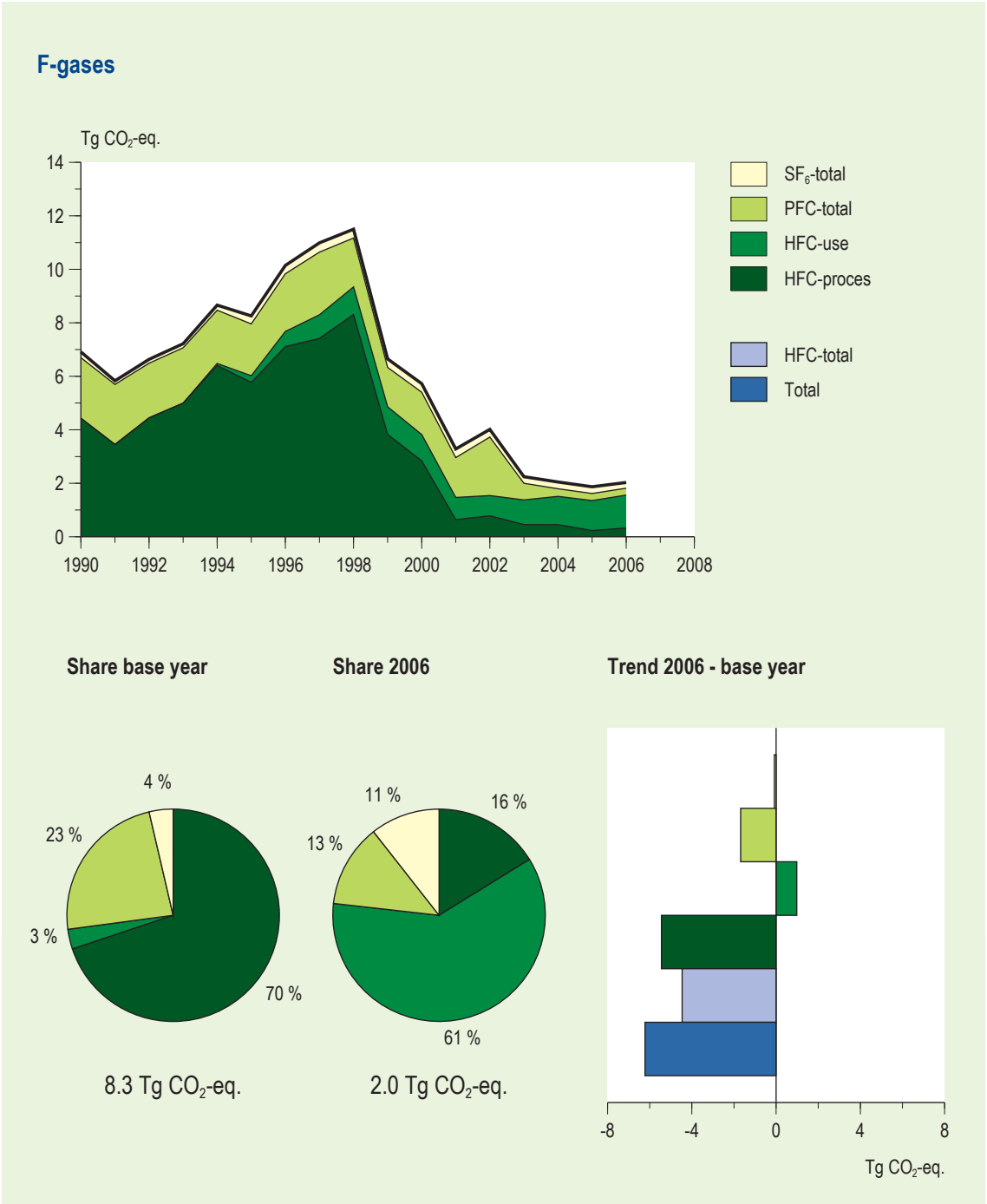


Figure 2.5 Fluorinated gases: trend, emission levels and share of individual F-gases, 1990–2006

2.2.5 Uncertainty in emissions specified by greenhouse gas

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

Per individual gas, the *trend* uncertainty in total emissions of CO_2 , CH_4, N_2O and the sum of the F-gases is estimated to be ±3%-, ±10%-, ±16%- and ±8%-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.

The IPCC sector 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 2006). The relative share of the other sectors decreased correspondingly. The emission level of the sector Energy increased by approximately 8% in the period 1990–2006, and total greenhouse gas emissions from the sectors Waste, Industrial processes and Agriculture decreased 51%, 30%, and 18%, respectively, in 2006 compared to the base year.

Compared to 2005, greenhouse gas emissions in the energy sector decreased by about 3.8 Tg (mainly CO_2) in 2006, due to a marked decrease in the category 1A1a 'Public electricity and heat production'. The emission of CO_2 from the combustion of fossil fuels in this category was reduced by approximately 3.8 Tg. The use of natural gas and coal, for example, was cut down by 5% and 6 % respectively. In spite of the reduction, the amount of electrical energy available remained at the same level due to promotion of renewable energy sources and extra imports of electricity. The use of renewable energy sources increased by approximately 40% in 2005, compared to the previous year, and net imports increased by 13%.

Trends in emissions by category and subcategory are described in more detail in chapters 3-8.

2.3.1 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%, ±10%, ±27%, ±41% 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 8% increase, for sector 2 Industry at ±6%-points in the 33% decrease, for sector 4 Agriculture at ±15%-points in the 18% decrease and for sector 6 Waste at ±9%-points in the 51% decrease.

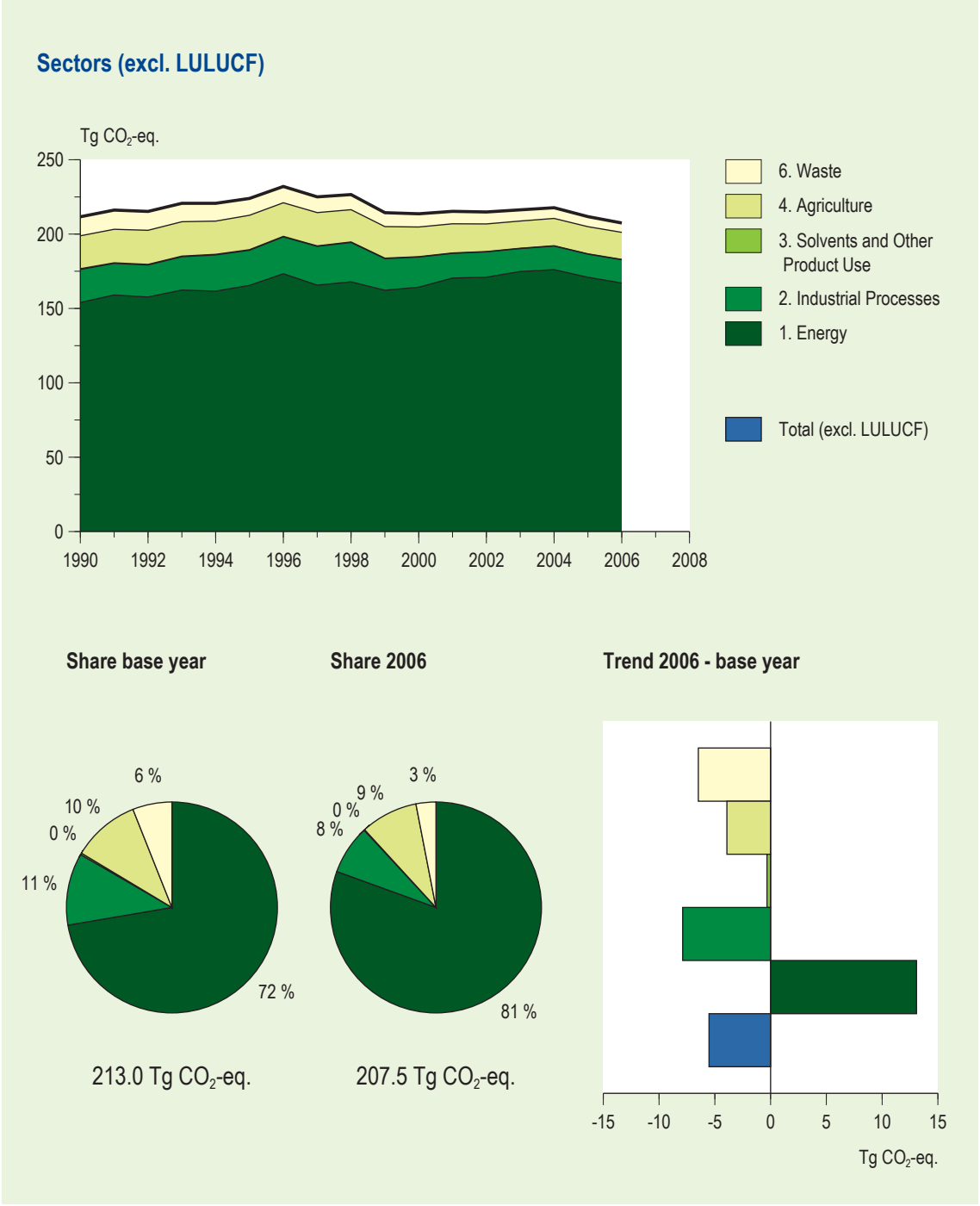


Figure 2.6 Aggregated greenhouse gases: trend, emission levels and share of sectors, 1990-2006

2.4 Emission trends for indirect greenhouse gases and SO_2

Figure 2.7 shows the trends in total emissions of CO, NO_x, NMVOC and SO_2. Compared to 1990, the CO and NMVOC emissions were reduced in 2006 by 49% and 64%, respectively. For SO_2 this is even 66%, and for NO_x, the 2006 emissions are 42% lower than the 1990 level. With the exception of NMVOC, most of the emissions stem from fuel combustion.
Because of the problems identified with annual environmental reporting (see section 1.3.2.) emissions of CO from industrial sources are not verified; however, experts have suggested that possible errors will have a minor effect on total emission levels. Due to lack of data, the time series for 1991–1994 was interpolated between 1990 and 1995.

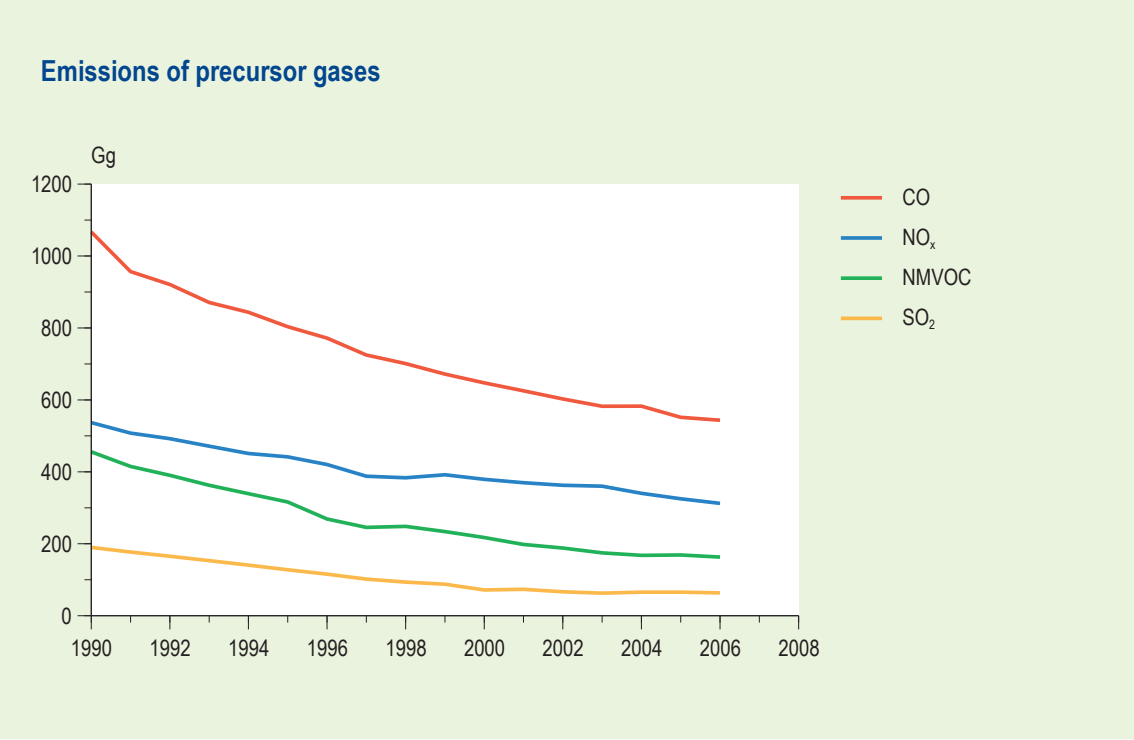


Figure 2.7 Emission trends of NO_x, CO, NMVOC and SO_2. (Units: Gg)

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

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).

3 Energy [CRF sector 1]

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 waste 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 2006 natural gas was the most important of the fossil fuels, contributing 56% to total fossil fuel use. Liquid fuels contributed 33%, and solid fuels, mainly coal used for public power generation, contributed another 11%. Although the combustion of fossil waste (reported under Other

Major changes in the Energy sector compared to the National Inventory Report 2007

Emissions: Compared to the previous submission, N_2O emissions from the sector *Energy* (subcategory Energy Industries, 1A1) increased for the years 1990 to 2005 by 12 to 58 Gg CO_2 eq (0.04, to 0.19 Gg) due to recalculated emissions from waste incineration. Also waste incineration data have been checked and corrected for waste composition and fraction of fossil carbon, resulting in slightly different biogenic CO_2 emissions reported in 1A1a. Emissions of inland navigation were recalculated based on new information gathered on the age of engines used in inland ships, resulting in 2 to 10% higher emissions (about 2% higher in 2005 and 2006). The N_2O and very small CH_4 emissions from passenger cars are now slightly higher (< 5%) compared to the previous submission due to new information on the number of kilometres driven.

Key sources: Compared to the previous submission, N_2O emissions from road transportation (1A3b) and CO_2 emissions from water borne navigation (1A3d) are now a key categories.

Methodologies: The N_2O emission factor for N_2O from waste incineration is now separately defined for installations with and without SNCR.

Fuels) has tripled since 1990, its share in total fossil fuel use is still only 1% at the present time. In the period 1990–2006 total fossil fuel combustion increased by 8%, of which two-thirds was due to a 12% increase in gas consumption, while liquid fuel use increased by 8%. At the same time the combustion of solid fuels decreased by 13%.

Total fossil fuel consumption for combustion decreased by about 1% between 2005 and 2006, mainly due to a 2% decrease in gas consumption, but also less solid fuels (3%) are used. The decreased use of solids and gas for combustion is mainly to be seen in power-generating activities (4% for solids and 5% for gaseous fuel use in category 1A1a), due to higher electricity imports and higher renewable energy production. Electricity import increased by 13% between 2004 and 2005; renewable energy increased by 40%. As the winter temperatures of 2006 were somewhat higher than in 2005, total gas consumption in the other sectors (1A4: residential, services, agriculture) was also lower (–1%) than in 2005.

Structure of energy production and consumption sectors

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

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

The Rotterdam 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. In addition, most marine fuel oil produced in Russia is transported to Rotterdam where it is sold on the market. Combined, this makes Rotterdam the world's largest supplier of marine bunker oils. Freight transport by trucks makes up a large share of road transport due to the many goods that are transferred from ships to trucks for further transport into Europe. In addition, Schiphol Airport is Western Europe's largest supplier of aviation bunker fuels (jet-fuel) (see section 3.8). The Netherlands also has one integrated steel plant, one cement manufacturer and two primary 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 8101: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels' (included in 1A);
- Protocol 8139: Emissions from biomass combustion. Memo item on CO_2, CH_4 and N_2O emission, including emissions from combustion of fossil waste (1A1a, 6B, memo item CO_2);
- Protocol 8103: CO_2, CH_4 and N_2O from 'Mobile Equipment' (1A2f, 1A4c);
- Protocol 8105: CO_2 from 'Road Transport' (1A3b);

- Protocol 8107: CH_4 from 'Road Transport' (1A3b);
- Protocol 8106: N_2O from 'Road Transport' (1A3b);
- Protocol 8104: CO_2, CH_4 and N_2O from 'Inland Aviation' (1A3a);
- Protocol 8110: CO_2, CH_4 and N_2O from 'Fisheries' (1A4c);
- Protocol 8108: CO_2, CH_4 and N_2O from 'Rail Transport' (1A3c);
- Protocol 8109: CO_2, CH_4 and N_2O from 'Inland Navigation' (1A3d);
- Protocol 8111: CO_2, CH_4 and N_2O from 'Military ships and aircraft' (1A5);
- Protocol 8112: CO_2, CH_4 and N_2O from 'Oil and Gas Production' (1B2);
- Protocol 8113: CO_2, CH_4 and N_2O from 'Oil and Gas Distribution/Transport' (1B2);
- Protocol 8102: CO_2, CH_4 and N_2O 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. According to FAO statistics annual production is less than about 10 kton and apparent consumption varies between about 15 and 40 kton per year (see http://faostat.fao.org/). Related CH_4 and N_2O emissions are therefore almost negligible (considerable less than 1 Gg per year).

Transparency

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

Overview of shares and trends in emissions

Table 3.1 and Figure 3.1 show the contribution of the source categories in the sector Energy to the total national greenhouse gas inventory. In 2006 the Energy sector accounted for 80% of the total national emissions (excluding LULUCF), the predominant share of these being CO_2 emissions. About 47% of the CO_2 emissions from fuel combustion stems from the combustion of natural gas, 17% 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 38% of the greenhouse gas emissions from this sector in 2006. Categories 1A2 'Manufacturing and construction industries', 1A3 'Transport' and 1A4 'Other sectors' (residential, services and agriculture/fisheries) contributed 17%, 22% and 23% of the total emissions, respectively (see Figure 3.1).

Since 1990, emissions from the Energy sector have increased approximately 8% (154.0 to 167.1 Tg CO_2-eq.), mainly due to increased CO_2 emissions in categories 1A1a 'Public electricity and heat production' (24%) and 1A3 'Transport' (37%).

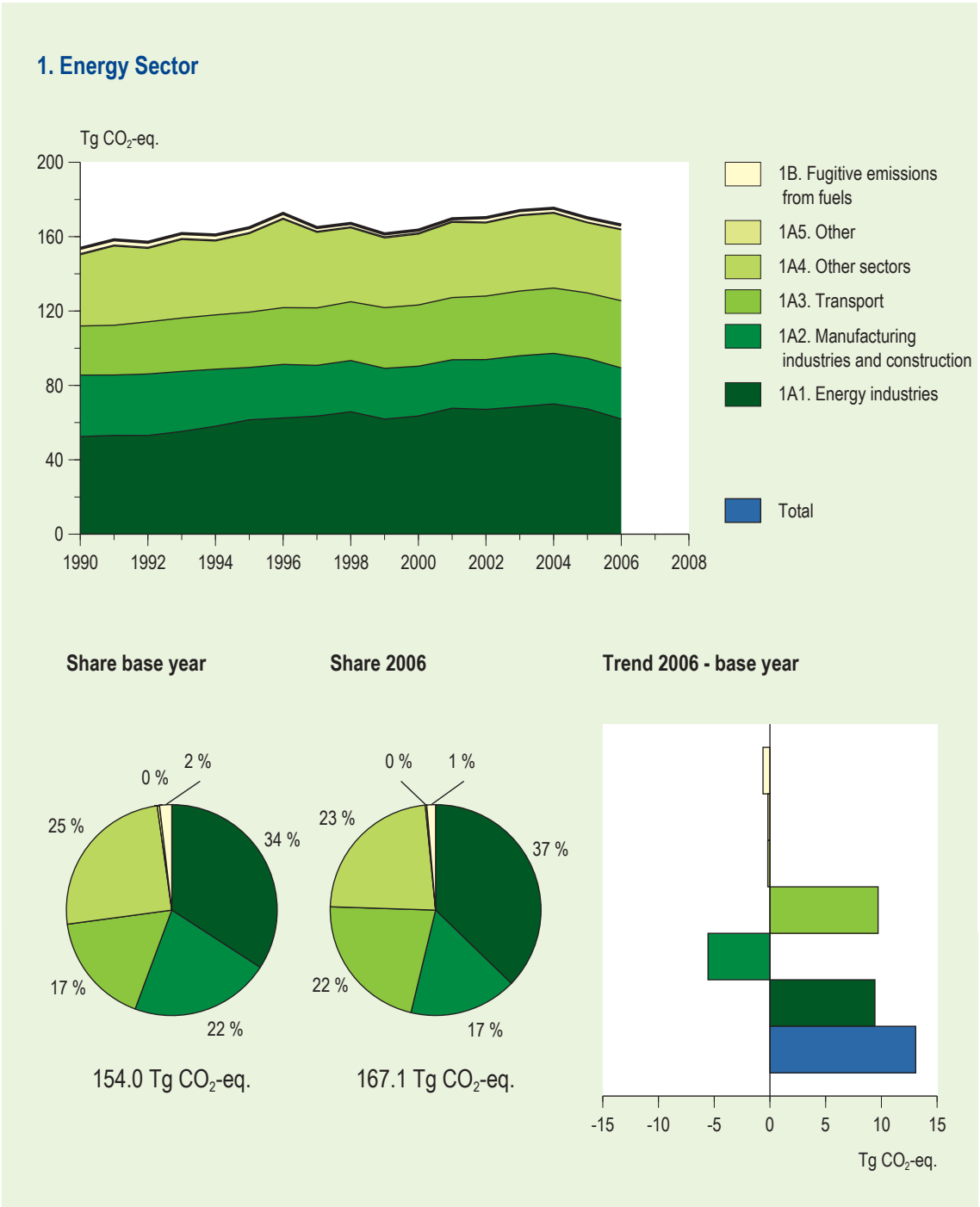


Figure 3.1 Sector 1 'Energy': trend, emission levels and share of source categories in sector 1, 1990-2006

Overall, emissions from 1A4 'Other sectors' have remained stable. Total Fugitive emissions from oil and natural gas' [1B] decreased by 27% in the period 1990–2006 (from 2.4 to 1.8 Tg CO_2-eq.), of which CH_4 emissions decreased by 58% and CO_2 increased by 38%. Between 2005 and 2006, total emissions in the Energy sector decreased by 8% or 5.5 Tg CO_2-equivalents, mainly as a result of decreased emissions from gas and solid fuel combustion from category 1A1a 'Public electricity and heating' (-3.2 Tg CO_2).

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

Sector/category	Gas	Key*	Emissions in base year		Emissions in 2006		Change 2006 - 2005		Contribution to total in 2006 (%)	
		Level, Trend, Non Key	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Tg CO_2-eq	By sector	Of total gas	Of total CO_2-eq
1 Energy	CO_2			151.2		165.0	-3.8	99	96	80
	CH_4		111.8	2.3	62.2	1.3	0.0	0.8	8	0.6
	N_2O		1.6	0.5	2.5	0.8	0.0	0.5	4	0.4
	All			154.0		167.1	-3.9	100		81
1A Fuel combustion	CO_2	*		151.2		163.5	-3.8	98	95	79
	CH_4		32.4	0.7	28.4	0.6	0.0	0.4	4	0.3
	N_2O		1.6	0.5	2.5	0.8	0.0	0.5	4	0.4
	All			150.7		164.1	-3.8	98		79
1A Emissions from stationary combustion (excl. 1A3)	CH_4	L2	24.9	0.5	26.1	0.5	0.0	0.3	3	0.3
1A1 Energy Industries	CO_2	*		52.5		61.9	-5.5	37	36	30
1A1a. Public Electricity and Heat Production	CO_2	*		39.9		49.3	-4.7	30	29	24
1A1a liquids	CO_2	L1,T1		0.2		0.7	-1.4	0	0	0
1A1a solids	CO_2	L,T1		25.8		23.6	-2.1	14	14	11
1A1a gas	CO_2	L,T		13.3		22.8	-1.1	14	13	11
1A1a other fuels: waste incineration	CO_2	L,T		0.6		2.1	0.0	1	1	1
1A1b. Petroleum refining	CO_2	*		11.0		10.7	-0.7	6	6	5
1A1b liquids	CO_2	L,T		10.0		8.0	-0.8	5	5	4
1a1b gases	CO_2	L1,T1		1.0		2.6	0.2	2	2	1
1A1c Manufacture of Solid Fuels and Other Energy Industries	CO_2	*		1.5		1.9	-0.1	1	1	0.9
1A1c gases	CO_2	L,T		1.5		1.9	-0.1	1	1	0.9
1A2 Manufacturing industries and construction	CO_2	*		33.0		27.5	0.3	16	16	13
1A2 liquids	CO_2	L,T1		9.0		8.4	1.0	5	5	4
1A2 solids	CO_2	L,T1		5.0		4.5	0.2	3	3	2
1A2 gases	CO_2	L,T		19.0		14.6	-0.9	9	9	7
1A2a. Iron and steel	CO_2	*		4.0		4.6	0.1	3	3	2
1A2b. Non-Ferrous Metals	CO_2	*		0.2		0.2	0.0	0.1	0.1	0.1
1A2c. Chemicals	CO_2	*		17.2		12.4	0.7	7	7	6
1A2d. Pup, Paper and Print	CO_2	*		1.7		1.6	-0.1	1.0	0.9	0.8
1A2e. Food Processing, Beverages and Tobacco	CO_2	*		4.1		3.8	-0.1	2	2	2
1A2f. Other	CO_2	*		5.8		4.8	-0.2	3	3	2
1A3. Transport	CO_2			26.0		35.6	1.0	21	21	17
	N_2O		0.9	0.3	1.5	0.5	0.0	0.3	3	0.2
	All			26.4		36.1	1.0	22		17
1A3a. Civil aviation	CO_2	Non key		0.04		0.04	0.0	0.0	0.0	0.0
1A3b. Road	CO_2	*		25.5		34.9	1.0	21	20	17
1a3b gasoline	CO_2	L,T1		10.9		13.2	0.2	8	8	6
1a3b diesel oil	CO_2	L,T		11.8		20.7	0.8	13	12	10
1a3b LPG	CO_2	L1,T		2.7		1.0	-0.1	1	1	0.5
1A3b. Road	N_2O	T2	0.9	0.3	1.5	0.5	0.0	0.3	3	0.2
1A3c. Railways	CO_2	Non key		0.1		0.1	0.0	0.1	0.1	0.0
1A3d. Navigation	CO_2	L1,T1		0.4		0.6	0.0	0.4	0.4	0.3
1A4. Other sectors	CO_2	*		37.9		38.1	0.4	23	22	18
	CH_4	*	18.7	0.4	17.3	0.4	0.0	0.2	2	0.2
	All			38.3		38.4	0.4	23		19
1A4 liquids (excl. From 1A4c)	CO_2	T		1.5		0.6	0.0	0.3	0.3	0.3
1A4a. Commercial/ Institutional	CO_2	*		7.5		10.6	0.9	6	6	5
1A4a gases	CO_2	L,T		6.6		10.3	0.8	6	6	5
1A4b. Residential	CO_2	*		19.5		17	-0.8	11	10	8

Sector/category	Gas	Key*	Emissions in base year		Emissions in 2006		Change 2006 - 2005		Contribution to total in 2006 (%)	
		Level, Trend, Non Key	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Tg CO_2-eq	By sector	Of total gas	Of total CO_2-eq
	CH_4		16.9	0.4	15.1	0.3	0.0	0.2	2	0.2
1A4b gases	CO_2	L,T1		18.7		17.1	-0.8	10	10	8
1A4c. Agriculture/Forestry/ Fisheries	CO_2	*		10.9		10.0	0.3	6	6	5
1A4c liquids	CO_2	L		2.5		2.6	0.0	2	1	1
1A4c gases	CO_2	L,T1		8.3		7.5	0.3	5	4	4
1A5 Other	CO_2	Non key		0.6		0.4	0.0	0.2	0.2	0.2
1B Fugitive emissions from fuels	CO_2	*		1.2		1.5	0.0	0.9	0.9	0.7
	CH_4	*	79.5	1.7	33.7	0.7	0.0	0.4	4	0.3
	All			2.8		2.2	2.6	1.3	1.1	1.1
1B1. Solid fuels transformation: coke production	CO_2	Non key		0.4		0.4	0.0	0.3	0.3	0.2
1B2. venting/flaring	CO_2	T		0.8		0.1	0.0	0.1	0.1	0.1
1B2. venting/flaring	CH_4	T	59.6	1.3	13.9	0.3	0.0	0.2	2	0.1
Total national emissions	CO_2		159,356	159.4	172,219	172.2	-3.7		100%	
	CH_4		1,211.3	25.4	775.4	16.3	0.0		100%	
	N_2O		64.3	19.9	54.7	16.9	0.0		100%	
National Total GHG emissions (excl. CO_2 LULUCF)	**All**			**213.0**		**207.5**	**-4.3**			**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.

Key sources

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

The following changes are found compared to the key source analysis for the NIR 2007:
- CO_2 emissions from 1A3 Mobile combustion: water-borne navigation: now key;
- N_2O emissions from 1A3 Mobile combustion: road vehicles: now key (Tier 2).

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 2007. 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, the reader is referred 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 factors, 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, 2008). In general, statistics for fuel consumption are much less accurate for the smaller figures, e.g. liquid and solid fuels in pulp and paper production and in the food processing industry and solid fuels in the other sectors (1A4a,b). The interannual variability in the data suggests that the uncertainty could be up to about 50%.

Time-series consistency
The emissions from fuel combustion are consistent with the national energy statistics, However, the time series of the energy statistics is not fully consistent at the detailed sector and detailed fuel-type levels for the years 1991–1994. This inconsistency is caused by revisions in the economic classification scheme that were implemented in 1993, a change from the 'special trade' to 'general trade' system to define the domestic use of oil products, some error corrections and the elimination of statistical differences. These changes were incorporated into the

data sets for 1990, 1995 and subsequent years, thus creating the existing inconsistency with the 1991–1994 dataset. For the base year 1990, 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).

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 recalculations

A source-specific recalculation was made for N_2O and biogenic CO_2 emissions from waste incineration included in Energy Industries (1A1a). For details see section 3.3.5. In transport, emissions of inland navigation were recalculated and CH_4 emissions from road transport have been revised. For details see section 3.5.5.

3.2.6 Source-specific planned improvements

There are no source-specific improvements planned.

3.3 Energy industries [1A1]

3.3.1 Source category description

This source category consists of 1A1a 'Public Electricity and Heat Production' (including emissions from waste incineration), 1A1b 'Petroleum Refining' and 1A1c 'Manufacture of Solid Fuels and Other Energy Industries'. Within these categories, natural gas and coal combustion by public electricity production and oil combustion by refineries are the dominating key sources. However, liquid fuels and other fuels (i.e. waste) in power generation and natural gas combustion in refineries and in manufacturing of solid fuels and other energy industries are also key sources. CH_4 and N_2O emissions from 1A1 'Energy Industries' contribute relatively little to the total national inventory of greenhouse gas emissions. CH_4 from stationary combustion is a 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 3.2; note that CO_2 from organic waste (waste organic part) does not contribute to net CO_2 emissions), since (almost) all incineration facilities also produce heat and/or electricity. In addition, a large fraction of the blast furnace gas and a significant part of coke oven gas produced by the one iron and steel plant in the Netherlands is combusted in the public electricity sector. This subcategory also includes the cogeneration (Combined Heat and Power, CHP) facilities (and sometimes also steam boilers) that are operated as joint-venture concerns.

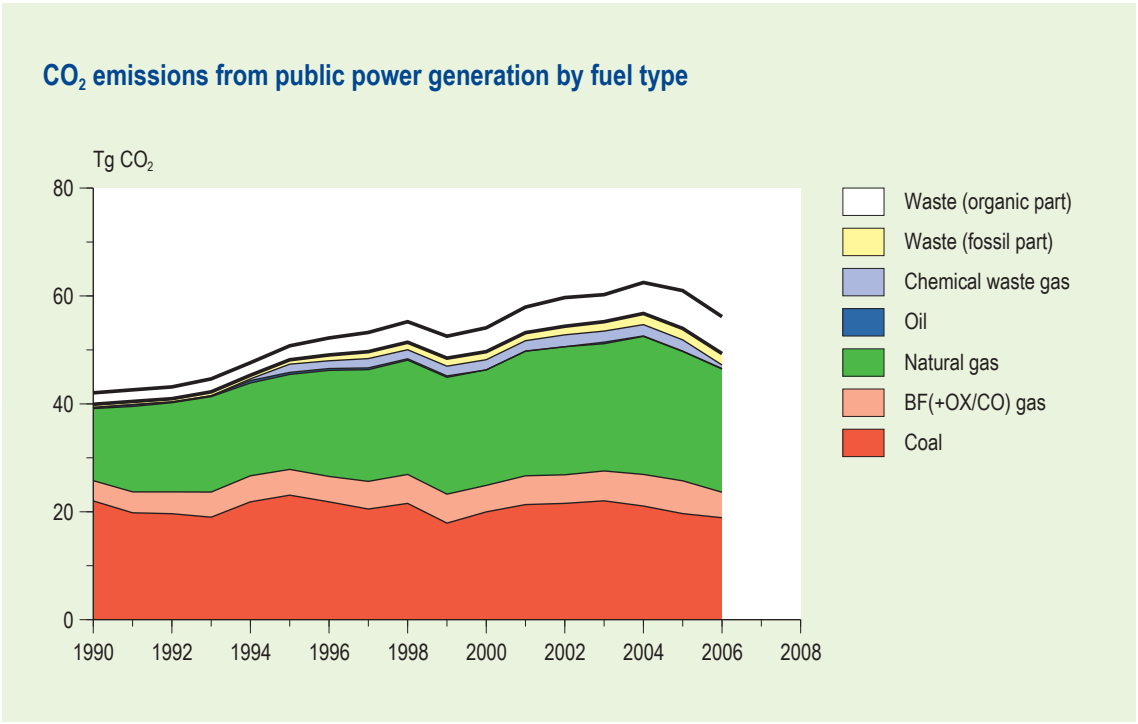


Figure 3.2 Trend in sources of CO_2 from fuel use in power plants (a small amount from coke oven gas, about 0.1 Tg, is included in coal)

Since CHP has a substantial and increasing share in fuel consumption and the ownership of several privately owned facilities has changed over time in joint-ventures with public electricity production industries, there has been a significant impact on emissions trends in the public electricity and heat production sector on one hand and the manufacturing industry and the other sectors on the other hand (see Figure 3.4).

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

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

Overview of shares and trends in emissions

In 2006 CO_2 emissions from category 1A1 'Energy industries' contributed 30% to the total national greenhouse gas emission inventory (excluding LULUCF) compared to 33% in 1990, while CH_4 and N_2O emissions from this same category 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 37% in 2006 (see Figure 3.3), partly due to a change in ownership of CHP plants (joint-ventures, which are allocated to this source category).

Between 1990 and 2006, total CO_2 emissions from 1A1 'Energy industries' increased 18%, from 52.7 to 62.3 Tg (see Figure 3.3). Due to an increasing demand for electricity, 1A1a 'Public electricity and heat production' (+9.4 Tg CO_2), is the most important source category responsible for the increased emissions in the category 1A1 'Energy industries'. In 2006, CO_2 emissions from 1A1 'Energy industries' decreased by about 8%, especially in category 1A1a 'Public electricity and heat production'.

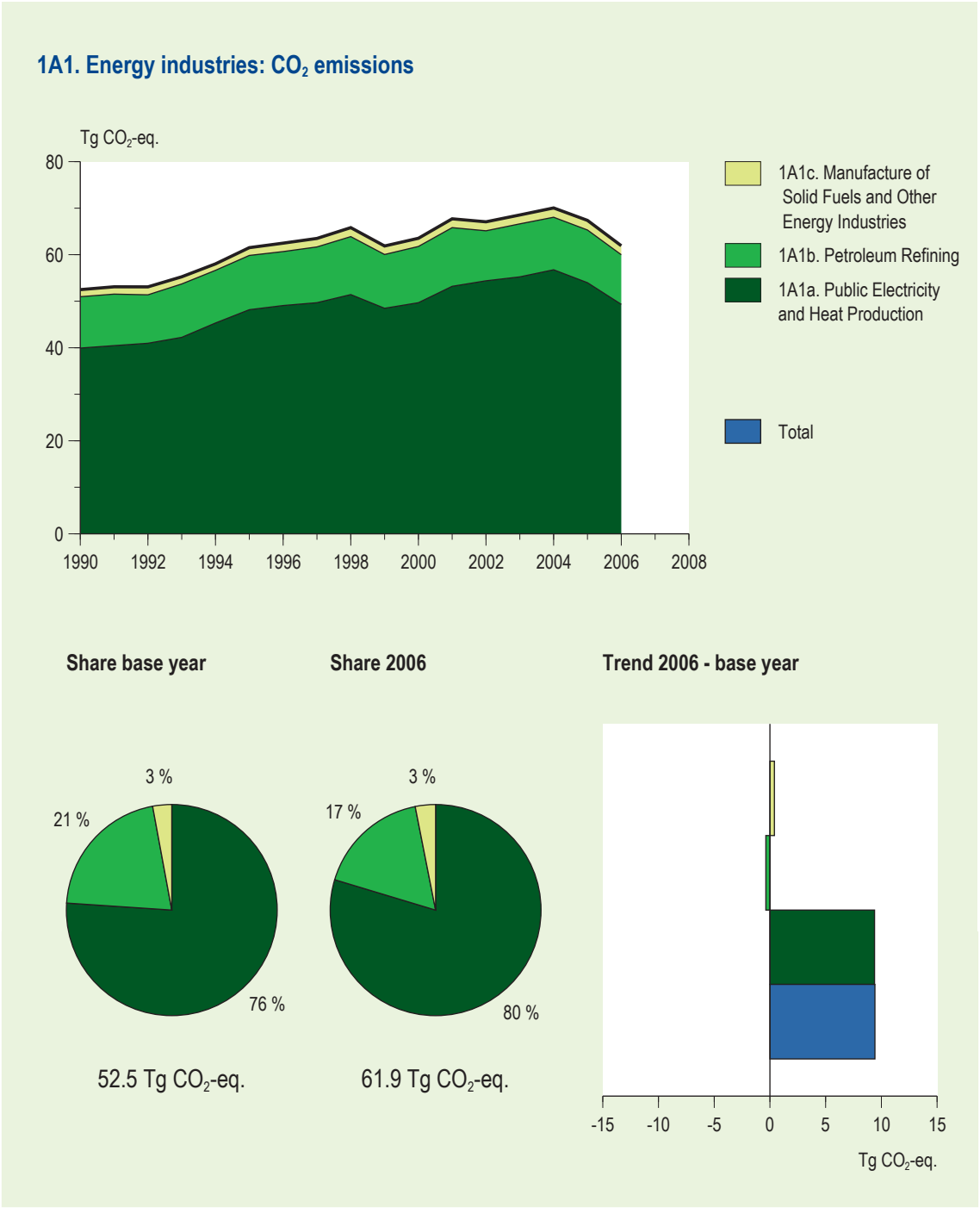


Figure 3.3 1A1 'Energy industries': trend, emission levels and share of source categories in 1A1, 1990-2006

Public Electricity and Heat Production [1A1a]
In 2006, 1A1a 'Public electricity and heat production' was the largest source category within the 1A1 Energy industries, accounting for 80% of the total greenhouse gas emissions from this category (see Figure 3.3). CO_2 emissions from waste incineration of fossil carbon represent 4% of the total greenhouse gas emissions in 1A1a Public electricity and heat production.

Between 1990 and 2006, total CO_2 emissions from 'Public electricity and heat production' increased by 24%, from 39.9 to 49.3 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 deposited in landfills. The increasing level of CO_2 emissions in this period is partly compensated by a shift from the use of coal to natural gas and the increased efficiency of power plants.

Between 1990 and 1998, changed ownership relations of plants (joint-ventures) caused a shift of cogeneration plants from 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.

In 2006, the emissions of CO_2 from the combustion of fossil fuels in this source category dropped by 9%. The 4.7 Tg decrease was partly due to 8%-points higher net imports, thus lower domestic production, e.g. by coal-fired power plants (-2.1 Tg CO_2). In addition, in 2006 significantly less blast furnace gas and chemical waste gas was used for power generation mainly due to a decrease in ownership of joint-ventures with the chemical industry (1A2c) (see Figure 3.5), of which the emissions were formerly allocated in the energy industries (1A1a). Further explanation of the trends after 1998 are discussed below under the section on Activity data and (implied) emission factors.

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 2006. However, the combustion emissions from this subcategory should be viewed in relation to the fugitive emissions reported under 1B2. Between 1990 and 2006 total CO_2 emissions from the refineries (including fugitive CO_2 emissions from hydrogen production reported in 1B2a-iv Refining) fluctuated between 11 and 12 Tg (11.0 Tg in 1990 and 10.7 Tg in 2006).

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 2006. 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. The combustion emissions from oil and gas production refer to the so-called 'own use' of the gas and oil production industry, which is the difference between the amounts of fuel produced and sold, after subtraction of the amounts of associated gas which is either flared or vented or otherwise lost by leakage etc. Production and sales data are based on the national energy statistics; amounts flared and vented are based on reports from the sector. CO_2 emissions from this source category increased from 1.5 Tg in 1990 to 1.9 Tg CO_2 in 2006 mainly due to the exploitation of less favourable production sites for oil and gas production compared with those exploited in the past.

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 are partly compensated for by a shift from coal to natural gas and the increased efficiency of power plants (Figure 3.3). 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 cogeneration plants and a few large chemical waste gas-fired steam boilers being shifted from 'Manufacturing Industries' to the 'Public Electricity and Heat Production' due to changed ownership (joint-ventures). The corresponding CO_2 emissions allocated to the Energy sector increased from virtually zero in 1990 to 8.5 Tg in 1998 and 9.1 Tg in 2005 (see Figure 3.5). In 2006 emissions decreased to 7.3 Tg due to higher net imports and a shift of ownership of cogeneration plants from joint-venture to a single owner in the chemical industry.

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

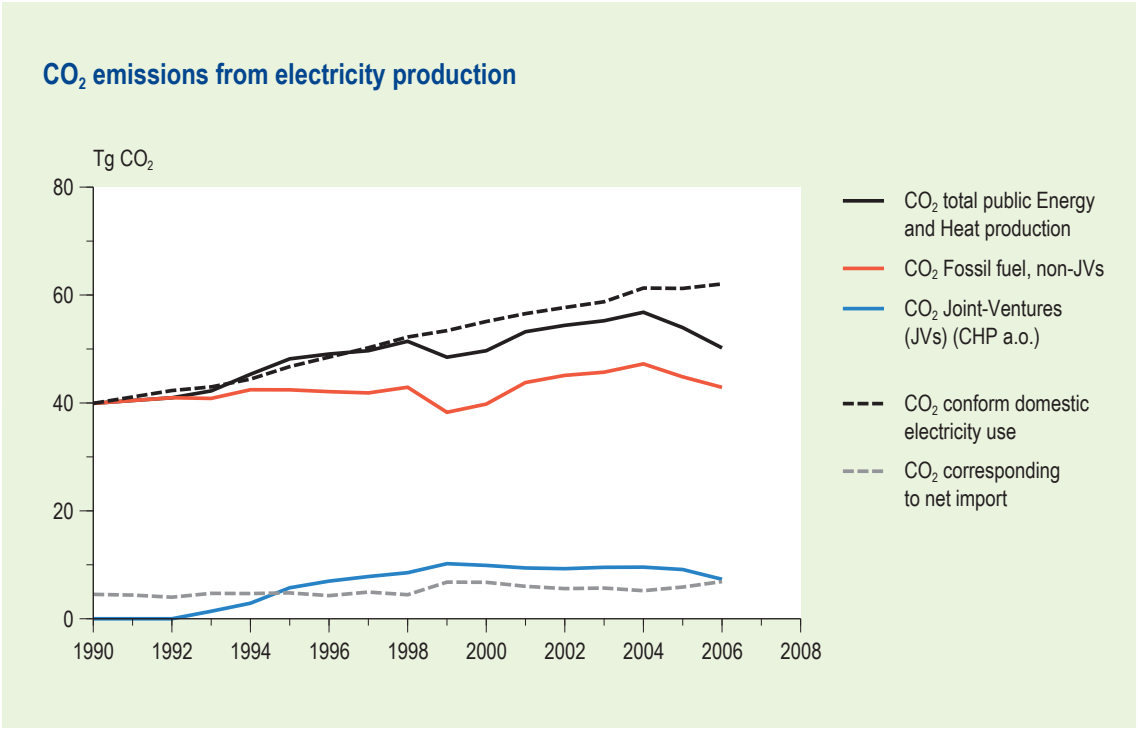


Figure 3.4 Trends in CO_2 emissions from public electric power generation (including public heat production)

In 2006, CO_2 emissions in this category decreased by 4.7 Tg. The use of natural gas and solid fuels was cut down by 5 and 8%, respectively. In spite of this reduction, the amount of electrical energy available remained at the same level partly due to extra net import of electricity, which increased by 2.5%-points to 18%. Of the 2.1 Tg decrease of solid fuels 1.4 Tg was due to significantly less use of blast furnace gas used for power generation (see Iron and Steel in section 3.4.1 for more information) while the remainder was due to less production by coal-fired power plants. However, in 2006 also significantly less chemical waste gas (included in 'liquid fuel') was used for public power generation mainly due to a decrease in ownership of joint-ventures with the chemical industry (1A2c) (see Figure 3.5), of which the emissions were formerly allocated in the energy industries (1A1a) but now under the chemical in (1A2c). This shift in allocation corresponds with a CO_2 decrease of 1.4 Tg.

After several years of a strong increase, in 2006 biomass combustion in power generation decreased by about 1%, mainly due to decreased co-combustion of biomass in coal-fired power stations. This is the result of a change in the MEP subsidising scheme to encourage the use of biomass in electricity production. Although very effective the MEP was more expensive than the government estimated. As a result in June 2005 the MEP for new large biomass projects and for offshore wind energy projects was cancelled (subsidies which were already granted are guaranteed for 10 years); the other categories of the MEP have been cancelled in September 2006.

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 3.4) 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 are used – included in solid fuels – thereby explaining the inter-annual variation in the implied emission factors (IEFs) for CO_2 .

CO_2 emissions from joint-ventures (cogeneration and steam boilers)

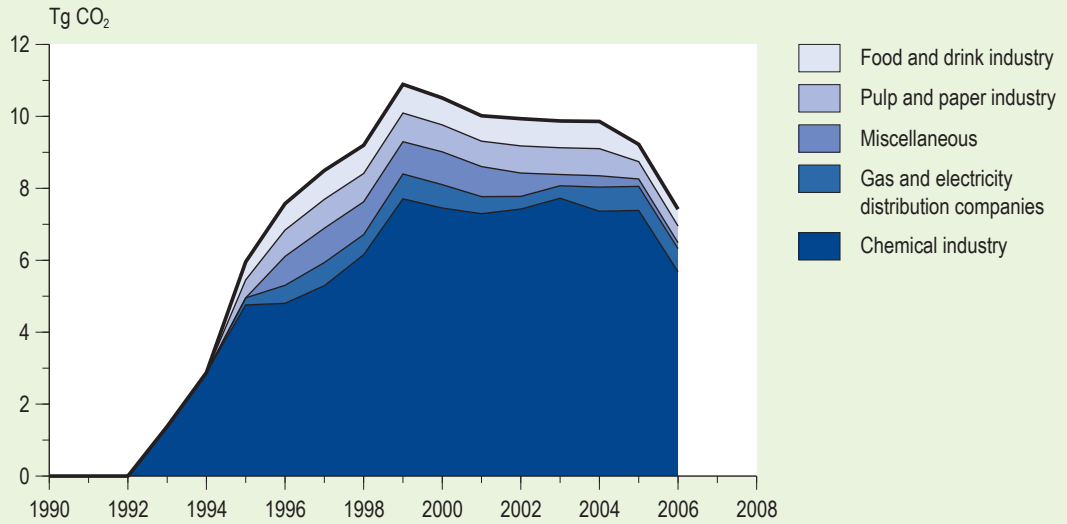


Figure 3.5 Trends in CO_2 emissions from joint-ventures of cogeneration plants and steam boilers

The strong increase in liquid fuel use in 1994 and 1995, with a sharp increase in 1995, is due to chemical waste gas being used, as shown in Figure 3.4, 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 4 percent. The increase in the CO_2 emission factor for 'other fuels' since 2004 is due to the increase in the share of plastics (which have a high carbon fraction) in the combustible waste (see Table 8.6 on composition of incinerated waste). The decrease in 2005 and 2006 in the implied emission factor for CO_2 from biomass is due to the increase of the share of pure biomass (co-combusted with coal-firing) as opposed to the organic carbon in waste combustion with energy recovery. For the former type a lower emission factor is applied than for the latter.

Refineries [1A1b]
Besides combustion emissions from this subcategory also fugitive CO_2 emissions from hydrogen production (including gasification) are reported under 1B2. For 2002 onwards, the latter are no longer included as 'unaccounted for' in liquid fuel combustion of this subcategory. This affects both activity data for liquid fuel and the related emissions. Resulting CO_2 combustion emissions from 'Refineries' decreased by 7% in 1999 and by 15% in 2002. This corresponds with similar reductions in the activity data in terms of liquid fuel combustion and in terms of crude throughput (somewhat larger, but partly compensated by increases in gas combustion). These liquid fuel combustion emissions constitute about 5% of the national total CO_2 emissions (see Table 3.2).

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

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

Manufacture of solid fuels (coke) and other energy industries (fuels production) [1A1c]
This category comprises mainly CO_2 emissions from natural gas. The dominating source is 'own use' for energy purposes by the oil and gas production and transmission industry. The emissions from this source category increased from 1.5 Tg in 1990 to 1.9 Tg CO_2 in 2006 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); liquids and gases in 1A1b and gases in 1A1c. A country-specific top-down (Tier 2) method is used for calculating the emissions for fuel combustion in the 1A1 'Energy Industries'. The fuel combustion emissions in this sector are calculated using fuel consumption data from national sectoral energy statistics and IPCC default emission factors for CO_2 and N_2O, with the exception of CO_2 for natural gas and chemical waste gas and coal, for which country-specific emission factors are used. When available, company-specific or sector-specific emission factors have been used, in particular for derived gases such as refinery gas, chemical waste gas and blast furnace gas (see Table A2.2). More details on methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.greenhousegases.nl and section 3.1).

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

For 1A1b 'Petroleum Refining' the calculation of emissions from fuel combustion is based on the sectoral energy statistics, using the fuel consumption for energetic purposes as activity data (including the consumption of residual refinery gases). Although the same method is still used, the quality of the data used to calculate and report CO_2 emissions is now improved by incorporating the CO_2 emissions reported by the individual refineries for 2002 onwards. Since 1998 one refinery operates the SGHP unit, supplying all the hydrogen for a large scale hydrocracker. When producing hydrogen also CO_2 is produced as a co-product from the chemical processes (CO_2 removal and a two stage CO shift reaction). Refinery data specifying these fugitive CO_2 emissions are available and used for 2002 onwards. The fuel used to provide the carbon for

this non-combustion process is subtracted from the fuel consumption used to calculation the combustion emissions reported in this subcategory. However, the use of plant-specific emission factors for refinery gas for 2002 onwards – arithmetically resulting from the reported CO_2 emissions and combustion emissions as calculated using the default data – also causes changes in the implied emission factor for CO_2 for total liquid fuel compared to the years prior to 2002 (i.e. the emission factor for refinery gas is adjusted to get exact correspondence between the total calculated CO_2 emissions and the total CO_2 emissions officially reported by the refineries).

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

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

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

Table 3.2 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	2005	2006
Liquid: total	10.0	9.9	9.3	10.2	10.0	10.4	10.1	10.0	10.6	9.7	10.2	10.8	8.6	9.3	9.0	8.9	8.0
o.w. oil products, excl. refinery gas	*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*	*2.6*	*2.3*
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*	*5.9*	*6.5*	*6.4*	*6.3*	*5.7*
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*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
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	2.5	2.6
Process vent in SGHP plant*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.9	0.9	0.9	0.9	0.9
Total CO_2 from refineries	11.0	11.1	10.4	11.5	11.3	11.7	11.6	12.0	12.4	11.6	12.1	12.6	10.7	11.4	11.3	11.3	10.7
Refinery act data: throughput (PJ)	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	2.3	2.4
CO_2/PJ throughput	5.0	4.4	4.0	4.1	4.0	4.3	4.3	4.4	4.4	4.8	0.0	5.0	4.9	5.0	4.9	4.9	4.5

* SGHP = Shell Gasification and Hydrogen Production Unit. These CO_2 emissions are reported under 1B2.

3.3.3 Uncertainty and time-series consistency

Uncertainties

The uncertainty in CO_2 emissions of this category is estimated to be 3% (see section 1.7 for more details). The accuracy of fuel consumption data in power generation and oil refineries is generally considered to be very accurate, with an estimated uncertainty of approximately 0.5%. The high accuracy in most of these activity data is due to the limit number of utilities and refineries that report their large fuel consumption as part of the national energy statistics and which are verified as part of the European Emission Trading Scheme. The two exceptions are solids in the power generation and liquids in refineries, which have a larger estimated uncertainty of 1% and 10%, respectively, based on the share of blast furnace gas in total solid consumption, the 'unaccounted for liquids' calculated for refineries and the recalculations made for 2002-2004 as presented in this report (Olivier and Brandes, 2008). The high uncertainty in the liquids in refineries apply mainly to the years prior to 2002, for which accurate reported CO_2 emissions are not available at the required aggregation level. The consumption of gas and liquid fuels in the 1A1c category is mainly from the oil and gas production industry, where the split into own use and venting/flaring has proven to be quite difficult, and thus a high uncertainty of 20% is assigned. For other fuels a 10% uncertainty is used, which refers to the amount of fossil waste being incinerated and thus to the uncertainties in the total amount of waste and the fossil and biomass fractions.

For natural gas the uncertainty in the CO_2 emission factor is now estimated to be 0.25% (instead of 1%) based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier and Brandes (2008); however this value is not yet used in the uncertainty assessment in section 1.7 and key source assessment in Annex 1. For hard coal (bituminous coal) an analysis was made of coal used in power generation (Van Harmelen and Koch, 2002). For the default power plant factor, 94.7 CO_2/GJ is the mean value of 1270 samples taken in 2000, which is accurate within about 0.5%. However, in 1990 and 1998 the emission factor varies ±0.9 CO_2/GJ (see Table 4.1 in Van Harmelen and Koch, 2002); consequently when the default factor is applied to other years, the uncertainty is apparently larger, about 1%. Analysis of the default CO_2 emission factors for coke oven gas and blast furnace gas reveals uncertainties of about 10% and 15%, respectively (data reported by the steel plant). Since the share of BF/OX gas in total solid fuel emissions from power generation is about 15-20%, the overall uncertainty in the CO_2 emission factor of solids in power generation is estimated to be about 3%. The CO_2 emission factors of chemical waste gas and – to a lesser extent – of BF/OX gas are more uncertain than those of other fuels used by utilities. Thus, for liquid fuels in these sectors is a higher uncertainty of 10% assumed in view of the quite variable composition of the refinery gas used in both sectors. For natural gas and liquid fuels in 'Oil and Gas Production' (1A1c) uncertainties of 5% and 2% are assumed, respectively, which refer to the variable composition of the offshore gas and oil produced. For the CO_2 emission factor of other fuels (fossil waste), an uncertainty of 5% is assumed, which reflects the limited accuracy of the waste composition and of the carbon fraction per waste stream. The uncertainty in the emission factors of CH_4 and N_2O from stationary combustion is estimated at about 50%, which is an aggregate for the various subcategories (Olivier and Brandes, 2008).

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 8101: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.3.5 Source-specific recalculations

The ERT reviewed the NIR 2006 in 2007 and recommended to provide justification for the validity of the used emission factor for waste incineration (1.4 kg N_2O/TJ for both the fossil part of the waste and the organic part (= biomass part) or to provide a revised estimate, since Table 8.6 in the NIR 2006 showing the composition of incinerated waste was not consistent with the actual values used for the calculation. The emission factor of 1.4 kg N_2O/TJ for both the fossil part of the waste and the organic part (= biomass part) of the waste incinerated was introduced before default IPCC factors for waste were published (IPCC 1996 Guidelines). In the Dutch protocol the emission factor for waste of 4 kg N_2O/TJ was set (Table 1-8, IPCC 1996 Guidelines) and in the NIR 2005, the value of 20 g/ton waste was presented (Table A3.1), but erroneously none of these emission factors were used.

In response to the ERT recommendation of 2007, a careful evaluation of the country-specific emission factors was made and it was decided to select the value of 20 g N_2O/ton waste incinerated as the national default for all facilities not equipped with Selective Non-Catalytic Reduction of NO_x (SNCR-DENO$_x$) abatement technology. This factor was documented in Spoelstra (1993) and is based on 2 days of concentration measurements at 3 ovens of one non-SNCR waste incinerator plant in the Netherlands. This value corresponds to an emission factor expressed in GJ of 2.44 g/GJ in 1990 and e.g. 1.89 g/GJ in 2004, using conversion factors of 8.2 GJ/ton for 1990 and 10.6 GJ/ton for 2006 (see Table 8.6). The uncertainty in this emission factor is estimated at about 100% (95% confidence interval) due to variability – as measured – of combustion conditions. This reference is also listed in the IPCC guidelines.

In the Netherlands also some waste incineration facilities use SNCR abatement using ammonia as reducing agent. The SNCR technology is known to increase the emission factor for N_2O (TNO, 1995; as communicated by Oonk (2005, personal communication), but in general for SNCR types using ammonia lower N_2O emission factors should be applied than for SNCR types using urea or cyan uric acid. For SNCR with ammonia the emission factor of 100 g N_2O/ton waste was adopted, which is about the middle of the range reported in TNO (1995). This corresponds to emission factors of 12.2 g/GJ in 1990 and 9.9 g/GJ in 2006 using the conversion factors mentioned above. The uncertainty in these emission factors are also estimated at about 100% due to variability – as reported in the references.

In 1990 only one waste incineration facility had SNCR abatement, with a share in the total amount of waste incinerated of 6%. In later years other incineration facilities started with SNCR abatement, increasing the share of SNCR to about 36% in 2006. Table 3.3.a shows the increasing fraction over time and the two emission factors converted into g/GJ over time and the weighted average value in g/GJ.

Table 3.3b shows the revised emissions for N_2O based on the emission factor of 2.4 g N_2O/GJ in 1990 for non-SNCR facilities and of 12.2 g N_2O/GJ in 1990 for facilities with SNCR, decreasing linearly to 1.9 and 9.4 g/GJ in 2004 due to the increase in energy contents per ton of waste and slightly increasing thereafter.

3.3.6 Source-specific planned improvements

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

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 (that means 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. Subcategory 1A2f 'Other' includes all other industry branches, among which are mineral products (cement, bricks, other building materials, glass), textiles, wood and wood products. Also included are the emissions from the building construction industry and the emissions of off-road vehicles (mobile machinery) for building construc-

tion and for the construction of roads and waterways and other off-road sources (except agriculture) (liquid fuels). The latter refers mainly to sand and gravel production.

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

Overview of shares and trends in emissions

In 2006 the share of CO_2 emissions from 1A2 'Manufacturing and construction industries' in the total national greenhouse gas emission inventory was estimated to be 16% compared to 21% in 1990. In contrast. the share of the other greenhouse gas emissions in this category is relatively small. Subcategory 1A2c 'Chemical industry' is the largest contributor to CO_2 emissions, accounting for approximately 52% in 1990 and 45% in 2006 of the total emissions from the manufacturing industry.

In the period 1990–2006, CO_2 emissions from combustion in 1A2 'Manufacturing and construction industries' decreased 17% (from 33.0 to 27.5 Tg; see Figure 3.6).

The chemical industry contributes the most to this decrease in emissions in this source category, with its contribution to CO_2 emissions decreasing by 28% or 4.7 Tg. When the re-allocations of CO_2 emissions to the Energy industry due to the above-mentioned formation of joint-ventures are taken into account (see sections 2.3.1 and 3.3.1 for more details), the CO_2 emissions from fuel combustion in most of the industrial source categories remained almost stable, while the production significantly increased (see section 3.4.1). Total CO_2 emissions from 1A2 'Manufacturing and construction industries' in 2006 increased from 27.2 to 27.5 Tg.

Table 3.3.a Emission factors used for N_2O from waste incineration, share of SNCR technology and weighted average emission factor (unit: g N_2O/GJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Fraction SNCR	6%	6%	6%	23%	23%	23%	33%	33%	33%	33%	34%	34%	35%	36%	36%	36%	36%
EF default	2.4	2.4	2.4	2.3	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	2.0	1.9	2.0	2.0
EF SNCR	12.2	12.0	11.8	11.6	11.5	11.3	11.1	10.9	10.7	10.5	10.4	10.2	10.0	9.8	9.4	9.9	9.9
Weighted avg. EF:	3.0	3.0	2.9	4.2	4.1	3.9	4.6	4.6	4.6	4.5	4.6	4.6	4.7	4.6	4.7	4.8	4.8

Table 3.3.b Recalculated emissions for N_2O from waste incineration in the Netherlands (1A1a: biomass (part), other fuel) (unit: Gg N_2O)

1A1a subcategory		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
other fuel	old	0.013	0.013	0.013	0.016	0.016	0.018	0.025	0.03	0.032	0.034	0.034	0.034	0.036	0.04	0.041	0.041
Biomass (part)	old	0.018	0.018	0.018	0.02	0.019	0.022	0.027	0.032	0.034	0.036	0.036	0.034	0.036	0.035	0.037	0.037
Total incineration	old	0.032	0.032	0.032	0.036	0.035	0.04	0.052	0.062	0.066	0.069	0.07	0.069	0.072	0.075	0.078	0.078
other fuel	new	0.029	0.028	0.027	0.046	0.046	0.050	0.081	0.097	0.107	0.110	0.109	0.114	0.121	0.131	0.147	0.140
Biomass (part)	new	0.040	0.039	0.038	0.064	0.055	0.061	0.090	0.105	0.109	0.114	0.122	0.113	0.120	0.114	0.115	0.126
Total incineration	new	0.069	0.067	0.065	0.110	0.102	0.111	0.171	0.203	0.216	0.224	0.230	0.227	0.240	0.245	0.262	0.266
difference (total)		0.037	0.035	0.033	0.074	0.067	0.071	0.119	0.141	0.150	0.155	0.160	0.158	0.168	0.170	0.184	0.188
difference (Gg CO_2eq.)		11.5	11.0	10.2	22.9	20.7	22.0	37.0	43.6	46.5	48.1	49.6	48.9	52.2	52.7	57.1	58.3

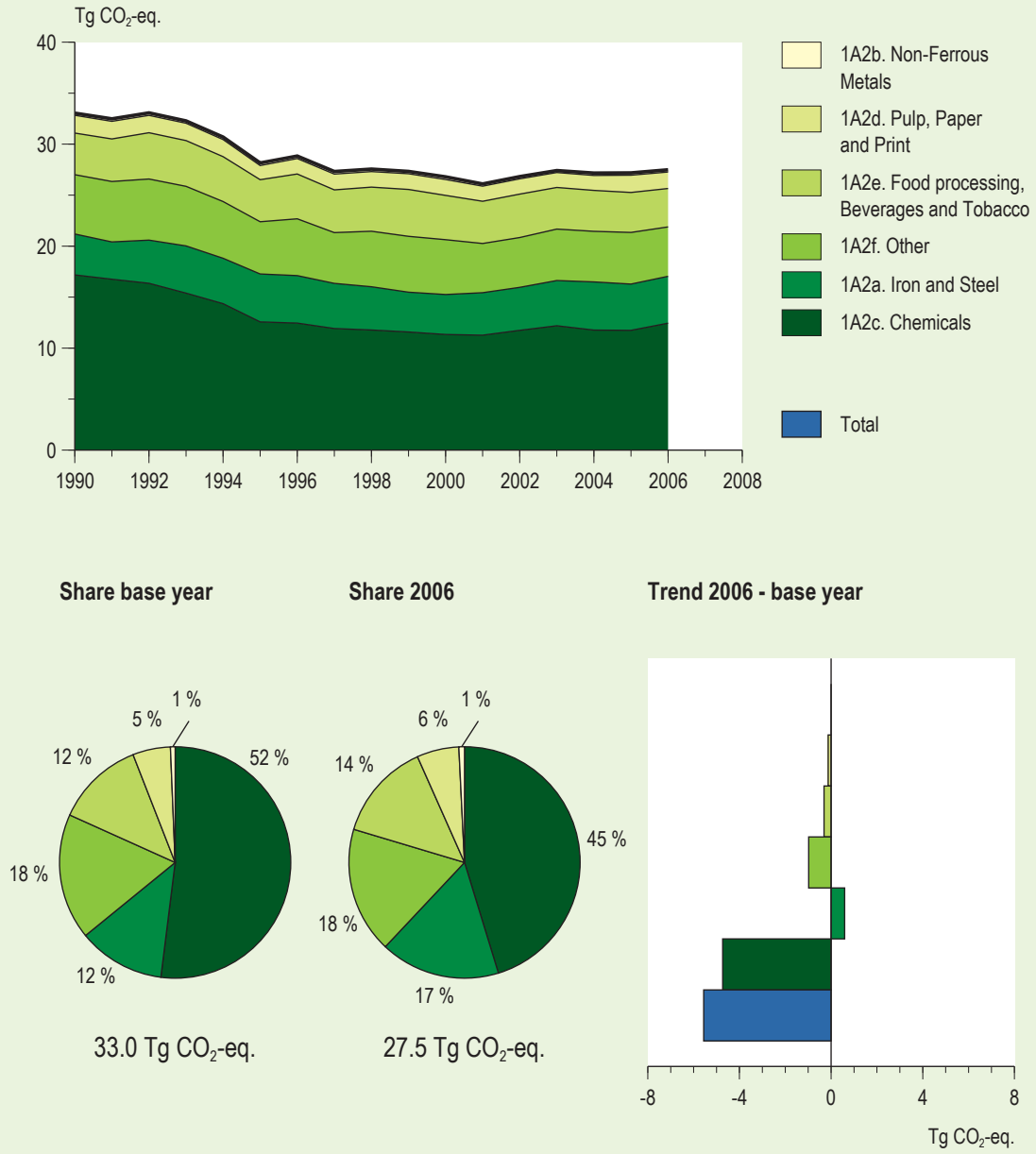


Figure 3.6 1A2 'Manufacturing and construction industries': trend. emission levels and share of source categories in 1A2, 1990-2006

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

Iron and Steel [1A2a]
The contribution of 1A2a 'Iron and steel' to the CO_2 emissions from 1A2 'Manufacturing and construction industries' was about 12% in 1990 and 17% in 2006. 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 2006 CO_2 emissions from solid fuel combustion of the iron and steel industry increased slightly (0.1 Tg).

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 45% in 2006.The combustion of natural gas and liquid fuels account for 55%, respectively 39% in the CO_2 emissions from the chemical industry. CO_2 emissions from this source category have decreased by approximately 28% since 1990, which is mainly due to the 45% decrease in the consumption of natural gas during the same period.

In 2006 CO_2 emissions from liquid fuel combustion in the chemical industry increased by 19% or 1.1 Tg CO_2 mainly due to a decrease in ownership of joint-ventures, of which the emissions were formerly allocated in the energy industries (1A1a), whereas emissions from gas combustion decreased 0.4 Tg in 2006.

The steady decline in the amount of natural gas and the 19% increase in 2006 of liquids used for combustion by the chemical industry can be explained largely by reallocation of the emissions to and from the Energy sector due to the above-mentioned formation of joint-ventures (see sections 2.3.1 and 3.4.1).

Taking into account all CO_2 emissions, including the net process emissions included in category 2B and the re-allocation of CO_2 emissions to the energy industry, the total CO_2 emission level from the chemical industry is rather constant in the period 1990–2006. 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 1990 and about 6% in 2006. In line with the decreased consumption of natural gas, CO_2 emissions have decreased approximately 7% since 1990, of which a substantial fraction is used for co-generation. The relatively low CO_2 emissions in 1995 can be explained by re-allocation of emissions to the energy sector due to the above-mentioned formation of joint-ventures. In 2006, CO_2 emissions from gaseous fuel combustion decreased by about 4% or 0.1 Tg CO_2.

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 14% in 2006. The CO_2 emissions, which originate largely from the combustion of natural gas, decreased by almost

8% in the period 1990–2006. This is due to a decrease since 2003 of joint-ventures of cogeneration plants located in the pulp and paper industry (see Figure 3.5), of which the emissions were formerly allocated in 1A2e but are now reported under public electricity and heat production (1A1a). This shift in allocation corresponds with a CO_2 decrease of about 0.3 Tg. In 2006 CO_2 emissions from gaseous fuel combustion in this source category decreased about 5%.

Other [1A2f]
The share of category 1A2f 'Other' (including construction and other off-road machinery) in the CO_2 emissions from 1A2 'Manufacturing and construction industries' was approximately 18% in 1990 and 2006. Most of the 4.8 Tg CO_2 emissions from this source category in 2006 stem from gas combustion (3.3 Tg), while almost all of the remaining CO_2 emissions are associated with the combustion of liquid fuels (1.4 Tg CO_2), of which off-road machinery accounts for 1.2 Tg CO_2. CO_2 emissions from this source category have decreased 17% since 1990, mainly due to an 11%decrease in the off-road machinery emissions. In 2006 total CO_2 emissions from the other manufacturing industries decreased 4%.

Activity data and (implied) emission factors
Although total industrial production has increased about by 36% (in fixed monetary units) since 1990, the combustion emissions of CO_2 have decreased by 17% – or by about 5.6 Tg – to which the shift of ownership through CHP joint-ventures has contributed more than 7 Tg and that of steam boilers in joint-ventures about 2 Tg CO_2.The largest change is in the chemical industry, the CO_2 emissions of which decreased by 28% or 4.7 Tg (with about the same amount of CHP re-allocated to the Energy sector and another 2 Tg CO_2 from steam boilers now operated in joint-ventures). Nevertheless, it can be concluded that, apart from the CHP re-allocation, by and large the CO_2 emissions from combustion have remained almost constant in most industry source categories, while their production has significantly increased. The trend in CO_2 combustion emissions from the 1A2 categories and the trends in the underlying production data are presented in Figures 3.7.a and 3.7.b. This figure shows that per category the inter-annual variation is closely linked and that CO_2 emission trends are generally lower than the activity trends. Apart from the re-allocation of joint-ventures, the remaining differences can be explained mainly by energy conservation. Between 1989 and 1999, the Dutch industrial sectors improved energy efficiency by 20%, which is equivalent with an energy conservation of 142 PJ (EZ, 2000) or approximately 8.5 Tg CO_2 emissions or more (depending on the fuel mix assumed).

Iron and steel [1A2a]
The iron and steel industry shows inter-annual variations in combustion CO_2 emissions that are mainly due to the varying amounts of solid fuels that are used in the sector. The 14% decrease in solid fuel use in 1999 and the 10% decrease in associated CO_2 emissions corresponds with the 8% decrease in crude steel production. When all CO_2 emissions from the sector are combined – including the net process emissions reported under category 2C1 – total emissions closely follow the inter-annual variation in crude steel production (Table 3.4). Total CO_2 emissions have remained rather constant in the period 1990–2006 even though production has increased by about 23%. This indicates a substantial energy efficiency improvement in the sector. This conclusion is supported by the decreasing trend in CO_2 losses from the coke and coal inputs in the blast furnaces, which have fallen from about 22% in 1990 to 14% at the present time and the corresponding increase (about 30%) in the capture and energetic use blast furnace gas (and oxygen furnace gas).

CO_2 combustion emissions and production trend of industrial sectors

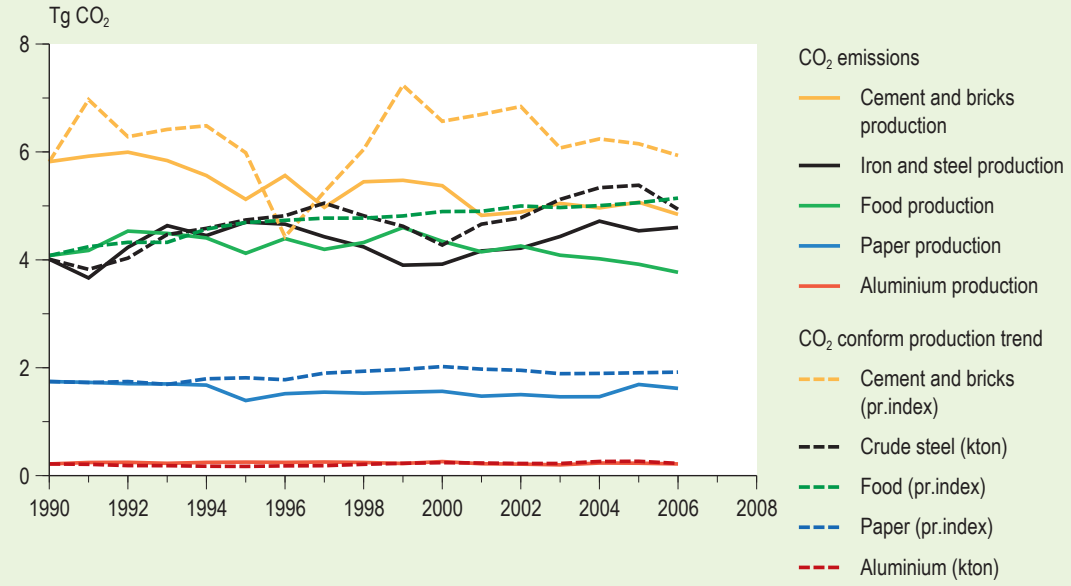


Figure 3.7a Trends in CO_2 emissions from combustion in industrial sectors

CO_2 combustion emissions and production trend in the chemical industry

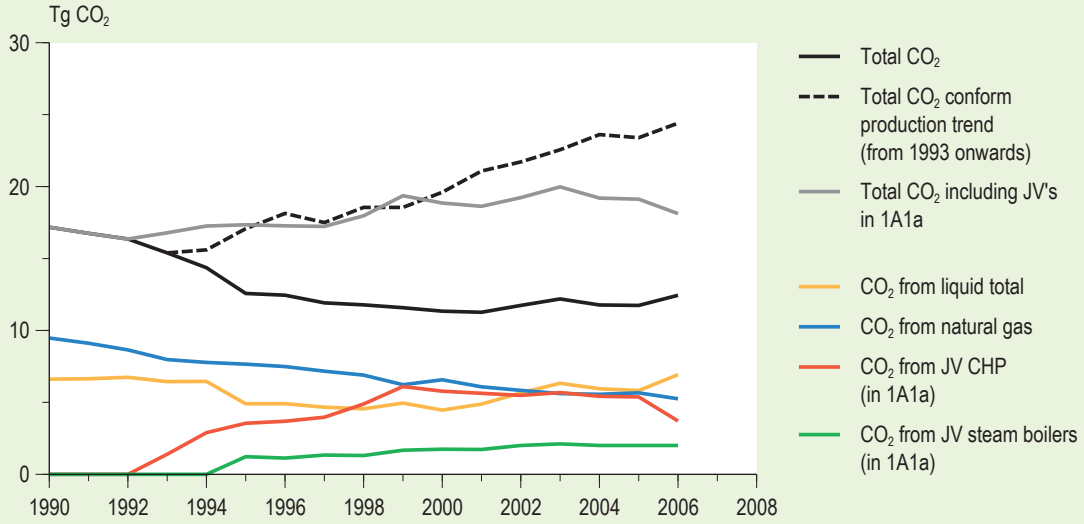


Figure 3.7b Trends in CO_2 emissions from combustion in the chemical industry

Table 3.4 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	2005	2006
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	3.8	3.9
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	3.3	3.1	3.2
N.B. BF/OX gas 1A1a	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	6.1	4.7
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	9.2	9.2	8.0
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	0.6	0.6
o.w. other than BF/OX 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	0.0	0.1
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	0.7	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	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	1.2	1.4
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	0.1	0.1
o.w. coke in blast furnaces	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	0.8	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	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	5.7	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	6.9	6.4
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	0.8	0.9

In 2006 steel production decreased by 8% due to maintenance and renovation of a blast furnace, which also explains the smaller amount of blast and oxygen furnace gas which was sold to the public electricity production sector (see 1A1a). Solid fuel combustion increased by 3% (+0.1 Tg CO_2) compared to 2005, which is due to a temporary decrease in overall energy efficiency of the steel production process due large-scale maintenance works on the blast furnace and a pellet production plant. This is also reflected in the increase of total CO_2 emissions per ton of steel produced as presented in Table 3.4.

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

Non-ferrous metals [1A2b]

The amounts of liquid and solid fuels vary considerably between years, but the differences in the amounts and related emissions are almost negligible. The inter-annual variation of the IEFs from liquid fuels is a result of changes in the mix of underlying fuels (e.g. the share of LPG which has a relatively low emission factor) and partly due to the small amounts used. Energy use in the primary 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 0.4 Tg in 2006, is reported under 2C.

Chemicals [1A2c]

The steady decreasing CO_2 emissions from the combustion of natural gas can be largely explained by the decreasing use or ownership of cogeneration facilities by the industry. CO_2 emissions from liquid fuel combustion stem predominantly from the combustion of chemical waste gas. The marked decrease in liquid fuel consumption since 1995 (see Table 3.5) is not due to a decrease in chemical production or data errors, but mainly to a large shift of ownership of a large cogeneration plant – one using chemical waste gas – into a joint-venture, thus re-allocating it to energy industries. In 2006 the number of cogeneration joint-ventures of the chemical indus-

try decreased, resulting in a re-allocation to the chemical industry. This also explains the 88% decrease in solid fuel combustion in 1994 and the 28% decrease in liquid fuel combustion in 1995: in these years the then-existing coal-fired and oil-fired cogeneration plants, respectively, shifted to joint-venture and thus moved to the 'Energy Industry'. Also the 21% decrease in 2006 in liquid fuel combustion is explained by a decrease in ownership of joint-ventures with the chemical industry (1A2c) (see Figure 3.5), resulting in more single owner cogeneration plants using chemical waste gas (see Table 3.5) in the chemical industry, of which the emissions were formerly allocated in the Energy industries (1A1a).

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 1990–2006 period (see Table 3.5). Since 1990 the production has increased significantly (e.g. in terms of fuels used as chemical feedstock), indicating a substantial improvement in energy efficiency and or structural changes within the chemical industry.
The increase in 2003 of the IEF for CO_2 from liquid fuels is also explained by the increase in the use of chemical waste gas and the change in composition[1]. The operation of the phosphorous plant started around 2000, which explains the increase in the IEF for solid fuels to about 149.5 kg/GJ. Similarly, the increased use of chemical waste gas (included in liquid fuels) since 2003 (see Table 3.5) and the changes in the mix of compositions explain the increase in the IEF for liquid fuels from about 55 to about 60 kg/GJ.

Pulp, paper and print [1A2d]
The CO_2 emission level in 1995 is relatively low, due to the shift of joint-venture cogeneration to the energy sector (approximately 1 Tg CO_2) (see Figure 3.5). The amounts of liquid and solid fuel combustion vary considerably between years, but the amounts and related emissions are almost negligible. The inter-annual variation in the IEFs for liquid fuels is due to variable shares of derived gases and LPG in total liquid fuel combustion. The emission factors for biomass combustion have not yet been re-calculated. The large changes in the (very small) amounts of biomass combustion are due to the incomplete monitoring of individual industries (see completeness paragraph in section 3.1). A large fraction, almost 0.5 Tg from a total of about 1.6 Tg CO_2, results from cogeneration (Figure 3.7.a).

Food processing, beverages and tobacco [1A2e]
The amounts of liquid and solid fuels vary considerably between years, but the amounts and related emissions are verifiably small. The inter-annual variation in the IEFs for liquid fuels is due to variable shares of LPG in total liquid fuel combustion. The emissions of biomass combustion have been re-calculated, although not yet validated. The large changes in the (very small) amounts of biomass combustion are due to incomplete monitoring of individual industries (see completeness paragraph in section 3.1). About 1.5 Tg of a total of about 4 Tg CO_2 is currently emitted by cogeneration plants owned by the food industry.

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

Other [1A2f] (including construction and other off-road)
Most of the present 4.8 Tg CO_2 emissions from this source category stem from gas combustion (about 3.3 Tg). Almost all of the remaining CO_2 emissions relate to the combustion of liquid fuels (1.2 Tg CO_2), of which off-road machinery accounts for 1.2 Tg CO_2. A very small portion of the CO_2 emissions (0.2 Tg) originates from cogeneration 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 Klein Goldewijk et al. (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). Fuel combustion emissions in this sector are calculated using fuel consumption data from national sectoral energy statistics and IPCC default emission factors for CO_2 and N_2O, with the exception of CO_2 for natural gas and chemical waste gas and coal, for which country-specific emission factors are used. When available, company-specific or sector-specific emission factors have been used, in particular for derived gases such as chemical waste gas, blast furnace gas and coke oven gas (see Annex 2). More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.greenhousegases.nl) and section 3.1.

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

For the chemical industry, CO_2 emissions from the production of silicon carbide, carbon black, methanol and ethylene from the combustion of residual gas (produced as by-product from the

Table 3.5 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	2005	2006
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	5.7	5.3
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	5.8	6.9
o.w. chem. Waste gas	5.4	5.0	5.0	5.0	4.9	3.8	4.0	3.8	3.8	4.1	3.8	4.2	5.1	5.8	5.7	5.6	6.7
N.B. chem. waste gas in power gen.	*0.0*	*0.0*	*0.0*	*0.0*	*0.3*	*1.5*	*1.4*	*1.7*	*1.7*	*1.8*	*1.8*	*1.9*	*2.1*	*2.2*	*2.1*	*2.1*	*0.7*
Total chem. Waste gas	5.4	5.0	5.0	5.0	5.2	5.3	5.5	5.5	5.4	5.9	5.7	6.1	7.2	8.0	7.8	7.7	7.4
o.w. other fuels	1.2	1.6	1.7	1.4	1.6	1.1	0.9	0.8	0.8	0.9	0.6	0.6	0.6	0.5	0.3	0.2	0.2
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	5.7	5.3
Solid fuels	1.1	1.0	1.0	1.0	0.1	0.0	0.1	0.1	0.3	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.3
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	3.1	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	11.7	12.4
Joint-Ventures (JV)	0.0	0.0	0.0	1.4	2.9	4.8	4.8	5.3	6.2	7.8	7.5	7.4	7.5	7.8	7.4	7.4	5.7
Total including JVs	17.2	16.8	16.4	16.8	17.3	17.3	17.3	17.2	18.0	19.4	18.9	18.6	19.2	20.0	19.2	19.1	18.2

non-energy use of fuels) are included in 1A2c 'Chemicals'. Although these CO_2 emissions are more or less process-related, they are included in 1A2 for practical purposes: consistency with Energy statistics that account for the combustion of residual gases. This inclusion in 1A2 is justified since there is no strict IPCC guidance on where to include those emissions.

The fuel consumption data in 1A2f 'Other Industries for Construction' and 'Other Off-road' are not based on large surveys. Therefore, the energy consumption data of this part of the 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 solids and liquids (Olivier and Brandes, 2008). This includes the uncertainty in the subtraction of the amounts of gas and solids for non-energy/feedstock uses on the one hand, including the uncertainty in the conversion from physical units to Joules, and the completeness of capturing blast furnace gas in total solid consumption and chemical waste gas in liquid fuel consumption.

For natural gas the uncertainty in the CO_2 emission factor is now estimated to be 0.25% (instead of 1%) based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier and Brandes (2008), but not yet used in the uncertainty assessment in section 1.7 and Annex 1. The 5% uncertainty estimate in the CO_2 emission factor for liquids is based on an uncertainty of 10% in the emission factor for chemical waste gas in order to account for the quite variable composition of the gas and its more than 50% share in the total liquid fuel use in the sector. An uncertainty of 10% is assigned for solids, which reflects the uncertainty in carbon contents of blast furnace gas/oxygen furnace gas based on the standard deviation in a 3-year average. BF/OX gas accounts for the majority of solid fuel use in this sector.

Time-series consistency

see section 3.2.3.

3.4.4 Source-specific QA/QC and verification

The trends in CO_2 emissions from fuel combustion in the iron and steel industry, non-ferrous industry, food processing, pulp and paper and other industries are compared to trends in the associated activity data: crude steel and 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 (chemical waste gas combustion and process emissions from ammonia production etc.), IEF trend tables are checked for large changes and large inter-annual variations at different levels and explained in the NIR. More details on the validation of the energy data is found in the monitoring protocol 8101: CO_2. CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.4.5 Source-specific recalculations

There have been no source-specific recalculations.

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 chemical waste 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.

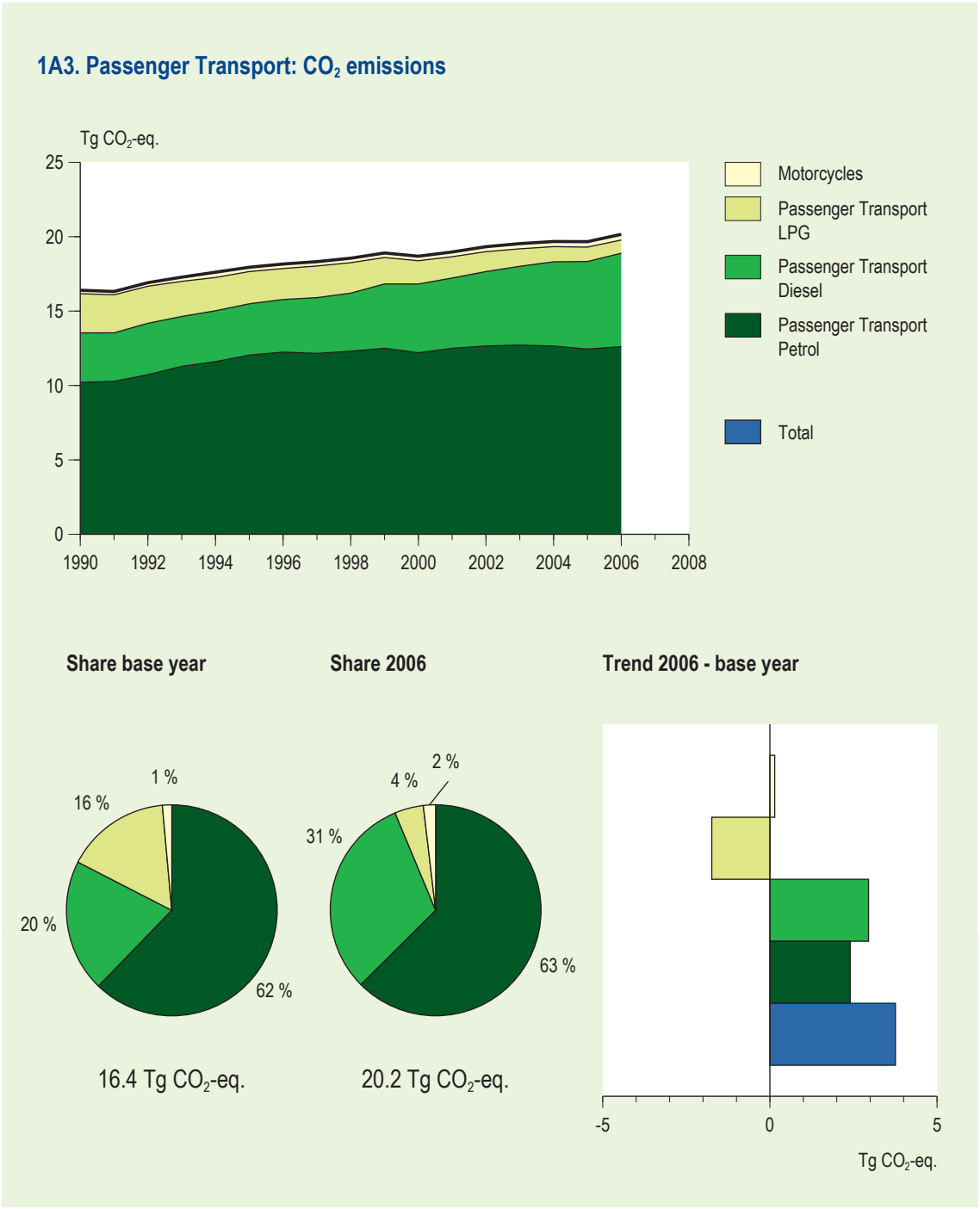


Figure 3.8 Category 1A3 'road transport': passengers: trend. emission levels and share of source categories in 1A3b 'Road transport-passengers', 1990-2005

Overview of shares and trends in emissions

Between 1990 and 2006, total greenhouse gas emissions from 1A3 'Transport' increased 37%, from 26.4 Tg CO_2-equivalents in 1990 to 36.1Tg CO_2-equivalents in 2006. The greenhouse gas emissions from the transport sector are summarised in Table 3.1 and Figures 3.8 and 3.9.

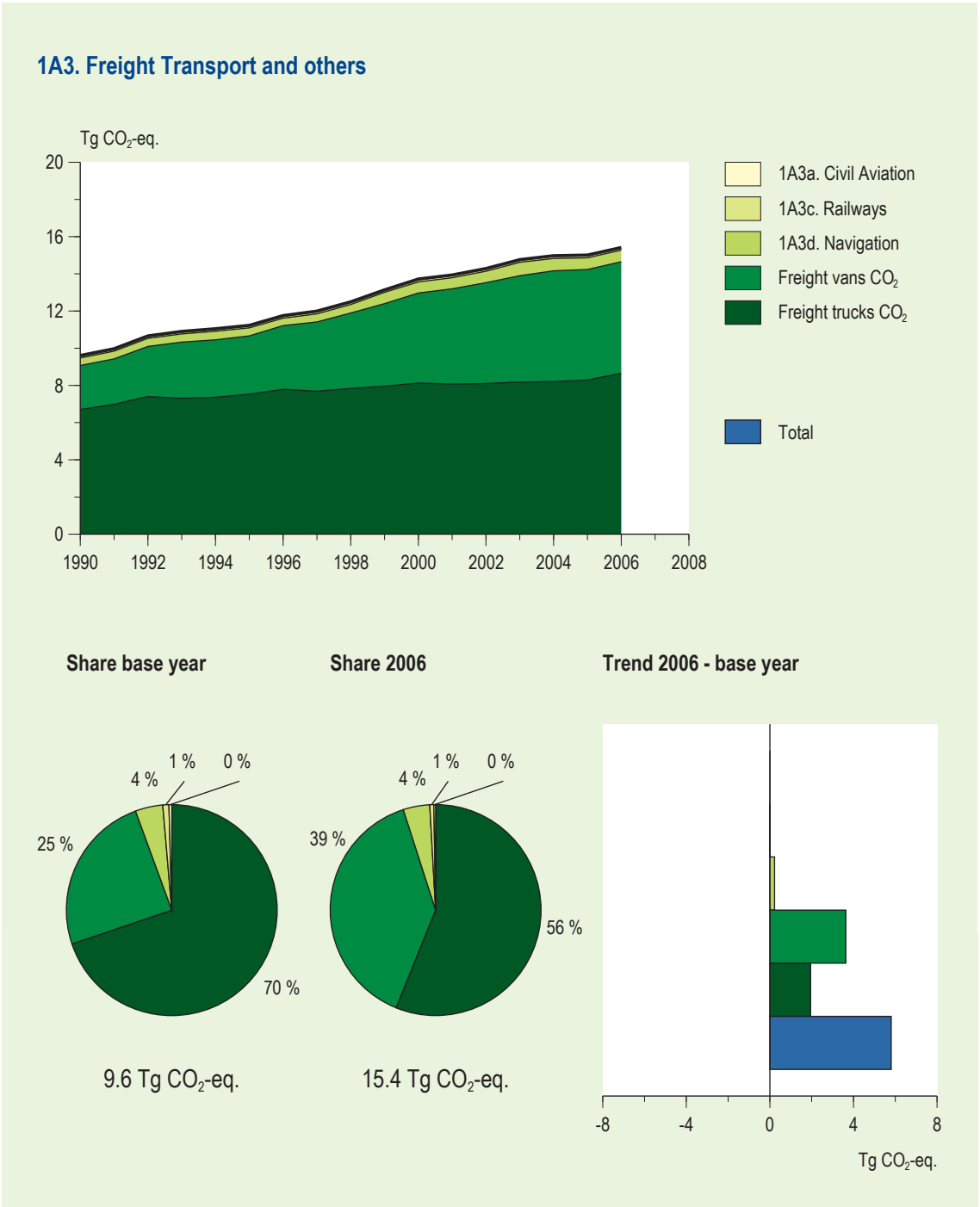


Figure 3.9 Category 1A3b' freight transport': trends. emission level and share in the emissions of source categories in 1A3b' freight transport'. 1990-2005

CO_2 emissions from 1A3b 'Road transport' prevail in this category (more than 95% over the whole timeseries). N_2O emissions in the Energy sector are also caused by this source category. In the period 1990–2006, total CO_2 emissions from 1A3 'Transport' increased 37%, mainly due to the 34% increase in fuel consumption by road transport. In 2006, CO_2 emissions are 0.8 Tg higher than in 2005 largely due to an increase (almost 5%) of diesel fuel combustion.

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 2006. Domestic aviation in the Netherlands emitted 0.04 Tg CO_2 in both 1990 and 2006.

Road transport [1A3b]
The contribution of 1A3b 'Road transport' to the national inventory of CO_2 emissions was 16% in 1990 and 20% in 2006. The largest contributors to this source category are passenger cars, which account for 63% in 1990 and 57% of road transport CO_2 emissions in 2006. See Figure 3.8 for trends in passenger transport (please note: Figures 3.8 and 3.9 give total CO_2 eq. emissions). The share of CO_2 emissions contributed by freight transport (including buses) to the total CO_2 emissions from road transport increased from 36% in 1990 to 42% in 2006. See Figure 3.9 for trends in freight transport.

In the period 1990-2006 CO_2 emissions from road transport increased by 9.3 Tg (33%) to 34.8 Tg in 2006. This increase is mainly caused by the increased use of passenger cars (+22% or 3.6 Tg) and vans (+152%, or 3.6 Tg). CH_4 emissions from road transport fell by about 66% between 1990 and 2006: this translates to a decrease in CH_4 emissions from 6.8 to 2.3 Gg. In 2006 passenger cars accounted for 67% of the total CH_4 emissions from road transport. N_2O emissions from road transport increased from 0.9 Tg in 1990 to 1.5 Tg N_2O in 1999 and remained more or less constant between 1999 and 2006.

Civil Aviation [1A3a]
The share of 1A3a 'Civil Aviation' in national total CO_2 emissions was less than 1% in both 1990 and 2006. Domestic aviation in the Netherlands released 0.04 Tg CO_2 in 1990 and in 2006, 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).

Navigation [1A3d]
The share of domestic waterborne navigation (1A3d) in national CO_2 emissions was small (about 0.3%) in both 1990 and 2006. Emissions were about 0.4 Tg in 1990 and 0.6 Tg in 2006.

Rail transport [1A3c]
The share of 1A3c Rail transport in national total CO_2 emissions was only 0.1% in 1990 and 2006 (0.1 Tg).

Key sources
CO_2 emissions from 1A3b 'Road Transport', all fuel types, are identified as key sources. CO_2 emissions from Navigation is a new key source. Also N_2O from road vehicles is now a (minor) key source, when uncertainty information is added (Tier 2 trend key source), see Table 3.1.

Activity data and (implied) emission factors

Road transport [1A3b]
While the share of petrol in fuel sales to road vehicles has remained rather constant over the period 1990-1999, there has been a shift from LPG to diesel fuel. This shift has increased the share of diesel in road transport fuel sales from 45% in 1990 to 58% in 2006 (see Figure 3.10).

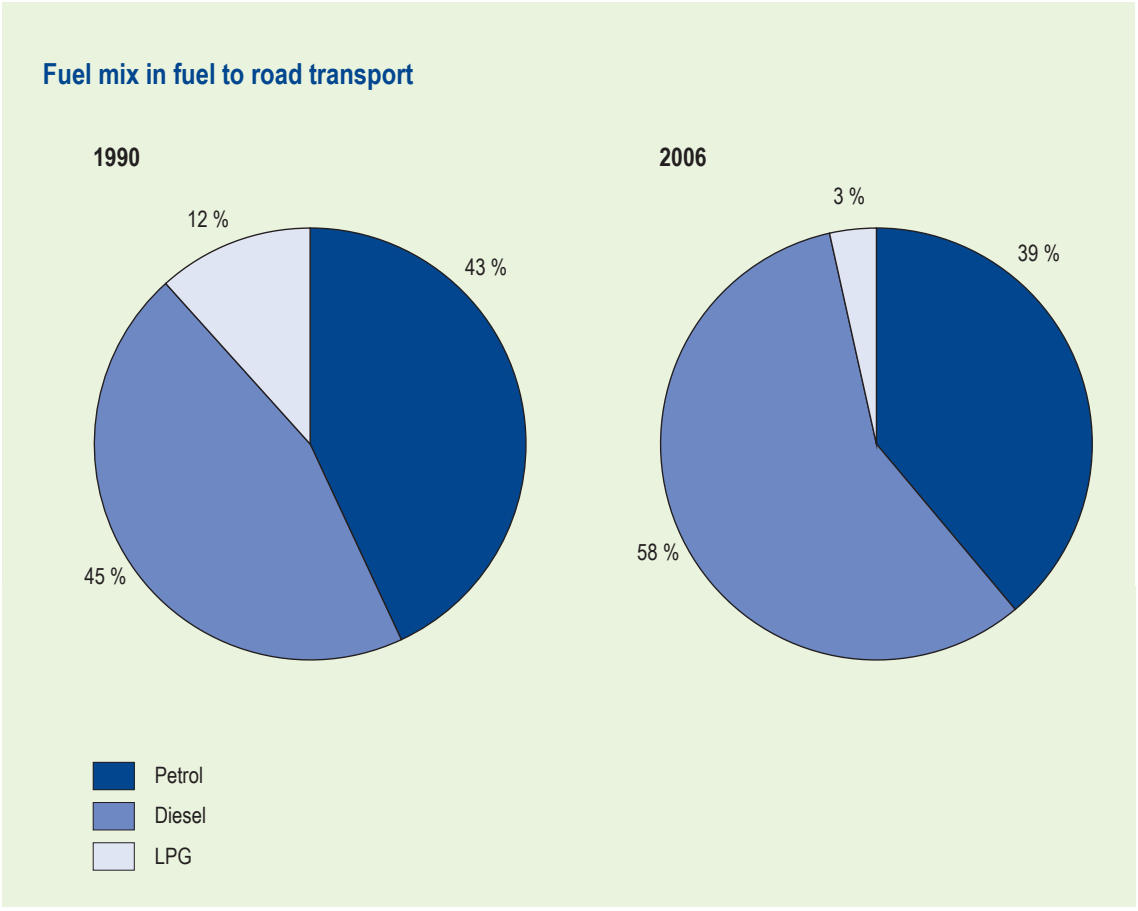


Figure 3.10 Shares of petrol (gasoline), diesel and LPG in fuel sales to 'Road Transport' 1990 and 2006

The 60% reduction of CH_4 emissions from road transport 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 1990–2006, primarily due to the effect of the increasing number of catalyst-equipped passenger cars on the road.

The increasing trend in N_2O emissions 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 2006, despite the increase in vehicle-kilometres, is explained by a mix of developments (see Figure 3.11):

- 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.

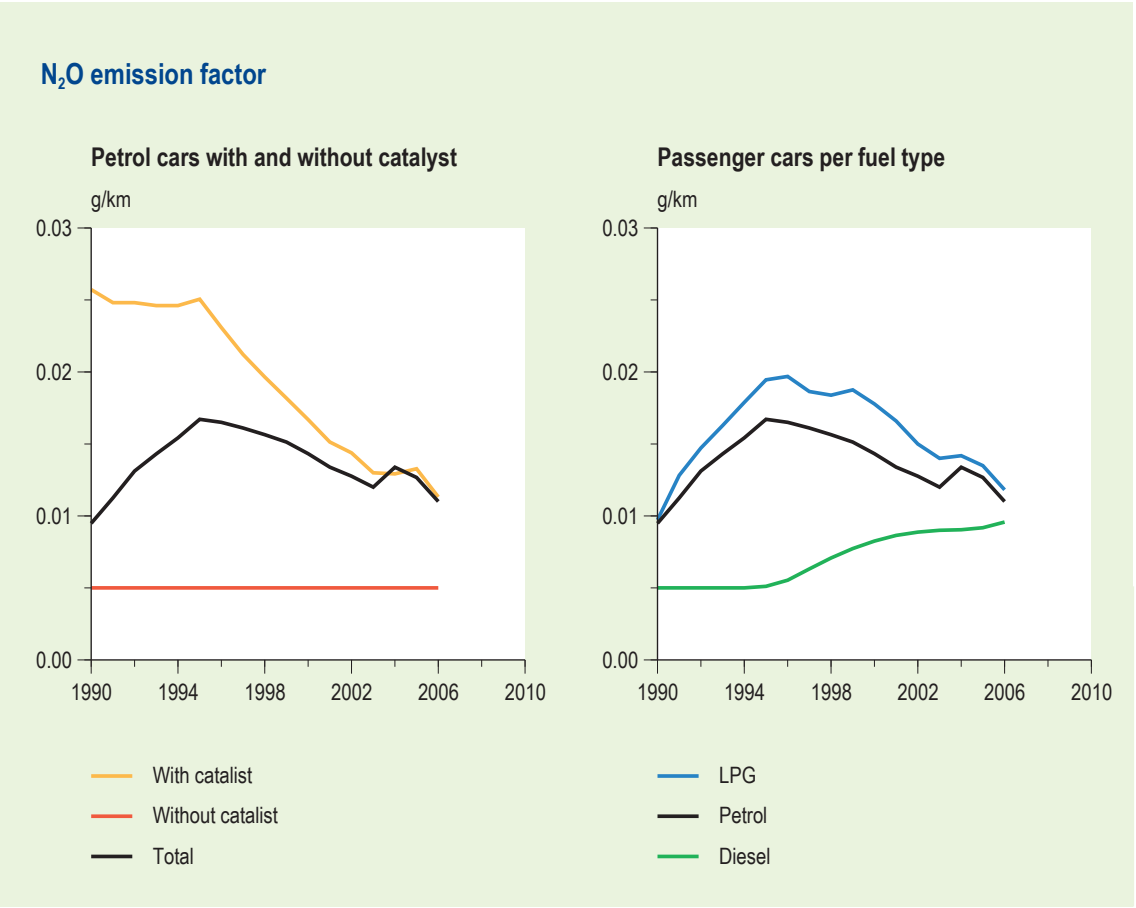


Figure 3.11 Trends in emission factors for N_2O

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 petrol (avgas) and jet kerosene for domestic flights in the Netherlands reported by the Civil Aviation Authority Netherlands (Pulles, 2000). Because of the very small amounts involved (342 TJ aviation petrol and 230 TJ jet kerosene), 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 petrol are used to calculate greenhouse gas emissions. Deliveries of bunkers to international aviation are not included in this source category.

Emissions of precursor gases (NO_x, CO, NMVOC and SO_2) 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. (2006), see Annex 2 for more details. The use of biofuel in road transport, which actually started in 2006 with a 0.4% share, has not yet been incorporated in the inventory.

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 recirculation) 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 more details. 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 (for example sold without levies and 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 NIR's of other West European countries (Ramírez et al., 2006). The uncertainty in fuel use by road vehicles is 2% for petrol, 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 high uncertainty in aviation is due to the very weak sales data available to estimate the fuel sales for domestic flights. See the previous section for more details on the fuel consumption estimation method for further explanation of the high uncertainty estimate. 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 NIR 2006, 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. 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.

3.5.5 Source-specific recalculations

In 2008 a recalculation of the time-series (1991-2006) for inland navigation (1A3d) was carried out. The recalculation was based on a survey that was carried out by TNO in which new information was gathered on the age of engines used in inland ships. The survey (which did not yield improved data for 1990) showed that the average engine age was less than previously assumed which has implications for the amount of fuel used (newer engines are more energy efficient). Since the emissions from inland navigation is a Tier 2 methodology (see Section 3.1.2) and is partly based on fuel consumed (rather that taken in), this new information had implications for the time series of CO_2, CH_4 and N_2O emissions. Apart from the new information on the age of engines a correction of the calculation of engine power was carried out. The effect was only noticeable for smaller ships. CO_2, CH_4 and N_2O emissions became slightly higher because of

this recalculation. Overall emissions from inland naviagtion are (3 to 10%) higher in the period till 2004 and for the years 2005 and 2006 slightly lower (approximately 2%)

CH_4 and N_2O emissions from road transport were also altered slightly due to the publication of an updated time series of vehicle kilometres for passenger cars by CBS. The CH_4 emission factors are partly based on the amount of kilometres driven by passenger cars which means CH_4 emissions were affected by the new time series as well. This recalculation was applied to the period 2000 to 2006 but did not affect earlier years. The recalculation led to a maximum increase of 5% of total CH_4 emissions from transport.

3.6 Other sectors [1A4]

3.6.1 Source category description

Source category 1A4 'Other Sectors' comprises the following categories:
- 1A4a 'Commercial and Institutional Services';
- 1A4b 'Residential';
- 1A4c 'Agriculture (mainly greenhouse horticulture), Forestry and Fisheries'.

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

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

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

Overview of shares and trends in emissions
The share of CO_2 emissions from 1A4 'Other Sectors' in total national CO_2 equivalent emissions (excluding LULUCF) was about 18% in 1990 and 2006, respectively. The share of CH_4 emissions from this source category in the national total greenhouse gas emissions is very small (0.4 Tg CO_2-eq. or about 0.2%); the share of N_2O emissions is almost negligible, 1A4b 'Residential' is the main contributor, contributing approximately 10% to the total national CO_2-equivalent emissions.

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

CO_2 emissions of 1A4 'Other sectors' increased 0.2 Tg or 0.6% in the period 1990–2006. The main contributor this increase is 1A4a 'Commercial/Institutional' (Figure 3.12 and Table 3.1), for

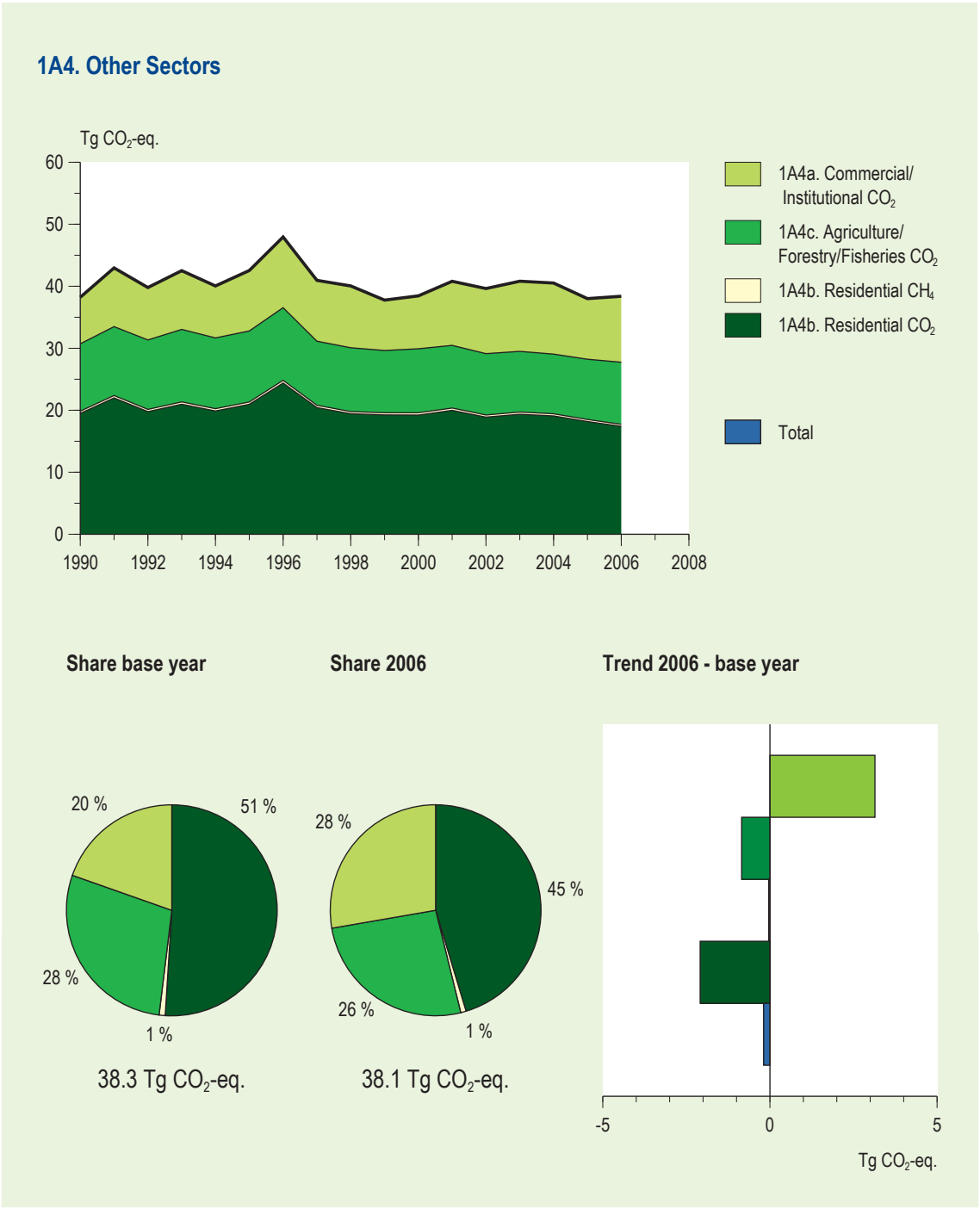


Figure 3.12 Category 1A4: trend. emission levels and share of source categories in emissions of 1A4 'Other sectors', 1990-2006

which emissions increased approximately 30% (from 7.5 Tg to 10.6 CO_2). This increase is partially compensated by the 8% (0.8 Tg) decrease in emissions from 1A4c 'Agricultural' and the 11% (2.1 Tg) decrease in emissions from 1A4b 'Residential'. The (overall) 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 10 Tg CO_2). CO_2 emissions from 1A4b 'Residential' remained more or less at the same level

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).

In 2006, CO_2 emissions from 1A4 'Other sectors' increased by 1.1% or 0.4 Tg compared to the 2005 level mainly due to increased gas combustion in the commercial and institutional sector.

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

Activity data and (implied) emission factors

Commercial and institutional services [1A4a]
In the 'Commercial/Institutional Services' sector, CO_2 emissions have increased 42% since 1990. However, when a temperature correction is taken into account, the structural, anthropogenic trend shows a somewhat lower increase of 23% in this period (see Peek, 2007, in preparation). The 'Commercial/Institutional Services' sector has grown strongly during this period: the amount of manpower (in man-years) increased 34% in the period 1990–2006. This increase is roughly comparable with the increase of fuel consumption (excluding electricity) of 45%, and thus of CO_2 emissions. It should be noted that of the 7.5 Tg CO_2 emissions from the service sectors, about 0.4 Tg in 1990, increasing to about 0.8 Tg in 2006, are emissions from cogeneration facilities, which may also provide electricity to the public grid.

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

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

Residential sector [1A4b]
When corrected for the inter-annual variation in temperatures, the trend in total CO_2 – i.e. in gas consumption – becomes quite smooth, with inter-annual variations of less than 4% (Figure 3.13). The variations are much larger for liquid and solid fuels because of the much smaller figures. The

biomass consumption is almost all wood (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 8139 on biomass fuel combustion).

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

In the 'Residential' sector, CO_2 emissions have remained almost constant since 1990. However, when the temperature correction is accounted for, the structural anthropogenic trend including temperature correction shows a decrease of 13% in this period (see Peek 2007, in preparation). Although the number of households and residential dwellings increased about 15% since 1990, the average fuel consumption per household decreased by about 23% mainly due to the improved insulation of dwellings and the increased efficiency of heating apparatus (increased use of high-efficient boilers for central heating).

Agriculture and forestry [1A4c] (stationary combustion)
Total CO_2 emissions in the 'Agriculture and Fisheries' category have decreased by about 8% since 1990, mainly due to a 10% decrease in gas consumption for stationary combustion. However, when the temperature correction is taken into account, the structural, anthropogenic trends of the total category show a decrease of 13% in this period (see Peek, 2007, in preparation). This is mainly due to energy conservation measures in greenhouse horticulture. Energy use in this sector accounts for approximately 85% of the primary energy use of the agricultural sector. Space heating and artificial lighting are the dominant uses of energy here. The sector has significantly improved its energy efficiency in the past decade (Van Harmelen and Koch, 2002). The total area of heated greenhouses increased about 8% in the 1990's and now occupies over 95% of the total area of greenhouses. In particular, the cultivation of flowers and plants showed a large aereal increase, namely of about 15%. Thus heated greenhouses have reduced their energy consumption, although their surface area has increased by about 8% and the physical production only decreased by 5% over this period (LEI/CBS, 2002). It should be noted that about 0.6–0.8 Tg of the CO_2 emissions from the agricultural sector are emissions from cogeneration facilities, which may also provide electricity to the public grid. In addition, since the fall of 2005 CO_2 from the hydrogen production plant in a refinery is starting to be used for crop fertilisation in greenhouse horticulture, thereby avoiding some CO_2 emissions otherwise generated by CHP facilities merely for producing CO_2 for horticultural production. Total annual amounts, however, will be limited to a few tenths of Tg CO_2. In addition, in 2006 production and use of biogas from composting of manure in the 'Agriculture/Forestry/Fisheries' category increased from virtually zero to 0.5 PJ.

Table 3.6 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	2005	2006
Agricultural machinery	1.2	1.4	1.4	1.4	1.5	1.6	1.5	1.5	1.5	1.5	1.5	1.6	1.4	1.5	1.5	1.4	1.4
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	1.1	1.1
Total mobile in 1A4c	2.4	2.6	2.6	2.7	2.8	3.0	2.8	2.8	2.7	2.8	2.7	2.8	2.5	2.6	2.5	2.5	2.5

Agricultural machinery and fisheries [1A4c] (mobile combustion)
In Table 3.6 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.

3.6.2 Methodological issues

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

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

Emissions from 'Off-road Machinery and Fisheries' in this category (1A4c-ii) are calculated based on IPCC Tier 2 methodologies. The fuel use data from LEI is combined with country-specific emission factors for CO_2 and IPCC default emission factors for N_2O and CH_4.

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 8109 for inland 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 (in particular the latest year) is monitored less accurately than that by the 'Residential' sector. Trends of emissions and activity data of these categories should be treated with some caution when drawing conclusions. The uncertainty in total CO_2 emissions from this source category is about 6%, with an uncertainty of the composite parts of about 5% for the 'Residential' sector, 9% for the 'Agricultural' sector and 20% for the 'Service' sector (see section 1.7 and Annex 1 for more details).

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

For natural gas the uncertainty in the CO_2 emission factor is now estimated at 0.25% (instead of 1%) based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier and Brandes (2008), 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

Table 3.7 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	2005	2006
Heating: degree-days (H)	2677	3163	2829	3076	2835	2917	3504	2929	2821	2676	2659	2880	2720	2913	2877	2765	2671
HDD: running normal (N)	3030	3017	3003	2989	2976	2962	2948	2934	2919	2905	3000	2876	2862	2848	2834	2794	2778
T-correction factor (= N/H)	1.13	0.95	1.06	0.97	1.05	1.02	0.84	1.00	1.03	1.09	1.13	1.00	1.05	0.98	0.98	1.01	1.04

'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 3.7), as explained in Visser (2005). Table 3.7 presents the calculated temperature correction factors for space heating (for more details see Peek (2008, in preparation)).

Figure 3.13 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 3.13 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.

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.

CO_2 emission trend with and without temperature correction

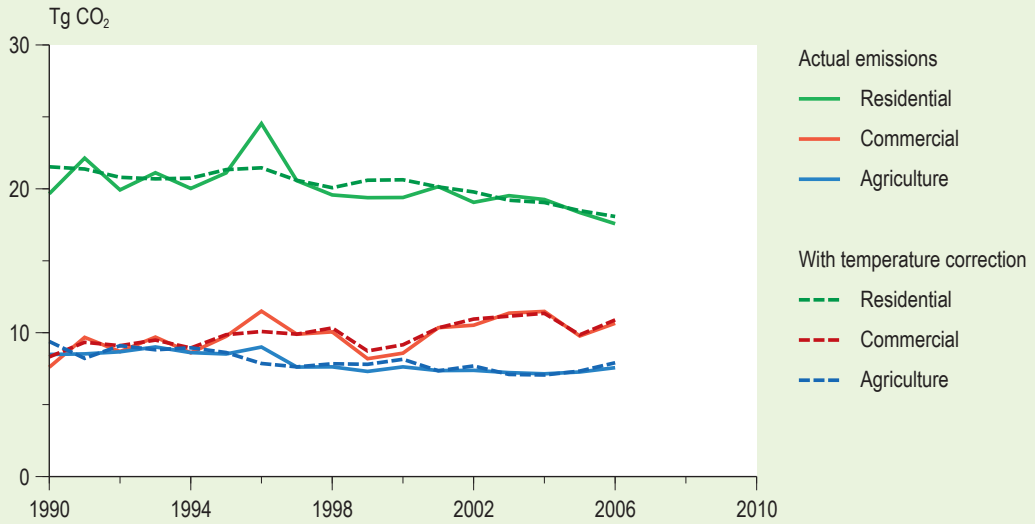


Figure 3.13 CO_2 emissions of 1A4 'Other Sectors': actual versus temperature-corrected trends. based on a 'normal' determined by the long-term trend

3.6.4 Source-specific QA/QC and verification

The trends in CO_2 from the three categories were compared to trends in related activity data: the number of households, number of persons employed in the 'Service' sectors and the area of heated greenhouses. Large annual changes were identified in special trend tables and explanations were sought (for example inter-annual changes in CO_2 emissions by calculating temperature-corrected trends to identify the anthropogenic emission trends). The trend tables for the IEFs were then used to identify large changes and large inter-annual variations at the category level for which explanations were sought and included in the NIR. More details on the validation of the energy data can be found in the monitoring protocol 8101: CO_2 , CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

3.6.5 Source-specific recalculations

There have been no source-specific recalculations.

3.6.6 Source-specific planned improvements

An improvement considered is 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 (in 1A5b). This category is not a key source.

Overview of shares and trends in emissions

The CO_2 emissions from this source category are approximately 0.5 Tg, with some inter-annual variation caused by different levels of operations, including fuel use for multilateral operations, which are included here (Table 3.8). The emissions of CH_4 and N_2O are negligible.

Activity data and (implied) emission factors

The emission factors used are presented in Table 3.9.

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

Table 3.8 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	2005	2006
Military ships	0.25	0.23	0.24	0.23	0.21	0.23	0.20	0.21	0.22	0.23	0.21	0.18	0.22	0.17	0.17	0.15	0.16
Military aviation	0.32	0.31	0.32	0.31	0.28	0.28	0.30	0.27	0.30	0.42	0.37	0.29	0.28	0.27	0.27	0.22	0.22
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	0.38	0.38

Table 3.9 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).

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 3.9). 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 recalculations

There have been no source-specific recalculations.

3.7.6 Source-specific planned improvements

There are no source-specific planned improvements.

3.8 International bunker fuels

3.8.1 Source category description

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

Overview of shares and trends in emissions

Emissions in category 1C1 'international bunkers' are not included in the total Dutch greenhouse gas emissions. Total greenhouse gas emissions in this category increased by 73%, from 39 Tg CO_2-eq,.in 1990 to 67 Tg CO_2-eq. in 2006. CO_2 emissions from 1C1b 'Marine bunkers' showing a 63% increase during this period (up to about 56 Tg in 2006). CO_2 emissions from 1C1a 'Aviation bunkers' increased by 141% in the same period to reach 11 Gg in 2006.

In 2006 CO_2 emissions from marine bunkers increased by 4% (+2.1 Tg). CO_2 emissions from aviation bunkers increased 0.9 % or 0.1Tg.

Activity data and (implied) emission factors

The energy consumption of 1C1b Marine bunkers and 1C1a Aviation bunkers has grown substantially in the period 1990–2006 (see Table 3.10). In 2006 marine bunker fuel consumption increased by about 4%.

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 recalculations

There have been no source-specific recalculations.

3.8.6 Source-specific planned improvements

There are no source-specific planned improvements.

3.9 CO_2 emissions from biomass

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

3.9.1 Source category description

In the Netherlands biomass fuels are used in various categories:

- 1A1a 'Electric Power and Heat Generation' – organic part of municipal waste combusted in waste incinerators that are recovering heat and electricity for energy purposes, wood and other biogenic material co-combusted in coal-fired power plants, biogas (methane) recovered by landfills operators and mostly combusted in CHP facilities owned by utilities;
- 1A2 'Manufacturing Industries' – mainly in the pulp and paper industry (e.g. paper sludge) and the wood construction industry (e.g. wood waste); biomass combustion in the cement industry is not reported;
- 1A3b 'Road transport'– effectively from 2006 biofuels are introduced in petrol and diesel fuel: ethanol is blended with petrol and in addition biodiesel is used;
- 1A4a 'Commercial/Institutional' – biogas (methane) recovered from waste water treatment plants and used for energy purposes, and some individual companies classified in 1A4a that report biomass combustion in their annual environmental reports;
- 1A4b 'Residential' sector –fuelwood only;

Table 3.10 Energy consumption[1] (Units:PJ) in the period 1990–2006

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Marine bunkers[2]	445	460	463	479	455	461	471	499	505	522	555	611	603	562	611	702	729
Heavy fuel oil	368	378	382	410	384	375	391	427	427	446	473	522	521	491	540	628	655
Gas/diesel oil	73	78	78	65	66	82	75	67	73	70	75	82	77	67	67	69	69
Lubricants	4	4	4	4	5	4	5	5	5	5	6	7	5	5	4	5	5
Aviation bunkers[3]	64	68	79	87	91	106	113	122	134	138	136	133	140	137	147	152	153
- jet fuel (kerosene)	64	68	79	87	91	106	113	122	134	138	136	133	140	137	147	152	153
Total bunkers	509	528	542	566	546	567	584	621	639	659	691	744	743	700	758	854	882

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

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

Activity data and implied emission factors

Table 3.11 and Table 3.12 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 80 PJ in 2006. 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. However, in 2006 biomass combustion in power generation after several years of a strong increase decreased by about 1%, mainly due to decreased co-combustion of biomass in coal-fired power stations. This is the result of a change in the MEP subsidising scheme to encourage the use of biomass in electricity production.

Although very effective the MEP was more expensive than the government estimated, as a result in June 2005 the MEP for new large biomass projects and for offshore wind energy projects was cancelled. On the other hand, fuelwood use in the 'Residential' sector has decreased somewhat since 1990. In addition, the use of biogas produced from landfills and WWTPs has increased significantly and now has about a 6% share in total biofuel combustion (reported in category 1A2). Through these developments, the share of residential biofuels decreased from 38% in 1990 to 12% in 2006. Note that no sludge combustion outside 1A1a has been reported and that no greenhouse gas emissions from charcoal combustion in barbeques are reported in source category 1A4.

3.9.2 Methodological issues

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

Charcoal consumption is included in Segers (2005), while the PRTR emissions from charcoal (for non-greenhouse gases) are derived from proxy data (a fraction of meat consumption is assumed to be prepared on barbeques fired with charcoal). As these two very small sources have a high degree of uncertainty, these sources are not (yet) included in the PRTR data set for green-

house gas emissions. However, according to FAO statistics annual apparent consumption varies between about 15 and 40 kton per year (see http://faostat.fao.org/) and related CH_4 and N_2O emissions are therefore almost negligible (e.g. considerably less than 1 Gg per year).

3.9.3 Uncertainty and time-series consistency

Uncertainty

The uncertainty in the activity data is much higher for biofuels than for fossil fuels since the monitoring of biomass use is much less detailed and less extensive. Based on expert judgements, the uncertainty in fuelwood and biogas consumption is estimated to be approximately 25% and 10%, respectively (Olivier and Brandes, 2008).

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

Time-series consistency

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

3.9.4 Source-specific QA/QC and verification

More details on the validation of the biomass fuel data can be found in the monitoring protocol 8139 on the Memo item: 'CO_2 from Biomass'.

3.9.5 Source-specific recalculations

In response to the in-country review in 2007, where the ERT noted that several of the data provided for waste incineration in the Waste chapter did not match the values used for the calculation of emissions, the calculation scheme and the data used (amount of waste incinerated, waste composition, fraction of fossil carbon) have been checked and corrected where needed. This has resulted in slightly different amounts of biomass activity data and in related biogenic CO_2 emissions reported in 1A1a, as shown in Tables 3.11 and 3.12.

3.9.6 Source-specific planned improvements

There are no source-specific planned improvements.

Table 3.11 Biomass fuel consumption specified per source category and fuel type (Units: in PJ)

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total 1A1. o.w.	13.8	13.9	14.2	16.1	15.4	17.4	22.0	25.3	27.3	29.5	32.6	35.4	41.2	37.6	44.9	60.8	60.3
- co-combustion	0.6	0.9	1.2	1.4	1.6	1.8	2.3	2.2	2.7	3.9	6.9	10.6	14.7	12.0	18.8	34.8	33.9
- waste incin.	13.2	13.0	13.0	14.7	13.8	15.6	19.7	23.1	24.6	25.6	25.7	24.8	26.5	25.6	26.1	26.1	26.5
Total 1A2	2.6	2.0	2.2	2.3	2.5	2.8	3.0	3.0	3.0	3.0	3.0	3.0	3.2	3.7	4.4	4.5	5.4
Total 1A3	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	0.0	NE*
Total 1A4	13.9	13.9	14.0	14.0	13.7	13.3	13.5	13.5	13.3	12.8	13.9	14.2	14.1	13.4	13.5	12.8	13.1
National total	30.3	29.8	30.3	32.3	31.6	33.5	38.4	41.8	43.6	45.3	49.5	52.6	58.6	54.6	62.8	78.2	78.8

* In 2006 about 2.0 PJ of the fuel consumption in road transport was biofuel (biodiesel and petrol blended with ethanol (Seegers and Wilmer, 2007). This has not yet been incorporated into the PER system.

Table 3.12 Organic CO_2 emissions (Units: Gg) reported as CO_2 from biomass combustion (included in 1A)

Cat.	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1A	Fuel combustion. o.w.:	3.9	3.8	3.8	4.1	3.9	4.3	4.9	5.3	5.5	5.7	6.2	6.5	7.1	6.8	7.6	8.8	8.8
1A1	Energy industries. o.w.	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	5.7	7.0	6.9
	- co-combustion	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.7	1.1	1.6	1.3	1.9	3.3	3.1
	- waste incineration	2.1	2.1	2.1	2.3	2.2	2.4	2.9	3.3	3.5	3.7	3.7	3.6	3.7	3.7	3.8	3.7	3.7
1A2	Manufacturing industries	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.6
1A3	Transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE*
1A4	Other sectors. o.w.:	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	1.3	1.4
1A4a	- Commercial/Institutional	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.3	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	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	0.0	0.1
Total memo CO_2 from biomass		3.9	3.8	3.8	4.1	3.9	4.3	4.9	5.3	5.5	5.7	6.2	6.5	7.1	6.8	7.6	8.8	8.8

[1] NO = Not occurring; NE = Not Estimated; o.w. = of which; cmp. = compare

* In 2006 about 0.4% of the fuel consumption in road transport was biofuel.

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

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

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.

Table 3.13 Comparison of CO_2 emissions: Reference Approach (RA) versus National Approach (in per cent)

Fuel type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Liquid fuels*	-0.2	1.5	2.0	-0.6	0.2	-1.7	-0.7	-1.1	-2.9	-2.6	-1.1	-1.7	-2.4	-1.5	-3.3	-2,4	-3.0
Solid fuels	9.8	11.0	9.3	8.1	8.8	7.2	8.0	8.7	6.6	7.0	6.1	4.5	5.8	7.1	5.9	6.9	7.6
Gaseous fuels	4.8	4.9	5.1	4.8	5.3	5.2	4.6	5.2	5.3	5.2	5.5	4.6	4.4	4.1	4.0	4.2	3.4
Other	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100	-100
Total (RA-NA)/NA	3.8	4.5	4.5	3.2	3.8	2.8	2.9	3.0	2.0	1.9	2.4	1.6	1.4	1.7	0.7	1.2	0.6

* Excluding international bunkers.

Table 3.14 Comparison of CO_2 emissions: differences between *corrected* Reference Approach (RA) versus *corrected* National Approach [(RA*-NA*)/NA*)] (in percentage)

Fuel type *	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Liquids	0.6	1.0	0.3	2.1	1.1	1.4	3.2	2.9	1.4	2.0	4.3	3.3	5.0	4.4	5.0	1.0	1.5
Solids	0.8	1.3	1.8	1.1	0.9	-0.2	1.0	0.9	0.4	0.3	0.5	-0.4	0.6	1.4	0.9	2.2	1.7
Gaseous	-0.8	-0.1	-0.3	-0.4	-0.4	-0.3	0.0	-0.2	-0.1	-0.1	0.1	0.2	0.0	-0.2	-0.5	-0.5	-1.4
Total corrected	-0.5	0.3	0.6	-0.3	-0.1	-0.9	-0.2	-0.4	-1.0	-1.0	-0.4	-0.7	-1.3	-0.9	-1.7	-1.4	-2.1

* Liquids incl. 2G; Solids incl. 1B1, 2A, 2B5, 2C1, 2D; Gaseous incl. 1B2, 2B1; Total incl. fossil waste.

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 3.13 the results of the IPCC Reference Approach calculation are presented for 1990–2006 and compared with the official national total emissions reported as fuel combustion (source category 1A).

It can be observed, as was done by the ERT in 2007, that CO_2 emissions from liquid fuels are lower in the reference approach than in the sectoral approach for all years, which is not plausible. Moreover, the difference for liquid fuels increases over time. This phenomenon can be explained by the followings peculiarities in the Netherlands' energy statistics: (a) accidentally, some chemical products are reported by companies as fuels, which leads to *increasing* CO_2 emissions in the reference approach; (b) LPG is included in the energy statistics; since a part is exported, which leads to *decreasing* emissions in the reference approach; (c) as export-related effect is larger than the product-reporting effect, the overall emissions are smaller in the reference approach than in the sectoral approach. The increase over time of the discrepancies is caused increasingly incorrect reporting of chemical products as fuels. The errors in reporting in the energy surveys have already been identified and corrected: in 2005 an improvement project started in the national energy statistics and correct reporting can be expected for the 2007 data (i.e. in the NIR 2009). From the information above it can be concluded that these problems only affect the reference approach (apparent consumption) and not the sectoral approach, since process emissions in the sectoral approach are calculated using a carbon balance and company-specific storage factors.

The annual difference calculated from the direct comparison varies between 0.6% for 2006 and 4.5% for 1991 and 1992 and is (2.5±0.6) % on average. The largest differences are seen for the 1990s. The 1990-2006 trends are 5.7% in the RA and 9.0% in the NA, respectively. However, if corrected for the fossil waste included in the NA and selected sector 1B and sector 2 emissions that should be added to the 1A total before the comparison is made, then the remaining differences in totals are much smaller and generally below 1.5% (see Table 3.14): between +0.6% in 2003 and -2.1% in 2006. Also, the largest differences do not concentrate in a particular time span of the

period in question. The corrected 1990–2006 trends differ only about 1%: 10.6% for the NA (= sum of sectoral emissions in source category 1A plus selected 1B and 2) and 9.6% for the RA (including fossil waste). The corrected comparison with the RA based on national energy balance data (including fossil waste from 1A for 'other fuels') shows differences in emissions from liquid fuels of up to -3% for a single year (except for 2004, when it was -4%) compared to -3% for several of the years when uncorrected comparisons were made; for solid fuels differences of up to 3% compared to 11% and for gaseous fuels -1% compared to +5% are calculated if corrections are made for 2G ('Non-Energy Uses') in NA-liquids, 1B1 ('Coke Production'), 2A ('Soda Ash'), 2B5, 2C1 ('Blast Furnaces) and 2D in NA-solids, and 1B2 ('Gas Flaring') and 2B1 (Ammonia') in NA-gases.

3.11 Feedstocks and other non-energy use of fossil fuels

3.11.1 Source category description

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

- CO_2 emissions from the use of feedstock and other non-energy uses of fuels: feedstocks from natural gas and oil products in the chemical industry (IPCC categories 2B1 and 2B5) and coke and coal inputs in blast furnaces in the iron and steel industry (part of 2C1);
- CO_2 emissions from other non-energy uses of fuels for their physical properties in other industrial sectors: coke for soda ash production (part of 2A4), coke (2D2), lubricants and waxes (2G4);
- Indirect CO_2 emissions from solvents and other product use (3);
- CO_2 emissions from 'Waste Incineration' (6C, in the Netherlands reported under 1A1a);
- CO_2 emissions from the combustion of by-products produced in the Industry sector (e.g. blast furnace gas, chemical waste gas and refinery gas), reported as combustion emissions in the Energy sector under 1A1a 'Electricity and Heat Production' and 1A1c 'Manufacturing Industry and Construction'.

Key sources

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

Overview of shares and trends in emissions

The share of total feedstock-related emissions, including the combustion of chemical waste gas and waste combustion in national total CO_2 emissions (excluding LULUCF) is about 12%. The largest part of these emissions, 64% in 1990 and about 80% in 2006, 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 chemical waste gas, which is predominantly used in the chemical industry. The share of combustion of the by-product gases and waste incineration reported under sector 1A has increased from 3% to 10% since 1990, while the share of industrial process emissions in sector 2 has remained about 3%. The share of emissions from 'Waste Incineration' (sector 6, but allocated under 1A1a) was 3% in 1990 and about 12% in 2006. The share of emissions from industrial processes (sector 2) decreased from 32% in 1990 to about 21% in 2006 (Table 3.15). Most of the feedstock emissions reported in sector 2 are found in the iron and steel industry in blast furnaces (2C1) and ammonia production in the chemical industry (2B1). Indirect CO_2 emissions from product use (domestic solvent evaporation in sector 3) account for a small share of about 1%.

Activity data and implied emission factors

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

Table 3.16 shows that the increase of oil feedstocks of about 65% since 1990 originates from a variety of inputs: naphtha use decreased by one quarter, whereas the feedstock use of natural gas liquids (NGL) increased by about two third. On average, it has been calculated for the CO_2 RA that about 20% of the carbon in the oil feedstocks and about 60% of the natural gas is emitted as CO_2 (e.g. about 2-3 Tg each from naphtha, NGL and natural gas) (see Table 3.17). Additional information on feedstock/non-energy uses of fuels is provided in Annex 4.

3.11.2 Methodological issues

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

Table 3.15 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	2005	2006
1A1a Public power & heat																	
BF/OF/OX 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	6.1	4.7
Chemical waste 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	2.1	0.6
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	2.1	2.1
1A2a Iron and Steel																	
BF/OF/OX gas	3.2	2.9	3.5	3.9	3.6	3.9	3.8	3.6	3.4	3.1	3.1	3.4	3.4	3.6	4.0	3.8	3.9
1A2c Chemicals																	
Chemical waste gas	5.4	5.0	5.0	5.0	4.9	3.8	4.0	3.8	3.8	4.1	3.8	4.2	5.1	5.8	5.7	5.6	6.7
TOTAL ENERGY (2)	13.0	12.4	13.1	14.3	14.3	14.8	15.1	15.6	15.6	15.8	15.2	16.3	17.5	18.8	19.7	19.7	18.1
2A Mineral products																	
Soda Ash Production	0.1	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2B Chemical industry																	
1 Ammonia Production	3.1	3.5	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	3.1	3.1
5 Prod. other chemicals	0.6	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
5 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	0.1	0.1
5 Prod. activated carbon 1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2C Metal Production																	
1 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	0.8	1.1
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	0.0	0.0
2G Other																	
4 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	0.2	0.2	0.2
TOTAL IND. PROC. (2)	6.2	6.2	5.8	5.5	6.0	6.1	5.5	6.0	5.7	5.6	5.5	4.8	4.8	4.9	4.9	4.9	5.1
3 Solvents / Product use	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	0.1	0.1
Total Feedstock/Non-Energy Use	19.6	18.9	19.1	20.0	20.5	21.1	20.8	21.7	21.5	21.6	20.8	21.3	22.5	23.9	24.8	24.7	23.3

1) 0.0 means a non-zero emission, less than 0.05.

2) Peat consumption is not included in the Netherlands Energy Statistics (NEH) but is taken from other sources.

Table 3.16 Chemical industry: feedstock uses of fuels (Units: PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Oil products[1)]	303	*337*	*346*	*314*	*329*	321	299	318	313	349	386	411	427	472	496	547	506
o.w. naphtha	136	*141*	*145*	*150*	*154*	159	176	171	117	111	74	77	94	181	159	104	73
o.w. natural gas liquids	143	*151*	*159*	*167*	*174*	182	168	169	164	181	201	210	253	217	227	237	252
o.w. LPG	63	*62*	*60*	*58*	*56*	55	20	38	39	28	39	35	3	4	20	36	29
o.w. gas/diesel oil	34	*29*	*24*	*20*	*15*	10	12	18	15	19	6	4	6	4	3	IE	IE
Natural gas	101	109	107	102	109	110	105	113	107	107	113	100	97	97	97	101	87

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.

Country-specific methodologies are used for the emissions from feedstock use and feedstock product use with country-specific or default IPCC emission factors (see Annex 2). Only indirect CO_2 emissions from domestic uses of petrochemical products are reported here. A full description of the methodology is provided in the monitoring protocol 8101: CO_2 , CH_4 and N_2O emissions from the stationary combustion of fossil fuels and protocol 8102: CO_2 , CH_4 and N_2O process emissions from fossil fuel use. In the Sectoral Approach, the Netherlands uses the following data sources to estimate these emissions:

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

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

3.11.3 Uncertainty and time-series consistency

Uncertainty

The uncertainty in the feedstock/non-energy use emissions of CO_2 in sector 2 is estimated to be about 5% and 2% for the production of soda ash (2A) and ammonia (2B1), respectively. For most other sector 2 sources the uncertainty estimate is about 10%. Emissions from chemical waste gas combustion reported in sector 1A are also less accurate – for example, about 10% – due to the variability of its carbon content; CO_2 emissions from waste incineration may have a similar uncertainty due to the limited accuracy of both the total activity data and the underlying composition and fossil carbon fraction of the various waste types. More details and assumptions on uncertainties in energy data and emission factors will be documented in Olivier and Brandes (2008).

Time-series consistency

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

3.11.4 Source-specific QA/QC and verification

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

3.11.5 Comparison with the CO_2 Reference Approach

All feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for CO_2 from fossil fuel use. The fraction of carbon not oxidized during the use of these fuels during product manufacture or other uses is subtracted from the total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidized have

been calculated as three average values, one each for gas, liquid and solid fossil fuels (see Annex 4 for more details). In Table 3.19 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 3.17). 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 comparison, the most relevant sources from Table 3.15 are summarized in Table 3.18; no attempt has been made to be completely accurate and complete. However, similar trends are seen 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.

3.12 Fugitive emissions from fuels [1B]

3.12.1 Overview source category

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

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

Table 3.17 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]	2005	2006	Trend
Liquids[1]	22.3%	5.0		5.2	4.9	5.1	5.0	5.6	6.1	6.6	6.8	7.8	7.9	8.8	8.1	3.1
Solids[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	0.4	0.3	-0.1
Gaseous	61.2%	3.5		3.8	3.7	3.9	3.7	3.7	3.9	3.5	3.4	3.2	3.4	3.5	3.0	-0.5
Total		8.9		9.4	9.0	9.5	9.2	9.8	10.4	10.5	10.6	11.4	11.7	12.7	11.4	2.5

1) Excluding refinery gas.

2) Coal oils and tars (from coking coal), coke and other bituminous coal, and coal derived gases (e.g. coke oven gas).

3) Using country-specific carbon fuel type-averaged Oxidation Factors, calculated from all processes for which emissions are calculated in the sectoral approach, assuming an oxidised fraction – for example ammonia – or by accounting for by-product gases.

Table 3.18 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	2005	2006	Trend
Liquids	Chemical waste gas in 1A + 2G4 lubr./wax	5.6		5.5	5.6	5.7	5.6	6.1	5.8	6.3	7.4	8.2	8.0	7.9	7.6	2.0
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	0.2	0.2	0.0
Gaseous	2B1 ammonia + 2B5 other chemicals[2]	3.6		3.9	3.7	3.9	4.0	4.0	4.0	3.4	3.3	3.3	3.6	3.7	3.6	0.0
Total		9.4		9.8	9.4	9.8	9.8	10.2	10.0	9.9	10.9	11.7	11.7	11.8	11.5	2.0

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

2) Including some emissions from coke use (or combustion of phosphorus furnace gas).

The contribution of emissions from source category 1B to the total national greenhouse gas emissions inventory was 1.3% in 1990 and 1.5% in 2006.

Between 1990 and 2006 total greenhouse gas emissions in this category increased from 2.8 Tg to 3.1 Tg. Because a pure CO_2 stream generated and released by refineries, which was previously reported as 'unaccounted for liquid fuel use' as part of 1A1b, is now separately reported and included in subcategory 1B2a-iv the emissions increased. Without this subcategory the emissions should be decreased to 2.2 Tg in 2006.

3.13 Solid fuels [CRF category 1B1]

3.13.1 Category description

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

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

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 3.19 shows the trend in CO_2 emissions from coke production during the period 1990–2006.

Table 3.19 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	2005	2006
CO_2 emissions (Gg)	403	430	431	446	559	517	651	505	492	446	422	412	430	464	509	457	449
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	60.3	61.6
CO_2 loss/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	7.6	7.3

Table 3.20 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	2005	2006
Grey cast iron	610	4.6	4.2	4	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.3	3.2	3.1	3.1	3.2	3.3	3.2
Other material	120	7.5	7.9	8	8.1	8.2	8.3	8.4	8.6	8.8	9	9.1	9.3	9.5	9.7	9.8	9.8	9.8
Total CH_4		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	12.8	13.0	13.1	13.0

3.14 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.

3.14.1 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, 2008).

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

3.14.2 Source-specific QA/QC and verification

No source-specific QA/QC and verification.

3.14.3 Source-specific recalculations

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

3.14.4 Source-specific planned improvements

No source-specific improvements planned.

3.15 Oil and natural gas [CRF category 1B2]

3.15.1 Category description

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

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

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

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 (2007, 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.

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

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

3.15.2 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.

3.15.3 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.

3.15.4 Source-specific QA/QC and verification

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

3.15.5 Source-specific recalculations

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

3.15.6 Source-specific planned improvements

There are no source specific improvement planned.

4 Industrial processes [CRF sector 2]

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.

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

- Protocol 8102: CO_2 , CH_4 and N_2O from Process emissions: fossil fuels;
- Protocol 8114: CO_2 , CH_4 and N_2O from Process emissions and product use;
- Protocol 8115: N_2O from Nitric acid production (2B2);
- Protocol 8116: N_2O from Caprolactam production (2B5);
- Protocol 8117: PFCs from Aluminium production (2C3);
- Protocol 8118: HFC23 from HCFC22 production (2E1);
- Protocol 8119: HFCs from Handling (2E3);
- Protocol 8120: HFCs from Stationary refrigeration (2F1);
- Protocol 8121: HFCs from Mobile air conditioning (2F1);
- Protocol 8122: HFCs from Foams (2F2);
- Protocol 8123: HFCs from Aerosols (2F4);
- Protocol 8126: SF_6 from Electrical equipment (2F8);
- Protocol 8125: SF_6 and PFCs from Semiconductor manufacturing (2F7);
- Protocol 8124: SF_6 from Sound-proof windows (2F9).

Major changes in sector 4 Industrial Processes compared to the National Inventory Report 2006

Emissions: In 2007 the NIR 2006 was reviewed by an UNFCCC Expert Review Team (ERT). On the ERT's recommendation the Netherlands has replaced the reported constant N_2O emissions(4 Gg) from the Caprolactam production (2B5) for the period 1990-2002 by a revised time series. This resulted in an emission decrease in the base year of 1,528 Gg. In response to the potential problem notified by the ERT, the average EF of 0.16 t CO_2/t glass has been replaced by plant-specific EFs. Based on these new EFs, the emissions from Glass production (2A7.1) have been recalculated for the period 1990-2006. Because the default C_2F_6/CF_4 weight fraction for CWPB is different from SWPB, the C_2F_6 emission from Aluminium production (2C3) have been recalculated for the period 1999-2005.

Key sources: During the in country review (April 2007), national experts discussed with the ERT if – according to the IPCC 1996 guidelines – reporting of indirect N_2O emissions because of NO_x (and also, as a relatively minor source, NH_3 emissions from non-agricultural sources) is legitimate. The guidelines are not very explicit on this subject. The ERT agreed upon inclusion of this source in the inventory. However, after internal discussions the Netherlands has decided *not to include* this source in the inventory. This means that the N_2O emissions in the base year decrease by 3.03 Gg (rounded).

Methodologies: The method to estimate SF_6 emission from Electrical equipment (2F8) has been changed. From 2006 onwards the country-specific method is equivalent to the IPCC Tier 3 method. Based on new emission data of 2006 and existing emission data of 1999 the SF_6 emission from Electrical equipment has been recalculated for the period 2000-2005.

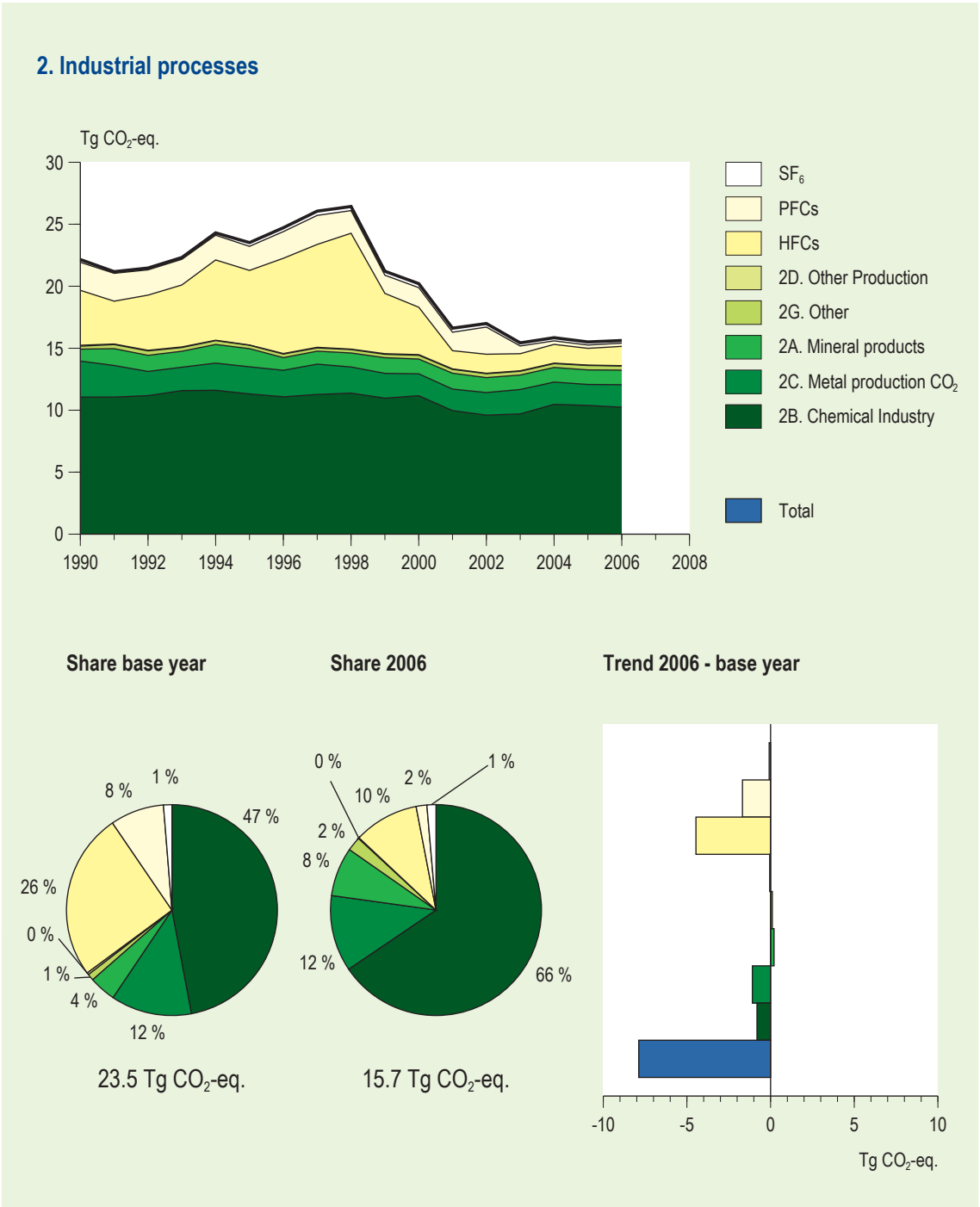


Figure 4.1 Sector 2 'Industrial processes: trend', emission levels and share of source categories in emissions from industrial processes, 1990-2006

Key sources

The key sources in this sector are presented in Table 4.1. Annex 1 presents all sources identified in the Industrial processes sector in the Netherlands. N_2O emission from Nitric acid production is a major key source in terms of level and trend. Other key sources are Caprolactam production, CO_2 emissions from Ammonia production, CO_2 emissions from steel and aluminium production, HFC emissions from Substitutes for ozone-depleting substances and CO_2 emission from use of non-limestone minerals.

Overview of shares and trends in emissions

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

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

Sector/category	Gas	Key	Emissions base-year		Emissions 2005		Emissions 2006		Absolute 2006-2005	Contribution to total in 2006 (%)		
			(1990 - 1995 Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Gg	by sector	of total gas	of total CO_2-eq
2 Industry	CO_2			7.9		7.0		7.1	74.3		4	3
	CH_4		14.1	0.3	14.9	0.3	14.1	0.3	-0.8		1.8	0.1
	N_2O		22.9	7.1	20.6	6.4	20.2	6.3	-0.3		37	3
	HFC*)			6.0		1.4		1.6	206.7		100	0.8
	PFC*)			1.9		0.3		0.3	-9.7		100	0.1
	SF_6*)			0.3		0.2		0.2	0.0		0	0.0
	All			23.5		15.5		15.7	150.9			7
2A. Mineral Products	CO_2	T1		1.0		1.2		1.2	-0.3	8	0.7	0.6
2B. Chemical industry	CO_2			3.7		3.7		3.7	-28.3	24	2.2	2
	N_2O		22.9	7.1	20.5	6.4	20.2	6.3	-0.3	41	37	3
	All					10.4		10.2	-149.3	66	5	5
2B1 Emissions from ammonia production	CO_2	L1		3.1		3.1		3.1	-34.2	20	2	1
2B1 Emissions from nitric acid production	N_2O	L,T	20.4	6.3	18.3	5.7	18.1	5.6	-0.2	36	33	2.7
2B5 Emissions from caprolactam production	N_2O	L,1	2.5	0.8	2.3	0.7	2.1	0.7	-0.1	4	4	0.3
2B5 Other chemical product manufacture	CO_2	L		0.6		0.6		0.6	5.9	4	0.4	0.3
2C. Metal Production	CO_2			2.9		1.7		1.8	131.8	12	1.1	0.9
	PFC*)			1.9		0.1		0.1	-25.9	0	24	0.0
	All			4.8		1.8		1.9	105.9	12		0.9
2C1 Iron and steel production (carbon inputs)	CO_2	L1, T1		2.5		1.2		1.4	202.2	9	0.8	0.7
2C3 PFC emissions from aluminium production	PFC*)	T		1.9	0.1	0.1		0.1	-25.9	0.4	24	0.0
2D. Other Production	CO_2			0.1		0.0		0.0	-13.7	0.1	0.0	0.0
2E. Production of halocarbons and SF6	HFC*)			5.8		0.2		0.3	93.9	2	21	0.2
2E1 HFC-23 emissions from HCFC-22 manufacture	HFC*)	T		5.8		0.2		0.3	93.9	2	21	0.2
2F. Consumption of Halocarbons and SF6	HFC*)			0.2		1.1		1.2	112.8	8	79	0.6
	PFC*)			0.0		0.2		0.2	16.3	1	76	0.1
	SF_6*)			0.3	0.2	0.2		0.0	0.0	0	0	0.0
	All			0.6		1.5		1.6	94.3	11		0.8
2F. Emissions from substitutes for ozone depleting substances	HFC*)	L,T										
2G. Other	CO_2			0.2	0.3	0.3	0.3	0.3	-15.1	2	0.2	0.2
	N_2O		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0
	All				0.4	0.4	0.3	0.3	-15.1	2	0.2	0.2
2G. Indirect N2O from NO2 from combustion and industrial processess	CO_2			0.2		0.3		0.3	-15.1	2	0.2	0.2
	N_2O		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total National emissions	CO_2			159.4		175.9		172.2	-3.7			
	CH_4		1,211.3	25.4		16.8		16.3	-0.5			
	N_2O		64.3	19.9		17.1		16.9	-0.2			
	HFC*)			6.0		1.4		1.6	0.2			
	PFC			1.9		0.3		0.3	0.0			
	SF_6			0.3		0.2		0.2	0.0			
Nat. total GHG emissions (excl. CO_2 LUCF)	All			213.0		211.8		207.4	4.3			

* Base year for F-gases (HFCs, PFCs and SF6) is 1995.

In 2006 Industrial processes contributed 7% to the total national greenhouse gas emissions (without LULUCF) in comparison to 11% in the base year. The sector is a major source of N_2O emissions in the Netherlands, accounting for 41% 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 8.1 Tg to 15.4 Tg CO_2-eq. in 2006 (–34%). CO_2 emissions from Industrial processes decreased 9% during the period 1990–2006. N_2O emissions decreased 11% in the same period. Total emissions of fluorinated gases (F-gasses) have been strongly reduced.

In 2006, total greenhouse gas emissions in the sector remained almost at the same level as in 2005. CO_2 emissions increased by 1% or 0.1 Tg CO_2 . HFC emissions showed an increase of 10% or 0.1 Tg CO_2 , while PFC and SF_6 emissions decreased further. The N_2O emissions remained almost at the same level as in 2005.

4.2 Mineral products [2A]

4.2.1 Source category description

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

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

From these categories, 2A7 was identified as a key source. CO_2 emissions from 2A2 Lime production are not estimated since production was negligible in the early 1990s and has stopped later, 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 negligible.

Overview of shares and trends in emissions
Total CO_2 emissions in category 2A increased from 1.0 Tg in 1990 to 1.2 Tg in 2006(see Table 4.1). The increased emissions during the period 1990-2006 are related to the increased production levels during that period.

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

Activity data are based on the following sources:

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

environmental reports of the coal-fired power plants. Data on the consumption of limestone and dolomite are based on statistical information obtained 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 0.51 – 0,54 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: Plant-specific EFs have been used for the years 1990 (0.13 t CO_2 /t glass), 1995 (0.15 t CO_2 /t glass) and 1997 (0.18 t CO_2 /t glass). For other years in the time series there were not enough data available for calculating plant-specific EFs. For the missing years 1991-1994 and 1996 the EFs have been estimated by interpolation. Because no further measurement data are available, the emission factor for 1998 – 2006 is kept at the same level as the EF of 1997 (0.18 t CO_2 /t glass).

4.2.2 Methodological issues

For all the source categories country-specific methodologies are used to estimate emissions of CO_2 , in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and emission factors are found in Protocols 8102 and 8114 on www.greenhousegases.nl, as indicated in section 4.1.
- 2A1 Cement clinker production: the CO_2 emissions from this source category are based on (measured) data reported by the single company in the Netherlands that produces clinkers. CO_2 emissions from cement production included in this source category are correlated to clinker production, not cement production. About 35% of the cement clinker used for cement production is imported into the Netherlands; consequently, comparison with emission factors based on cement production data would provide the wrong impression.
- 2A3 Limestone and dolomite use: the CO_2 emissions from this source category are based on consumption figures for limestone use – derived from plaster production figures – for flue gas desulphurisation (FGD) with a wet process by coal-fired power plants and for apparent dolomite consumption (mostly used for road construction). No activity data are available to estimate other sources of limestone and dolomite use.
- 2A4 Soda ash production and use: only one company in the Netherlands is producing soda ash using the Solvay process. CO_2 emissions are calculated based on the non-energy use of coke, assuming the 100% oxidation of carbon.
- 2A7 Other: CO_2 emissions from this source category refer to Glass production. Emissions are estimated based on gross glass production data and a country-specific emission factors.

4.2.3 Uncertainties and time-series consistency

Uncertainties

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

Uncertainty estimates used in the Tier 1 analysis are based on the 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, as these are ‚minor sources for CO_2 this was not given any further consideration.

Time-series consistency

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

4.2.4 Source-specific QA/QC and verification

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

4.2.5 Source-specific recalculations

In 2007 the NIR 2006 was reviewed by an ERT. In the following table documents the sector specific issues raised by the ERT, and the response of The Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
2.A.1. Cement production	CO_2	Non-KC			X

Description of problem identified:

The Party reports CO_2 emissions from cement production based on a plant specific methodology, which is not described in the NIR and also not presented in the protocols. For the 2006 submission, the implied emission factor (IEF) of CO_2 from clinker production was 0.540 t CO_2/t clinker for all years except for 2004 where the IEF was 0.555 t CO_2/t clinker. The IEF for this source category is the highest among all Parties that reported their inventories in 2006 and also higher than the IPCC default value (0.51 t CO_2/t clinker). The Party does not provide sufficient explanation to justify such IEF high values, and therefore the base year emissions may be overestimated.

Recommendation by ERT:

The ERT recommends that the Party check and clarify with the plant the methodology applied and the type of measurement used in estimating emissions from clinker production. The technology process has to be described and all types of fuels used in the kiln or material added as combustibles should be reported. The chemical content data of CaO in clinker production and the methodology used by the plant to estimate emissions should be described to justify the high value of the IEF for the whole time series.

Response / Information by Party:

Cement Clinker is produced in one plant in the Netherlands. The methodology for measurements and for calculating emissions can be described as follows.

During the production of clinker, the raw material marl, which is mainly calcium carbonate($CaCO_3$), is heated, or calcinated; CO_2 is produced as by-product. The production of clinker takes place in a dry rotary kiln system with a length of 180 m. and a diameter of 5,5 m.Because of changes in raw material composition it is not possible to estimate reliable CO_2 process emissions by calculating the clinker production(as AD) by a default EF. For that reason the company has chosen to base the calculation of CO_2 emissions on the carbonate content of the process input.

The first carbonate input in the kiln is the raw material marl. The CO2 emission is calculated on a monthly basis by multiplying the amount of raw material by a derived process EF. Of every batch in a month a sample is taken just before the raw material is fed to the kiln. The process EFs and composition data for batches of raw material are determined in a laboratory. The EF is determined by measuring the weight loss of the sample (excluded the amount of organic carbon). The monthly EF is set as the average of all sample EFs determined that month.
The second carbonate input in the kiln is sewage sludge. Also the CO2 emission from this source is calculated monthly by multiplying the amount of sewage sludge by the monthly derived process EF.
Besides the CO2 emissions resulting from calcination of the carbonate input in the kiln, the company considers the CO2 emission from the burning off the small amount of organic carbon in the raw material as a process emission.
As a result, the total yearly process emissions of the company is the sum of all monthly emissions of the following sources:
A. CO2 from the calcination of the carbonate input of the raw material, marl;
B. CO2 from the calcination of the carbonate input of sewage sludge;
C. CO2 from the burning of organic carbon in the raw material
The average CaO content of the clinker of the company measures 65,4%.
The following fuels are used in the kiln:

- natural gas;
- lignite;
- spent glycol;
- rubber;
- aper sludge;
- ofire pellets;
- sewage sludge
- animal meal;
- fine cokes;
- node substances;
- PDF-sludge;

Note that the methodology described above is applied for the whole time-series. The monitoring protocol concerned will be updated accordingly. The (more detailed) description provided above is based on information (personal communication) received from the company; and also on the monitoring protocol applied for emissions trading (this protocol is approved by the Netherlands Emission authority (NEa); the Government organisation responsible for emission trading (ETS) in the Netherlands).

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
2.A.7.1. Glass production	CO_2	Non-KC			X

Description of problem identified:

The Party estimates CO2 emissions from glass production using an EF of 0.16 t CO2/t glass which is an average of EFs for three years. The plant-specific emission factors are reported for the years 1990 (0.13 t CO2/t glass), 1995 (0.15 t CO2/t glass) and 1997 (0.18 t CO2/t glass). Available data from plants for other years have not been considered. The Party is requested to verify the basis for using a constant EF of 0.16 t CO2/t glass for all years, given the availability of data for other years. The ERT believes that the use of a constant EF of 0.16 t CO2/t glass leads to over estimation of emissions for the base year since the estimated EF for 1990 was 0.13 t CO2/t glass.

Recommendation by ERT:

The ERT recommends to estimate emissions for each year based on the average EF available from all plants for that specific year. For the missing years, the Party is recommended to use interpolation/extrapolation to estimate the EFs.

Response / Information by Party:

In response to the potential problem notified by the ERT, the average EF of 0.16 t CO2/t glass has been replaced by plant-specific EFs – mostly based on measurements for the years 1990 (0.13 t CO2/t glass), 1995 (0.15 t CO2/t glass) and 1997 (0.18 t CO2/t glass). For other years in the time series there were not enough data available for calculating plant-specific EFs. For the missing years 1991-1994 and 1996 the EFs have been estimated by interpolation. Because no further measurement data are available, the emission factor for 1998 – 2004 is kept at the same level as the EF of 1997 (0.18 t CO2/t glass).
The IPCC 1996 guidelines do not provide a default EF. The IPCC 2006 guidelines, however, provide default values. The EF of 0.18 is in the range of the default EFs provided in the new guidelines.
Based on these new EFs, the emissions have been recalculated. The effects of the recalculations are presented in the table below.

Recalculated CO_2 emissions from Glass production (2A7.1) (Units: Prod. in ton, EF in ton CO_2/ton glass, Emission in Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Prod. level	1095	1139	1138	1194	1250	1306	1365	1423	1490	1557	1530	1502	1477	1530	1530
EF	0.130	0.134	0.138	0.142	0.146	0.150	0.165	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
Em-new	142	153	157	170	183	196	225	256	268	280	275	270	266	275	275
Em-old	176	183	183	192	201	210	219	229	239	250	246	241	237	246	246
Difference	-34	-30	-26	-22	-19	-14	6	27	29	30	29	29	29	29	29

4.2.6 Source-specific planned improvements

There are no source-specific improvements planned.

4.3 Chemical industry [2B]

4.3.1 Source category description

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

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

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

Key sources
Ammonia production, Other chemical product manufacture and use of non limestone or dolomite minerals are identified as key-sources for CO_2 emissions. Nitric acid production and Caprolactam production are key-sources for N_2O emissions (see Table 4.1).

Overview of shares and trends in emissions
Figure 4.2 shows the trend in CO_2-equivalent emissions from 2B 'Chemical industry' in the period 1990–2006. Table 4.1 gives an overview of shares in emissions of the main categories.

Emissions from this category contributed 5% to the total national greenhouse gas emissions (without LULUCF) in the base year and 2006. Nitric acid production is the most important source of N_2O emissions from industrial processes in the Netherlands. The contribution of N_2O emissions from 2B 'Chemical industry' was 3% of the total national greenhouse gas emission inventory.

From 1990 to 2006, total greenhouse gas emissions in 2B 'Chemical industry' decreased by 9%, mainly due to reduction of N_2O emissions from the production of nitric acid. In 2006 total greenhouse gas emissions in 2B 'Chemical industry' remained almost at the same level as in 2005.

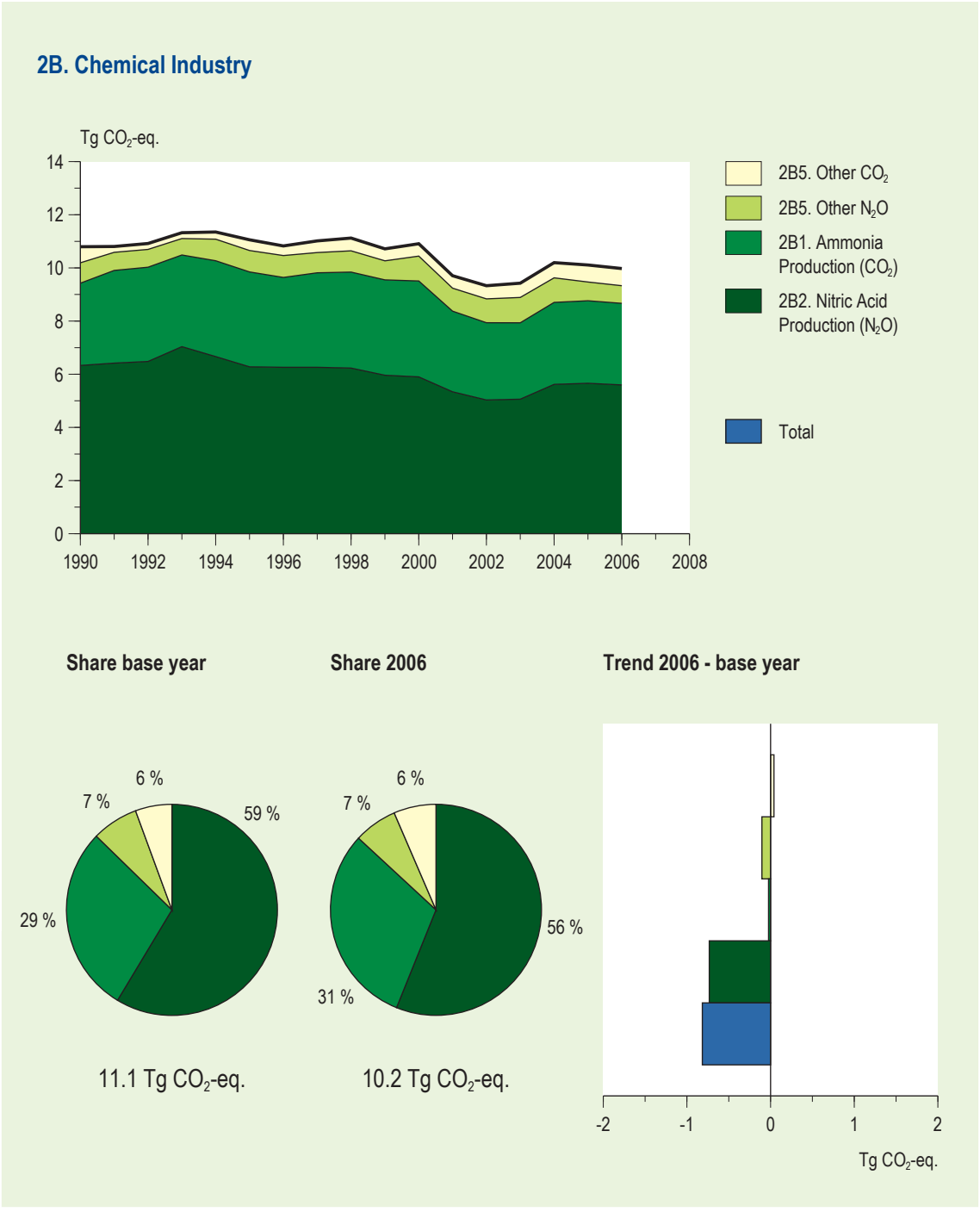


Figure 4.2 Category 2B 'Chemical industry: trend', emission levels and share of source categories in emissions from 2B 'Chemical industry', 1990-2006

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
B2. Nitric acid production	6,330	6,417	6,479	7,037	6,665	6,278	6,262	6,262	6,231	5,962	5,898	5,341	5,032	5,060	5,617	5,659	5,597
B5. Other	766	681	672	619	812	805	822	759	802	716	936	863	897	954	923	705	662
Total	7,096	7,098	7,151	7,656	7,477	7,083	7,084	7,021	7,033	6,678	6,834	6,204	5,929	6,014	6,540	6,364	6,259

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

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

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

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

4.3.2 Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in monitoring protocols 8102, 8114, 8115 and 8116 on the website www.greenhousegases.nl.

Activity data are based on the following sources:

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

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

- Ammonia production: a country-specific CO_2 emission factor is used. This emission factor is based on a 17% fraction of the carbon in the gas-feedstock not being 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.

4.3.3 Methodological issues

For all the source categories of the chemical industry the methodologies used to estimate the greenhouse gas emissions are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). Country-specific methodologies are used for the CO_2 process emissions from the chemical industry. More detailed descriptions of the methods used and emission factors can be found in the protocols (8102, 8114, 8115 and 8116) 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 Release & Transfer Register (PRTR).
- 2B5 Other chemical products: N_2O emissions from 2B5 Other chemical industry, which mainly originate from Caprolactam production, are also based on emission data reported by the manufacturing industry (based on measurements). Emission factors and activity data are confidential. CO_2 emissions included in this source category are identified as a key source and based on country-specific methods and emission factors. These refer to the production of:
- Industrial gases: CO_2 emissions are estimated based on use of fuels (mainly natural gas) as chemical feedstock. An oxidation fraction of 20% is assumed, based on reported data in environmental reports from the relevant facilities.
- Carbon electrodes: CO_2 emissions are estimated based on fuel use (mainly petroleum coke and coke). A small oxidation fraction – 5% – is assumed, based on reported data in the environmental reports.
- Activated carbon: CO_2 emissions are estimated on the basis of the production data for Norit and by applying an emission factor of 1 t/t Norit. The emission factor is derived from the carbon losses from peat uses reported in the environmental reports. As peat consumption is not included in the national energy statistics, the production data since 1990 have been estimated based on an extrapolation of production level of 33 Tg reported in 2002. This is considered to be justified because this source contributes relatively little to the national inventory of greenhouse gases.

- Ethylene oxide: CO_2 emissions are estimated based on capacity data by using a default capacity utilization rate of 86% and applying an emission factor of 0.45 t/t ethylene oxide.

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

4.3.4 Uncertainties and time-series consistency

Uncertainties

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

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

Time-series consistency

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

4.3.5 Source-specific QA/QC and verification

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

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

4.3.6 Source-specific recalculations

In 2007 the NIR 2006 was reviewed by an ERT. In the following table documents the sector specific issues raised by the ERT, and the response of The Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
2.B.5. Caprolactam production	N_2O	L,T			X
Description of problem identified: The Party reported constant N2O emissions from this category (4 Gg) for the period 1990-2002 based on a plant-specific methodology and EFs. Activity data (AD) and EF are reported as confidential in the 2006 submission. During the review, the Party provided information that, according to the permit of the company, the capacity of Caprolactam is now 250,000 t/yr. According to recent information available (such as the 2006 IPCC Guidelines and the underlying studies for these guidelines) for emission factors from this industry, the ERT believes that the reported base year emissions may be overestimated.					
Recommendation by ERT: The ERT encourages the Party to check AD and plant-specific EF to justify the potentially high EF used and, should the emissions be found to be overestimated for the base year, to revise the estimates correspondingly.					
Response / Information by Party: Since 1952 Caprolactam is produced as part of the production cycle for nylon materials at one plant in the Netherlands. Until 2005 no measures have been taken to reduce N_2O emissions. By increasing the operation time of the plant the Caprolactam production capacity has been increased from 200,000 in 1990 to 250,000 tons in 2005.					

The Netherlands has replaced the reported constant N_2O emissions from this category (4 Gg) for the period 1990-2002 by a revised time series, based on:
(1) a production-index series (real production data are confidential business information) over the period 1990-2004 received from the company;
(2) the reported N_2O emissions in 2003 and 2004 based on measurements by the company (for 2004, corrected emission data are used as reported in the NIR 2007).
Because the N_2O emission from Caprolactam production is not straightforward proportional to the production level, the uncertainty related to the recalculated emissions is relatively high. Nevertheless the Netherlands is confident that the new time series is better reflecting the emissions than the time series provided in the NIR 2006 submission.
The production-index series is presented in table 1. The effects of the recalculations and correction are presented in table 2 and table 3.

Table 1 The production-index series for Caprolactam production (2B5),1990=100.00 (Source: Company information)

Year	Index	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Index	Year	100.00	88.86	87.64	80.79	105.96	105.02	107.26	99.07	104.60	93.45
Year	Index	2000	2001	2002	2003	2004					
Index	Index	122.10	112.62	117.00	120.32	124.52					

Table 2 Effects of recalculations and correction of N_2O emissions from Caprolactam production (2B5) (Units: ton N_2O)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Old serie	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	3,077	2,448
New serie	2,472	2,196	2,167	1,997	2,620	2,597	2,652	2,449	2,586	2,310	3,019	2,784	2,893	3,077	2,978
Difference	-1,528	-1,803	-1,833	-2,003	-1,380	-1,404	-1,348	-1,551	-1,414	-1,690	-981	-1,216	-1,107	0	530

Table 3 Effects of recalculations and correction of N_2O emissions from Caprolactam production (2B5) (Units: Gg CO_2-eq)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Old serie	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	954	759
New serie	766	681	672	619	812	805	822	759	802	716	936	863	897	954	923
Difference	-474	-559	-568	-621	-428	-435	-418	-481	-438	-524	-304	-377	-343	0	164

Because the real production data are confidential, the Netherlands has estimated the IEF for 1990, 1995 and 2003 by dividing the emission by production levels derived from the production capacity. For this calculation, it is assumed (expert judgement) that the actual production amounts about 90% of the production capacity. The production capacity was 200,000; 220,000 and 250,000 ton for 1990, 1995 and 2003, respectively.
This calculation results in the following IEFs:
(1990): 13.7 ; (1995): 13.1; (2003): 13.7
These IEFs are in the same order of magnitude (somewhat lower) as the proposed default EF of 14.5 for older plants (this proposal was included in the second-order draft of the 2006 IPCC Guidelines, Volume 3, 3.40, Table 3.5).

4.3.7 Source-specific planned improvements

There are no source-specific improvements planned.

4.4 Metal production [2C]

4.4.1 Source category description

General description of the source category

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

- 2C1 Iron and steel production: CO_2 emissions: The Netherlands has one integrated iron and steel plant (Corus, previously named Hoogovens). Integrated steelworks convert iron ores into steel by means of sintering, producing pig iron in blast furnaces and converting pig iron to steel in basic oxygen furnaces. For the purpose of the inventory, emissions from integrated steelworks are estimated for these three processes as well as for some other minor processes. Emissions from sintering are included in 1A. During the production of iron and steel, coke and coal are used as reducing agents in the blast and oxygen furnaces, resulting in the production of CO_2 . In addition, CO_2 is produced as by-product from the use of limestone during the conversion from pig iron to steel. A portion of the coke oven gas and blast/oxygen

furnace gas produced during these processes is sold to a nearby power plant to be used as fuel. These CO_2 emissions are included in category 1B. The carbon content of the blast and oxygen furnace gases lost is included in source category 2C1.

- 2C3 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 (2C5) are identified in the inventory.

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

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

Total CO_2 emissions from 2C1 'Iron and steel production' decreased by 1.1 Tg during the period 1990–2006. In 2006 the CO_2 emissions remained at the same level as in 2005

PFC emissions from primary 'Aluminium industry' (2C3) decreased by 1.8 Tg CO_2-eq. between 1995 and 2006. In 2006 the PFC emissions remained at the same level as in 2005.

Table 4.3 shows the trend in implied CF_4 and C_2F_6 emission factors (IEF) for aluminium production during the period 1990–2006. The largest company produces approximately two thirds of the national total production. The IEFs decreased by 97% between 1995 and 2006. In 1998 the smallest company switched from side feed to point feed; this switch was followed by the larger company in 2002/2003, thereby explaining the decreased IEF from this year onwards. The higher level of the IEF in 2002 is caused by specific process-related problems during the switching process by the larger producer.

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocols 8102, 8114 and 8117 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.

Table 4.3 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	2005	2006
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	0.03	0.03
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	0.01	0.00

[1] In the NIR 2007, the IEF was erronuously rounded at 0.01

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.

4.4.2 Methodological issues

The methodologies used to estimate the greenhouse gas emissions for all source categories of metal production are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and emission factors are found in protocols 8102, 8114 and 8117 on the website www.greenhousegases.nl as indicated in section 4.1:

Iron and steel production (2C1):
CO_2 emissions are estimated using a Tier 2 IPCC method and country-specific value for the carbon contents of the fuels. Carbon losses are calculated from coke and coal input used as reducing agents in the blast and oxygen furnaces, including other carbon sources such as limestone and the carbon contents in the iron ore (corrected for the fraction that ultimately remains in the steel produced):

- CO_2 from coke/coal inputs = amount of coke * EF_{coke} + amount of coal * EF_{coal} – (blast furnace gas + oxygen oven gas produced) * EF_{BFgas} (1a)
- CO_2 from limestone use = limestone use * ZF(limestone) * $EF_{limestone}$ (1b)
- CO_2 from ore/steel = (C-mass in ore, scrap and raw iron purchased – C-mass in raw steel)* 44/12 (1c)
- The same emission factors for blast furnace gas and oxygen furnace gas are used (see Annex 2).

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

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

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 1990–2006. Emission factors are plant-specific and are based on measured data.

4.4.3 Uncertainties and time-series consistency

Uncertainties

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

Because the default C_2F_6/CF_4 weight fraction for CWPB is different from SWPB, the C_2F_6 emission from one producer have been recalculated for the period 1999-2005.

Table 4.4 Effects of the recalculation of PFCs from primary aluminium production (2C3) 1990-2005 (in Gg)

Gas		1990	1991	1992	1993	1994	1995[1)]	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PFCs	NIR2007	2246	2224	2019	2041	1958	1901	2104	2243	1715	1323	1387	1326	2066	439	106	87
	NIR2008	2246	2224	2019	2041	1958	1901	2104	2243	1715	1325	1388	1327	2067	440	107	88
	Difference	0	0	0	0	0	0	0	0	0	2	1	1	2	1	1	1

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.

Key sources
This minor source is no key source for CO_2

Overview of shares and trends in emissions
Emissions vary at around 0.05 Gg, and are rounded off to either 0.1 or 0.0 Gg (see Table 4.1).

Activity data and (implied) emission factors
Detailed information on the activity data and emission factors can be found in monitoring protocol 8102 on the website www.greenhousegases.nl.

The activity data used to estimate CO_2 emissions from this source are based on national energy statistics from Statistics Netherlands (CBS) on Coke consumption. Emission factors are derived from the national default carbon content of coke (Corus, MJVs 2000-2006).

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 8102 on the website www.greenhousegases.nl, as indicated in section 4.1.

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

4.5.3 Uncertainties and time-series consistency

Uncertainties
The Tier 1 uncertainty analysis in Annex 7 shown in Tables A7.1 and A7.2 provides estimates of the uncertainties according to the IPCC source category. The uncertainty in the emissions of this category is estimated to be 5%. Since this is a very small emission source, the uncertainties in this category are not analysed further in more detail. Therefore, in the uncertainty analysuis and

the keysource analysis the emissions in this category (2D) are combined with the emissions in category 2G (Other industrial emissions), see Section 4.8.

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

4.5.4 Source-specific QA/QC and verification

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

4.5.5 Source-specific recalculations

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

4.5.6 Source-specific planned improvements

There are no source-specific improvements planned.

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

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

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

Total HFC emissions in category 2E were 5.8 Tg in 1995 and 0.3 Tg CO_2-eq. in 2006, with HFC-23 emissions from HCFC-22 production being the major source of HFC emissions. Other HFC emissions from handling contributed 15 % to the total HFC emissions from this category in 2006.

Table 4.5 Trends in HFC-23 by-product emissions from the Production of HCFC-22 and HFC emissions from Handling activities (2E) (Units: Gg CO_2-eq.)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2E1. HFC-23	4,432	3,452	4,423	4,947	6,278	5,759	6,887	6,709	7,791	3,440	2,421	450	685	415	354	196	281
2E3. HFCs	NO	NO	25	51	129	12	224	707	519	384	418	192	98	41	100	39	48
HFC total	4,432	3,452	4,447	4,998	6,407	5,771	7,110	7,416	8,310	3,825	2,838	641	783	455	454	235	329

Table 4.5 shows the trend in HFC emissions from the categories HCFC-22 production and HFCs from handling activities for the period 1990–2006. The emissions of HFC-23 increased about by 35% in the period 1995–1998 due to the increased production of HCFC-22. However, in the period 1998–2000, the emissions of HFC-23 decreased by 69% following the the installation of a thermal afterburner at the plant.

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

The significant emission fluctuations of the two companies during the period 1992-2006 can be explained by the large variety in handling activities, which depends on the demand of the costumers.

Activity data and (implied) Emission factors

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

- Production of HCFC-22: production figures on HCFC-22 are confidential.
- Handling activities (HFCs): activity data used to estimate HFC emissions are confidential.

(Implied) emission factors used to estimate the emissions of F-gases from this category are based on the following:

- Production of HCFC-22: Destruction factor of the thermal afterburner used is 99.99%.
- Handling activities (HFCs): the emission factors used are plant-specific and confidential, and they are based on 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 8118 and 8119 on the website www.greenhousegases.nl.

4.6.2 Methodological issues

The methodologies used to estimate the greenhouse gas emissions included in this category are in compliance with the ipcc *Good Practice Guidance* (IPCC, 2001). More detailed descriptions of the method used and emission factors can be found in the protocols 8118 and 8119 on website www.greenhousegases.nl as indicated in section 4.1:

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

4.6.3 Uncertainties and time-series consistency

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

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

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 recalculations 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-Stationary refrigeration: HFC emissions;
- 2F1-iMobile air conditioning: HFC emissions;
- 2F2-Foams: HFC emissions; (included in 2F9);
- 2F4-Aerosols: HFC emissions; (included in 2F9);
- 2F9-Other: HFC emissions.
- 2F6-PFC emissions from PFC use.

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

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

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

Key sources

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

Overview of shares and trends in emissions

The contribution of F-gas emissions from category 2F to the total national inventory of F-gas emissions was 7 % in the base year 1995 and 81 % in 2006. This corresponds to 1.6 Tg CO_2-eq. and accounts for 0.8% in the national total greenhouse gas emissions in 2006.

The level of HFC emissions increased by a factor of 3 in 2006 compared to 1995, mainly due to increased HFC consumption as a substitute for (H)CFC use. PFC emissions increased due to a higher production level of the Semiconductor manufacturing industry. And actual emissions of SF_6 remained rather stable during the period 1995–2006. Table 4.6 gives an overview of the trends in actual emissions from 1990-2006.

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
HFC-134a	NO	NO	NO	NO	17	48	81	116	137	130	162	210	259	310	370	416	475
HFC-143a	NO	NO	NO	NO	NO	6	26	48	68	73	106	143	179	217	256	291	328
HFC-125	NO	NO	NO	NO	NO	7	25	43	57	60	87	119	149	180	212	241	271
HFC-152a	NO	NO	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	NO	NO
Other HFCs	NO	NO	NO	NO	57	188	435	678	770	772	630	357	172	216	219	170	157
HFC Total	NO	NO	NO	NO	74	249	567	885	1,032	1,035	985	828	759	923	1,056	1,118	1,231
PFC use	18	21	24	28	32	37	51	101	114	147	193	163	120	180	179	178	194
SF_6 use	217	134	143	150	191	301	312	345	329	317	320	325	286	248	251	250	215
Total HFC/PFC/SF_6	236	155	167	178	297	587	931	1,331	1,474	1,499	1,498	1,316	1,164	1,351	1,487	1,546	1,640

Activity data and (implied) emission factors
Detailed information on the activity data and emission factors can be found in the monitoring protocols 8120–8126 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.
- 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 Sound-proof windows and Electron microscopes are equivalent to IPCC Tier 2 methods and from 2006 onwards the country-specific method for the source Electrical equipment is equivalent to the IPCC Tier 3 method.

More detailed descriptions of the methods used and emission factors can be found in the protocols 8120-8126 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.

Table 4.7 Effects of the recalculation of SF_6 emissions (2F) 1990-2005 (in Gg CO_2-eq)

Gas		1990	1991	1992	1993	1994	1995[1)]	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
SF_6	NIR2007	217	134	143	150	192	301	312	345	329	317	335	356	332	309	328	338
	NIR2008	217	134	143	150	192	301	312	345	329	317	320	325	286	248	251	250
	Difference	0	0	0	0	0	0	0	0	0	0	-15	-31	-46	-62	-77	-88

1) Base year for F-gases in the Kyoto Protocol

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

The method to estimate SF_6 emission from Electrical equipment (2F8) has been changed. From 2006 onwards the country-specific method is equivalent to the IPCC Tier 3 method. The SF_6 emission is now based on the annual input and output of SF_6. Based on new emission data of 2006 and existing emission data of 1999 the SF_6 emission from Electrical equipment has been recalculated by interpolation, for the period 2000-2005.

4.7.6 Source-specific planned improvements

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

4.8 Other industrial processes [2G]

4.8.1 Source category description

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

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

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

Key sources

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

Overview of shares and trends in emissions

The small CO_2 and CH_4 emissions remained rather constant between 1990 and 2006.

Activity data and (implied) emission factors
Detailed information on the activity data and emission factors can be found in the monitoring protocols 8102 and 8114 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);
- Production of drinking water: Volume Statistics Netherlands (CBS);
- Fuel use: energy statistics obtained from Statistics Netherlands (CBS).

Emission factors:
- Fireworks: CO_2 : 43 t/t; CH_4: 0.78 t /t; N_2O: 1.96 t/t (Brouwer et al., 1995);
- Candles: 2.3 t/t (EPA, 2001);
- Production of drinking water: 2.47 tons CH_4 /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).

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

4.8.2 Methodological issues

The methodologies used to estimate the greenhouse gas emissions included in this category are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and the emission factors can be found in protocols 8102 and 8114 on the website www.greenhousegases.nl as indicated in section 4.1:
- Fireworks and candles: country-specific methods and emission factors are used to estimate emissions of CO_2 , CH_4 and N_2O.
- Degassing of drinking water: a country-specific methodology and emission factor are used to estimate the CH_4 emissions, which is the main source of CH_4 emissions in this category.
- Miscellaneous non-energy fossil fuel product uses (i.e. lubricants and waxes): a Tier 1 method is used to estimate emissions from lubricants and waxes using IPCC default emission factors.

4.8.3 Uncertainties and time-series consistency

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

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

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

Time-series consistency

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

4.8.4 Source specific QA/QC and verification

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

4.8.5 Source specific recalculations

In 2007 the NIR 2006 was reviewed by an ERT. In the following table documents the sector specific issues raised by the ERT, and the response of The Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
2.G. Indirect N_2O from deposition of NO_x from combustion and Industrial Processes	N_2O	L, T (T2)		X	X

Description of problem identified:

The Party reported indirect N_2O from the deposition of NO_x. Specifically, the Party reported aggregated NO_x and aggregated N_2O emissions from (1) industrial source categories, (2) stationary combustion sources and (3) transport. However, during the review the ERT concluded that the calculation for estimating NO_x emissions from transport is not in line with the IPCC guidelines. The methodologies used for NO_x emissions from industrial processes and stationary combustion are not described in the NIR, which makes it difficult for the ERT to evaluate the conformity of the methodologies used to the IPCC guidelines and the IPCC GPG. The ERT concluded that emissions for the base year from this source may be over- or underestimated.

Recommendation by ERT:

The Party should provide sufficient description of the methodologies used to estimate NO_x emissions from stationary combustion and industrial processes. This will enable the ERT to evaluate the conformity of such methodologies to the IPCC guidelines and GPG.
For NO_x emissions from transport, the Party is requested to revise emission estimates in accordance with the IPCC guidelines and to submit sufficient documentation to substantiate this revision.

Response / Information by Party:

During the in country review, national experts discussed with the ERT if – according to the IPCC 1996 guidelines – reporting of indirect N_2O emissions because of NO_x (and also, as a relatively minor source, NH_3 emissions from non-agricultural sources) is legitimate. The guidelines are not very explicit on this subject. The ERT agreed upon inclusion of this source in the inventory. **However, after internal discussions the Netherlands has decided** not to include **this source in the inventory.** This means that the N_2O emissions in the base year *decrease* by 3.03 Gg (rounded).
Main reasons for this decision are:
(1) the Netherlands seems to be the only Annex 1 Party that interpreted the 1996 IPCC guidelines in a way that including indirect N_2O emissions related to NO_x (and NH_3) emissions from non-agricultural sources in the inventory is allowed;
(2) from a scientific perspective, the proper way to calculate these indirect N_2O emissions, is by deriving them from nitrogen deposition in the Netherlands. This nitrogen deposition is determined by emissions inside as well as outside the national territory of the Netherlands. Since it is agreed that only the emissions stemming from activities within the national territory are to be reported, it seems difficult to calculate the indirect N_2O emissions on a scientific sound basis and at the same time stay within the agreed approach for the national accounting of emissions.
Another issue touched by the ERT, is that the Netherlands' approach for calculating the NO_x emissions from the road transport sector as activity data for estimating indirect N_2O emissions from this source is not in accordance with the IPCC guidelines. This is relevant in the context of reporting of NO_x as ozone precursor. Therefore, the NO_x emissions have now been calculated and reported in the CRF in accordance with the IPCC definition. For that purpose, fuel use (PJ) per fuel type (petrol, diesel, LPG) is multiplied by an EF for NO_x. The methodology is described in Klein (2006). This report is available on www.greenhousegases.nl

Description of problem identified:

The emissions of N_2O for this category (indirect N_2O emissions from combustion and industrial processes) in CRF table 2(I).A-Gs2 are calculated using 595.49 Gg NO2 as total national emissions. However, in CRF Summary1.As1 table the value for total NO_x emissions is 559.33 Gg. Therefore, N_2O emissions appear to be overestimated.

Recommendation by ERT:

The ERT recommends to check the activity data used for the calculation of N_2O emissions for this category, make the totals in the two tables consistent and revise the estimate correspondingly.

Response / Information by Party:

Taking into account the comments of the ERT, the NO_x emissions from the transport sector are calculated and reported according to IPCC definitions (see also the answer on the former potential problem). The revised national total NO_x emission for 1990 is 564.24 Gg. This figure is now reported in the CRF.

4.8.6 Source specific planned improvements

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

5 Solvent and other product use [CRF sector 3]

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 cans with cream).

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

This sector comprises all non-combustion emissions from sectors other than the manufacturing and energy industries, with the exception of :
- Indirect CO_2 emissions from 3C Chemical products, manufacture and processing. These 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 mineral oil products (e.g. lubricants, waxes, etc.). These are included in 2G Industrial processes.
- Several minor sources of CH_4 emissions from non-industrial, non-combustion sources. These are included in sector 2G because the CRF does not permit methane emissions to be included in sector 3.

The following 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 8114: CO_2 , N_2O en CH_4 from Other process emissions and product use.

Major changes in sector 3 *Solvent and other product use* compared to the National Inventory Report 2007

Emissions: No changes.

Key sources: There are no changes in the key source allocation in this sector.

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

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

Sector/category	Gas	Key	Emissions base-year (1990)		Emissions 2005		Emissions 2006		Change 2006 - 2005	Contribution to total in 2006 (%)		
		Level, Trend	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq		By sector	Of total gas	Of total CO_2-eq
3 Solvent and other product use	CO_2			0.3		0.1		0.1	-0.3		0.1	0.1
	N_2O		0.73	0.2	0.25	0.1	0.26	0.1	0.0		0.5	0.0
	All			0.5		0.2		0.2	2.7			0.1
3A. Paint application	CO_2			0.2		0.1		0.1	-1.6	29	0.0	0.0
3A. Paint application	All		212	0.2	64	0.1	62	0.1	-1.6	29		0.0
3B. Degreasing and drycleaning	CO_2			0.0		0.0		0.0	0.0	1	0.0	0.0
3B. Degreasing and drycleaning	All		4.24	0.0		0.0		0.0	0.0	1		0.0
3D. Other	CO_2			0.1		0.1		0.1	1.3	33	0.0	0.0
	N_2O		0.73	0.2	0.25	0.1	0.26	0.1	0.0	38	0.5	0.0
3D1 Anaesthesia	N_2O		0.65	0.2	0.13	0.0	0.12	0.0	0.0	18	0.2	0.0
3D3 Aerosol cans	N_2O		0.08	0.0	0.12	0.0	0.14	0.0	0.0	20	0.3	0.0
3D. Other	All			0.3		0.1		0.2	4.3			0.1
Total National Emissions	CO_2			159.4		175.9		172.2	-3,706.6		100.0	
	N_2O		64	19.9	55	17.1	55	16.9	-0.6		100.0	
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.0		214.3		210.1	-4,284.2			

Overview of shares and trends in emissions

Table 5.1 shows the contribution of the emissions from Solvent and other product use in the Netherlands. Total greenhouse gas emissions from Solvent and product use in the Netherlands were 0.5 Tg CO_2-eq. in 1990 and 0.2 Tg CO_2-eq. in 2006.

Total emissions of the sector declined by 60% between 1990 and 2003, and remained stable between 2003 and 2006. CO_2 emissions from the sector decreased by 54% between 1990 and 2006, mainly due to decreasing indirect emissions from paints that resulted from the implementation of an emission reduction programme for NMVOC (KWS2000). N_2O emissions fell by 61% from 1990 to 2002 due to the better dosing of anaesthesia in hospitals and other medical institutions. Total N_2O emissions declined since 1990 by 64%.

Key sources

Solvent and product use is a minor source of greenhouse gas emissions. No key sources are included in this sector. The most relevant sources are indirect CO_2 emissions from paint application and use of N_2O for anaesthesia 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 paints and paints used by households and professional painters. Indirect emissions from the use of solvents in Degreasing and dry cleaning are included in CRF

source category 3B, which covers the use of solvents for cleaning and degreasing of surfaces, the dry cleaning of clothing and textiles and the degreasing of leather.

Activity data and implied emission factors
Detailed information on the activity data and emission factors of NMVOC estimates can be found in the monitoring protocol 8114 on the website www.greenhousegases.nl.

Activity data: consumption data and NMVOC contents of products are mainly provided by trade associations, such as the VVVF (for paints), the NCV (for cosmetics) and the NVZ (for detergents).

The consumption of almost all solvent-containing products has increased since 1990. However, the general NMVOC content of products (especially paints) has decreased over the past years, resulting in a steady decline in NMVOC emissions since 1990 (see section 2.4). Due to the increased sales of hairspray and deodorant sprays NMVOC emissions have increased slightly in recent years. It is assumed that the NMVOC contents of these products have remained stable.

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

5.2.2 Methodological issues

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

The indirect CO_2 emissions from NMVOCs are calculated from the average carbon contents of the NMVOC in the solvents.

3A	3B	3D
0.72	0.16	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 27%.

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

5.2.4 Source-specific QA/QC and verification

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

5.2.5 Source-specific recalculations

In the last submission (from 2003 onwards) the CO_2 emissions were based on incorrect NMVOC data. These were replaced by revised figures resulting in a decrease of the CO_2 emissions of 8.4 Gg CO_2 eq. in 2005.

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 8114 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.

Domestic sales of cream in aerosol cans have shown a strong increase since 2000. In 2005 sales increased 7%, in 2006 15%. The increase is reflected in the increased emissions in these years.

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 (based on data provided by one producer), and is assumed to be constant over time.

5.3.2 Methodological issues

Country-specific methodologies are used for the N_2O sources in Sector 3. Since the emissions in this source category are from non-key sources for N_2O, the present methodology complies with the IPCC Good Practice Guidance (IPCC, 2001). A full description of the methodology is provided in the monitoring protocol 8114 on the website www.greenhousegases.nl.

5.3.3 Uncertainties and time-series consistency

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

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

5.3.4 Source-specific QA/QC and verification

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

5.3.5 Source-specific recalculations

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

5.3.6 Source-specific planned improvements

There are no source-specific improvements planned.

6 Agriculture [CRF sector 4]

6.1 Overview of the sector

Emissions of greenhouse gases from Agriculture include all anthropogenic emissions from the agriculture sector, with the exception of emissions from fuel combustion and CO_2 emissions by land use in agriculture. These emissions are included in 1A4c Agriculture/forestry/fisheries (section 3.6) and in 5 LULUCF (section 7.3 and 7.4).

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

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

Manure management (4B) includes all emissions from confined animal waste management systems (AWMS). CH_4 emissions from animal manure produced in the meadow during grazing are included in category 4B Manure management; N_2O emissions from this source are included in category 4D2 Animal production. These different approaches are in accordance with IPCC Guidelines (IPCC, 2001).
Methane emissions from agricultural soils are regarded as natural (non-anthropogenic) emissions and therefore are not included.

The following protocols on www.greenhousegases.nl describe the methodologies, activity data and emission factors applied in estimating N_2O and CH_4 emissions in the agricultural sector in the Netherlands:
- Protocol 8127 and 8128: CH_4 from Enteric fermentation (4A);
- Protocol 8130: CH_4 from Manure management (4B);
- Protocol 8129: N_2O from Manure management (4B);
- Protocol 8131: N_2O from Agricultural soils: indirect emissions (4D);
- Protocol 8132: N_2O from Agricultural soils: direct emissions and emissions from animal production (4D).

Major changes in the Agriculture sector with respect to the National Inventory Report 2006

Emissions: Compared to the previous NIR submission, N_2O and CH_4 emissions slightly decreased as a result of a small decrease in animal numbers and in manure nitrogen supply to soil.

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

Methodologies: As a result of the in-country review in april 2007, the Netherlands has adjusted the calculation method for nitrous oxide emission from manure management. The total amount of nitrogen excreted from animals is no longer adjusted for nitrogen from ammonia volatilization during manure management, which makes the estimate consistent with the IPCC GPG.

Table 6.1 Contribution of main categories and key sources in Agriculture

Sector/category	Gas	Key	Emissions base-year		Emissions 2005		Emissions 2006		Change 2006–2005	Contribution to total in 2006 (%)		
		Level, Trend, Non-key	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Tg CO_2-eq	By sector	Of total gas	Of total CO_2-eq
4. Agriculture	CH_4		499.6	10.5	419.1	8.8	417.5	8.8	0.0	48	54	4.2
	N_2O		37.4	11.6	30.6	9.5	30.4	9.4	-0.1	52	55	4.5
	All			22.1		18.3		18.2	-0.1	100		8.7
4A. Enteric fermentation	CH_4		358.4	7.5	302.1	6.3	300.5	6.3	0.0	35	39	3.0
4A1 Cattle	CH_4	L,T	322.3	6.8	270.3	5.7	268.6	5.6	0.0	31	35	2.7
4A Swine	CH_4		20.9	0.4	17.0	0.4	17.0	0.4	0.0	2	2	0.2
4A2-13 Other animals	CH_4	NK	15.2	0.3	14.8	0.3	14.9	0.3	0.0	2	2	0.1
4B. Manure management	CH_4		141.2	3.0	117.1	2.5	117.0	2.5	0.0	13	15	1.2
	N_2O	L	2.6	0.8	2.8	0.9	2.7	0.9	0.0	5	5	0.4
	All			3.8		3.3		3.3	0.0	18		1.6
4B2 Cattle	CH_4	L,T2	74.8	1.6	68.9	1.4	69.2	1.5	0.0	8	9	0.7
4B8 Swine	CH_4	L,T2	54.3	1.1	44.4	0.9	44.1	0.9	0.0	5	6	0.4
4B9 Poultry	CH_4	T2	11.5	0.2	3.0	0.1	2.9	0.1	0.0	0	0	0.0
4B2-7, 10-13 Other animals	CH_4	NK	0.5	0.0	0.8	0.0	0.8	0.0	0.0	0	0	0.0
4D Agriculture soils	N_2O		34.8	10.8	27.8	8.6	27.6	8.6	0.0	47	50	4.1
4D1 Direct soil emissions	N_2O	L,T	14.8	4.6	15.5	4.8	15.5	4.8	0.0	26	28	2.3
4D2 Animal production on agricultural soils	N_2O	L,T	4.2	1.3	2.1	0.7	2.0	0.6	0.0	4	4	0.3
4D3 Indirect emissions	N_2O	L,T	15.7	4.9	10.2	3.2	10.1	3.1	0.0	17	19	1.5
Total national emissi-ons (excl. Int bunkers)	CH_4		1,211.3	25.4	802.1	16.8	775.4	16.3	-0.6		100	
	N_2O		64.3	19.9	55.2	17.1	54.7	16.9	-0.2		100	
National Total GHG emissions (excl. CO_2 LUCF)	All			213.0		211.8		207.5	0.0			100

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

Overview of shares and trends in emissions

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

In 2006 CO_2-equivalent emissions from sector 4 'Agriculture' contributed 8.7% to the total national emissions (without LULUCF) compared to 10% in 1990. In 2006, emissions of CH_4 and N_2O from agricultural sources each accounted for roughly 55% of the national total CH_4 and N_2O emissions. Category 4A 'Enteric fermentation' is the main source of CH_4 emissions and category 4D 'Agricultural soils' is the largest source of N_2O emissions included in this sector.

Total greenhouse gas emissions from Agriculture decreased by approximately 18% between 1990 and 2006, from 22.1 Tg CO_2-eq. in 1990 to 18.2 Tg CO_2-eq. in 2006 (see also Figure 6.1). This decrease was largely the result of decreasing numbers of livestock, a decreased application of animal manure and a decreased use of synthetic fertilizers.

From 2005 to 2006, both N_2O and CH_4 emissions in the sector slightly decreased. For some sources emissions stabilized, while for others they decreased.

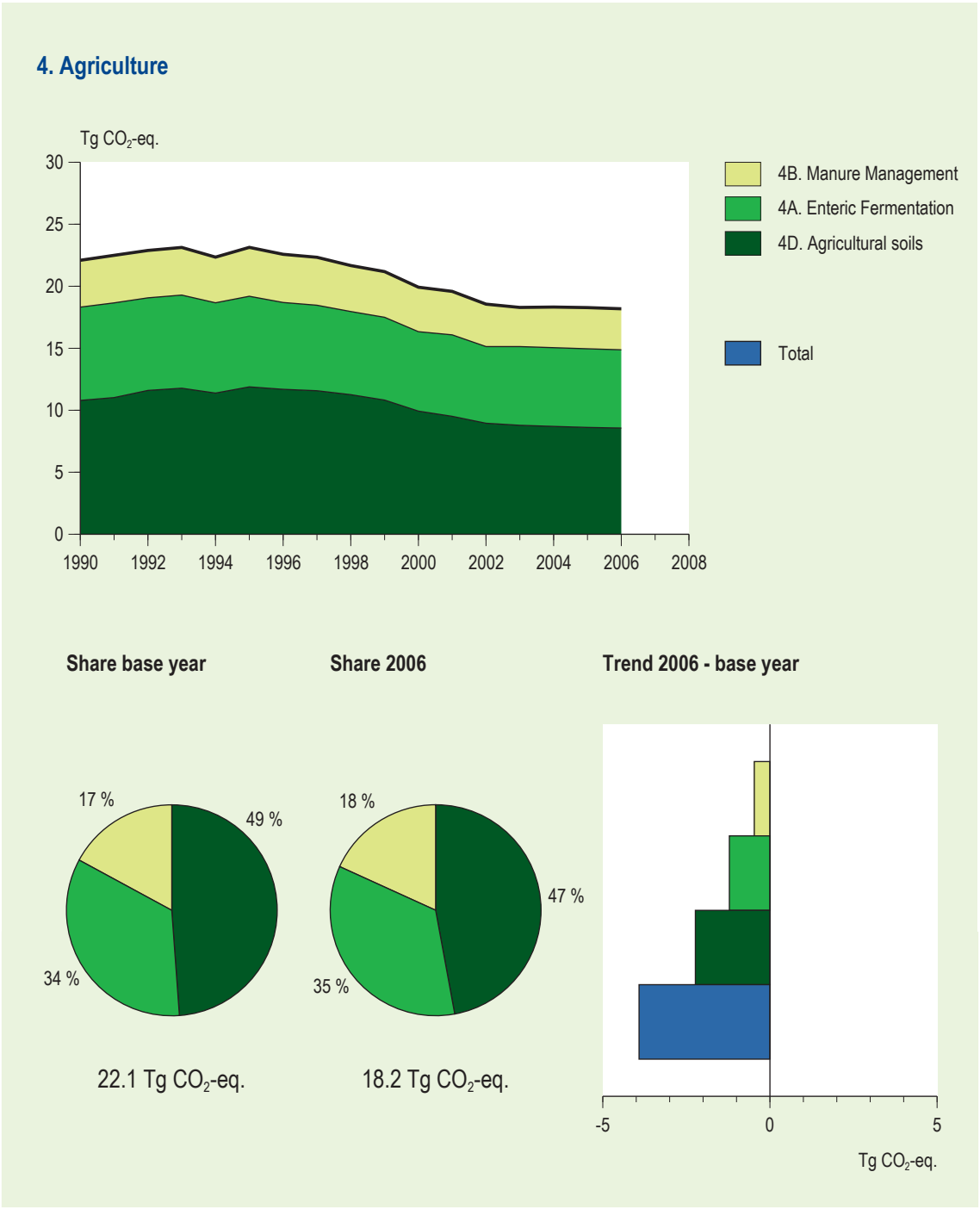


Figure 6.1 Category 4 'Agriculture: trend', emission levels and share of source categories in emissions of 4 'Agriculture', 1990-2006

Overview of trends in activity data

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

Activity data for the livestock numbers are based on the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl and in background documents (e.g. Van der Hoek and Van Schijndel, 2006; Van Schijndel and Van der Sluis, 2008). Table 6.2 presents an overview.

Table 6.2 Numbers of animals in 1990–2006 (1000 heads) (CBS, 2006)

Animal type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Cattle	4,926	5,062	4,920	4,797	4,716	4,654	4,551	4,411	4,283	4,206	4,070	4,028	3,858	3,759	3,767	3,799	3,745
- Adult dairy cattle	1,878	1,852	1,775	1,747	1,698	1,708	1,665	1,591	1,611	1,588	1,504	1,539	1,486	1,478	1,471	1,433	1,420
- Adult non-dairy cattle	120	139	146	156	146	146	146	145	145	153	163	161	151	144	145	152	143
- 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	2,214	2,182
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	1,363	1,376
Goats	61	70	63	57	64	76	102	119	132	153	179	219	255	274	282	292	310
Horses	70	77	86	92	97	100	107	112	114	115	118	120	121	126	129	133	128
Pigs (*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	11.3	11.4
Poultry (*1000)	95.6	94.4	99.7	98.6	95.9	93.6	94.1	96.0	101.5	107.6	107.2	103.4	104.0	75.0	88.5	95.9	94.7

For cattle, three categories are distinguished:
- Dairy cattle: adult 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), including adult male cattle.

Between 1990 and 2006 (dairy) cattle, pigs and sheep numbers decreased by 24, 18 and 19% respectively, while poultry numbers remained fairly constant. Goat numbers increased by a factor 5 and horse numbers increased by 83%.

For adult dairy cattle, the decrease in numbers can be explained as follows. Milk production per cow increased between 1990 and 2006, a development which has resulted from both genetic changes in cattle (due to breeding programmes) and the change in amount and composition of feed intake. Total milk production in the Netherlands is determined mainly by EU policy on milk quota, which remained unchanged in the same period. In order to comply with the unchanged milk quota, animal numbers of adult dairy cattle had to decrease to counteract the effect of increased milk production per cow. Between 1990 and 2006 the numbers of young (dairy) cattle follow the same trends as those of adult female cattle – namely, a decrease. (Van Schijndel and Van der Sluis, 2008).

In addition, the Netherlands manure and fertilizer policy influences livestock numbers. Especially young cattle, pigs and poultry numbers decreased by the introduction of measures like buying up part of the so-called pig and poultry production rights (ceilings for total animal numbers) by the government and lowering the maximum nutrient application standards for manure and fertilizer. For pigs and young cattle the decreasing trend of the past has levelled off the last couple of years. For swine it has changed into a slight increase in both 2005 and 2006.

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 remain on the pig farms for a relatively long period (accumulation of pigs).

An increase in the number of poultry is observed between 1990 and 2002. In 2003, however, poultry numbers decreased by almost 30% as a direct result of the avian flu outbreak. In the years after 2003 the poultry population has recovered to a large extent and reached a level of 10% below the 2002 level in 2006.

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

6.2 Enteric fermentation [4A]

6.2.1 Source category description

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

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

Overview of shares and trends in emissions
In 2006 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 cattle; this source contributed substantially (appr. 90%) to the CH_4 emissions from Enteric fermentation in 2006. The second largest CH_4 emission source in category 4A is swine (6%). 4A Other consists of sheep, goats and horses, and accounts for 5%.

CH_4 emissions from Enteric fermentation decreased from 7.5 Tg CO_2-eq. to 6.3 Tg (–16%) between 1990 and 2006, with CH_4 emissions from Enteric fermentation by cattle and swine decreasing by 17% and 19%, respectively. From 2005 to 2006 a rather small decrease indicates a stabilization of the CH_4 emission (Figure 6.2).

Activity data and (implied) emission factors
Trends in CH_4 emission from Enteric fermentation are explained by a change in animal numbers, a change in emission factor or both.

Detailed information on data sources for activity data and emission factors can be found in the following monitoring protocol:
- Protocol 8127 and 8128: CH_4 from Enteric fermentation (4A);

More details and specific data (activity data and emission factors), including data sources, are incorporated into background documents. All relevant documents concerning methodology, emission factors and activity data are published on the website www.greenhousegases.nl. Table 6.2 (in Section 6.1) presents an overview of animal numbers.

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

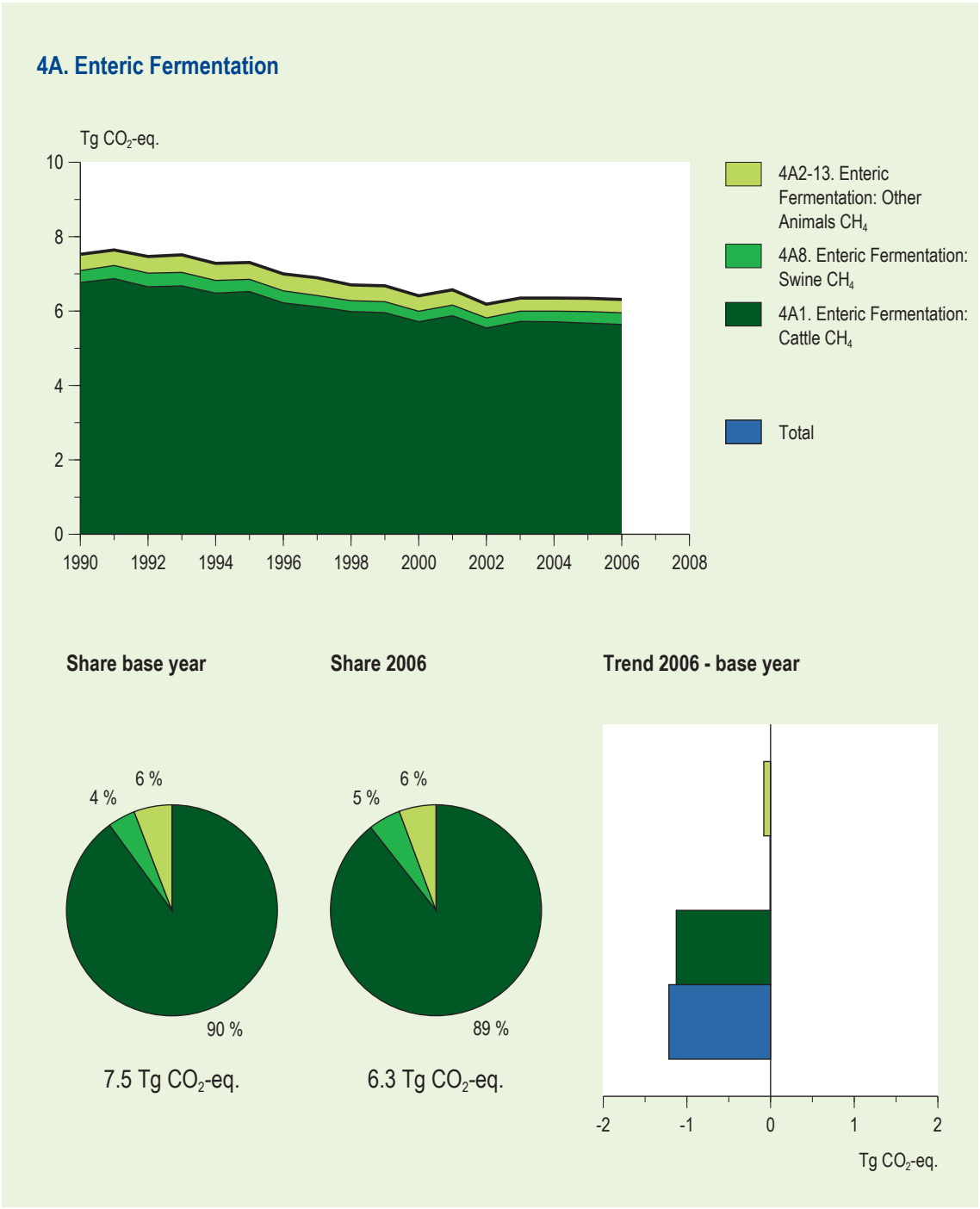


Figure 6.2 Category 4A 'Enteric fermentation: trend', emission levels and share of source categories in emissions of 4 'Agriculture', 1990-2006

Trends in cattle IEF

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

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	2005	2006
Adult dairy cattle	108	108	108	111	112	113	111	114	115	117	118	121	119	125	126	128	129
Adult non-dairy cattle	67	67	67	67	67	67	66	67	66	68	68	68	69	73	74	72	73
Young cattle	38	38	38	39	38	39	37	37	36	35	35	35	35	36	35	34	34

Table 6.4 Milk production (kg milk/cow/year) and IEF (kg CH_4/animal) for adult dairy cows

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Milk production	6050	6090	6140	6270	6405	6580	6626	6803	6827	7034	7416	7336	7187	7494	7415	7568	7744
IEF for methane	108	108	108	111	112	113	111	114	115	117	118	121	119	125	126	128	129
Young cattle	38	38	38	39	38	39	37	37	36	35	35	35	35	36	35	34	34

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

For both adult dairy and adult non-dairy cattle during the period 1990–2006 IEF increased primarily as a result of an increase in total feed intake. For dairy cattle a change in the feeds nutrient composition partly counteracted this effect (see Section 6.2.2). For young cattle the IEF decrease between 1990-2006 can be explained by a decrease in the average total feed intake due to a shift towards a relatively high share of meat calves in the young cattle population (Van Schijndel and Van der Sluis, 2008).

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

In 1997 for instance, a milk production of about 6800 kg per year per cow led to an emission factor of 114 kg per animal per year, about 4% lower compared to the default of 118 kg per animal per year. An explanation of the difference can be found in the data on feed intake and nutrient composition used to calculate the methane emissions (Bannink, 2008). With increasing milk production per cow a decrease in amount of CH_4 emission per litre milk (from 0.018 to 0.017 kg CH_4 per litre milk) can be noticed.

For adult non-dairy cows the higher IEF (compared to the IPCC default value of 48 per animal) for the Netherlands can be explained by the higher total feed intake per adult non-dairy cow. The relatively large share of meat calves for white and rose veal production explains the relatively low IEF for young cattle compared to the IPCC default value (Van Schijndel and Van der Sluis, 2008).

6.2.2 Methodological issues

A detailed description of the method, data sources and emission factors is found in the protocol on www.greenhousegases.nl, as indicated in section 6.2.1. 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 activity data on animal numbers and the appropriate emission factors.

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

Cattle

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

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

The intake of grass silage, maize silage, wet by-products, concentrates and grass products is estimated from national statistics found at www.cbs.nl (Van Bruggen, 2008). More information on the the Netherlands VEM system is presented in Smink et al. (2005).

Adult dairy cows

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

Young cattle and non-dairy cattle

The methane emission factor (EF) for enteric fermentation by non-dairy and young cattle is calculated by multiplying the gross energy (GE) intake by a methane conversion factor (Smink, 2005). Changes in GE intake are based on changes in the total feed intake and on the share of feed components. Data on the amounts of feed components, expressed as dry matter (DM) intake are found at www.cbs.nl (Van Bruggen, 2008) and in van Schijndel and Van der Sluis (2008).

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

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

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

Where:

- GE intake = Dry Matter (DM) intake × 18.45 MJ/kg DM (IPCC, 2001).

- MCF = 0.04 for white veal calves and 0.06 for the other categories of young cattle and adult non-dairy cattle (IPCC, 2001).

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

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

As 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.

6.2.3 Uncertainty and time-series consistency

Uncertainty
The Tier 1 uncertainty analysis shown in Annex 7 provides estimates of uncertainty according to IPCC source categories. The uncertainty of CH_4 emissions from enteric fermentation from cattle sources is based on the judgements of experts and is estimated to be about 15% in annual emissions, using a 5% uncertainty for animal numbers (Olivier, 2008) and 15% for the emission factor (Bannink, 2008). The uncertainty in the emission factor for swine and other animals is estimated to be 50% and 30%, respectively (Olivier, 2008)

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

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

6.2.4 Source-specific QA/QC and verification

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

6.2.5 Source-specific recalculations

As a result of the in-country review of the NIR 2006 in April 2007 specific issues were raised by the Expert Review Team (ERT). The following table documents the sector specific issues raised by the ERT, and the response of the Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
4. Agriculture	All gases	Not applicable		X	

Description of problem identified:
During the review, the ERT found that the Party rounded the values of activity data (AD) and final estimates of emissions before importing them into the CRF tables. This practice can lead to over- or underestimation of emissions in the base year.

Recommendation by ERT:
The ERT recommends that the Party report the values of AD and emissions in the CRF tables without prior rounding, i.e., with the same number of digits in the values as in the background calculations.

Response / Information by Party:
The Netherlands has incorporated the recommendations of the review team in the CRF (leading to a very minor reduction of CH_4 emissions (expressed in CO_2 eq. accounting for 0.0002 Mt).

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. For instance, in comparison to anaerobic conditions, aerobic conditions in the manure management system will in general increase N_2O emissions and decrease CH_4 emissions. Furthermore, longer storage times and higher temperatures will increase CH_4 emissions compared to shorter storage times and lower temperatures.

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

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

Overview of shares and trends in emissions
In 2006, Manure management accounted for 18% of the total greenhouse gas emissions from the agricultural sector (Table 6.1 and Figure 6.4). In the Netherlands CH_4 emissions from Manure management are particularly related to cattle and swine manure management, which, in 2006, contributed 8% and 5%, respectively, to the total greenhouse gas emissions in the agricultural sector. Poultry is a minor key source for CH_4 emissions by manure management. Furthermore, N_2O emissions from Manure management contribute 5% of the total greenhouse gas emissions from the agricultural sector.

Between 1990 and 2006, the emission of CH_4 from Manure management decreased by 17%. Emissions from cattle, swine and poultry decreased by 8%, 19% and 75%, respectively, during this period. From 2005 to 2006, the emission of CH_4 from Manure management slightly decreased.

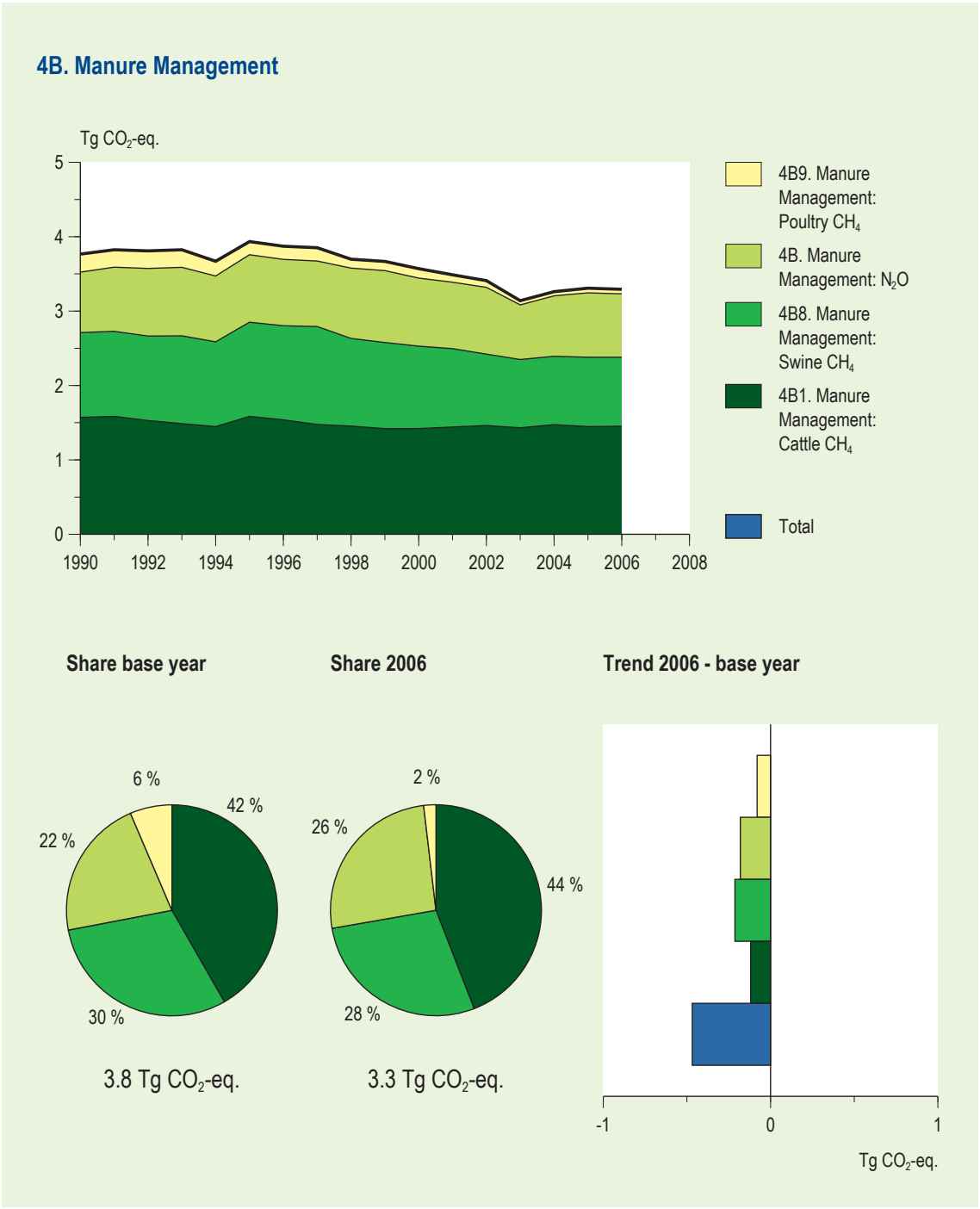


Figure 6.4 Category 4B Manure management: trend, emission levels and share of source categories in emissions of 4 'Agriculture', 1990-2006

The emissions of N_2O from Manure management increased 5% between 1990 and 2006, from 2.6 to 2.7 Gg N_2O in 2006 (Table 6.1). The relatively large decrease in N_2O emissions of solid manure in 2003 is a direct result of the decrease in poultry animal manure. This decrease was due to the reduction in the number of poultry animals that followed the avian flu epidemic. In 2004 and 2005, N_2O emissions increased once again following the recovery of poultry animal numbers, while in 2006 the emission decreased as a consequence of lower poultry numbers.

Activity data and (implied) emission factors

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

- Protocol 8130: CH_4 from Manure management (4B);
- Protocol 8129: N_2O from Manure management (4B);

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

Activity data on animal numbers can be found on the website www.cbs.nl and in a background documents (Van der Hoek and Van Schijndel, 2006 and Van Schijndel and Van der Sluis, 2008).

The decreased CH_4 emission from swine between 1990 and 2006 largely results from the decrease in their animal numbers. For adult non-dairy cattle and young cattle to a great extent this is also the case. For adult dairy cattle the decrease in CH_4 emission is much lower than the decrease in animal numbers as a consequence of a higher IEF. For poultry the large decrease in CH_4 emissions between 1990 and 2006 can only be explained by the rather small decrease in animal numbers in combination with a higher IEF.

The slightly increased N_2O emissions from Manure management between 1990 and 2006 is explained by an increase in a higher IEF partly counteracted by a decrease in N excretion in the stable.

CH_4 implied emission factors (IEF) for Manure management

The CH_4 IEF for Manure management are calculated annually for all animal categories. A Tier 2 approach is used based on country specific data on animal manure production per animal, on manure characteristics, like organic matter (OM) content on (liquid) manure storage conditions. Table 6.5 shows the implied emission factors for Manure management specified by the animal categories that contribute the most to CH_4 emissions.

Trends in IEF

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

In short, between 1990 and 2006 the increase in the manure production per cow and in the organic matter content of dairy cattle manure combined with a shift to more stable manure resulted in an increased methane emission from manure management per cow. These changes combined with the decrease in the number of adult dairy cow since 1990 fully explain the slight increase in the total CH_4 emission of milk-producing cows.

Table 6.5 CH_4 implied emission factor (kg/head) for Manure management as specified by animal category, 1990–2006

Animal type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Cattle																	
- dairy cattle	27.70	27.70	27.70	27.70	27.70	30.48	30.48	30.48	30.48	30.48	33.15	33.15	35.70	35.70	37.50	37.50	38.34
- non-dairy cattle	3.23	3.23	3.23	3.23	3.23	3.53	3.53	3.53	3.53	3.53	3.45	3.45	3.45	3.45	3.45	3.45	3.45
- young cattle	7.66	7.73	7.73	7.58	7.45	8.18	8.03	7.96	7.78	7.57	7.18	7.35	7.25	6.98	6.76	6.63	6.52
Swine*	3.90	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	3.92	3.89
Swine exclpiglets	6.22	6.22	6.08	6.05	6.06	6.85	6.85	6.82	6.72	6.62	6.58	6.58	6.62	6.60	6.60	6.58	6.58
- fattening pigs	4.97	4.97	4.78	4.78	4.78	5.74	5.74	5.74	5.51	5.51	5.51	5.51	5.51	5.51	5.51	5.51	5.51
- breeding swine	11.39	11.34	11.38	11.45	11.53	11.56	11.50	11.39	11.23	11.46	11.21	11.29	11.36	11.22	11.31	11.29	11.32
Poultry	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.06	0.05	0.06	0.05	0.04	0.04	0.03	0.03	0.03

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

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

Compared to 1990, the IEF of *swine* manure management (based on total swine numbers, including piglets), hardly changes in 2006. However, there are some inter-annual changes. These changes can be explained by looking at emissions factors of underlying swine categories. The calculation method for CH_4 emissions from swine manure management is based on the liquid manure production of adult breeding swine (in which manure production by piglets is accounted for). So presenting the underlying IEFs gives a better understanding of the inter-annual changes.

For fattening pigs the 15% increase in IEF between 1990 and 1995 is explained by a 4% decrease in manure production per animal combined with a 20% increase in organic matter (OM) content of the manure. The 4% decrease in IEF between 1997 and 1998 is explained by a 4% decrease in manure production per animal. These changes are mainly the result of a change in liquid manure handling. In order to decrease the liquid manure volume, the mixing of rinsing water with manure was prevented as much as possible. As a consequence not only manure volume decreased, but also an increase in the OM concentration of manure occurred. A higher OM content results in a higher emission factor.

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

For more details see Van der Hoek and Van Schijndel (2006) and Van Schijndel and Van der Sluis, 2008).

Table 6.6 N_2O implied emission factor for Manure management and total N-excretion per animal manure management system, 1990-2006 (Units: mln kg/year and kg N_2O/kg manure)

	1990	1995	2000	2001	2002	2003	2004	2005	2006
Total N-excretion	493.0	501.2	414.9	411.8	394.9	375.7	373.2	379.1	377.3
-liquid system	431.2	429.6	338.0	337.0	318.7	316.1	305.1	305.5	305.1
-solid storage	61.9	71.6	76.9	74.8	76.2	59.6	68.1	73.6	72.2
N_2O emission manure management	2.62	2.93	2.95	2.88	2.90	2.37	2.62	2.79	2.75
N_2O IEF manure management	0.0053	0.0058	0.0071	0.0070	0.0073	0.0063	0.0070	0.0074	0.0073

Comparison with IPCC defaults

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

Also the values of one of the underlying parameters per manure management system, Volatile Solids (VS), also called Organic Matter (OM) per animal type are not directly comparable. The Netherlands approach differs from the IPCC method in that the Netherlands uses the VS content of the manure (kg VS per kg manure) instead of volatile solids VS produced per animal per day (kg per head per day) in the IPCC calculation equations. By multiplying the VS per kg manure with the manure production per year, the annual VS production in manure in the Netherlands can be compared with the annual VS production underlying the default IPCC emission factors. More details are presented in Van Schijndel and Van der Sluis (2008). Compared to the IPCC default MCF values, the Netherlands MCF values for liquid manure systems of swine, poultry and cattle are slightly lower because part of the manure is stored under cooler conditions. For solid manure systems, the Netherlands uses a MCF of 1.5% for all animal categories; for manure production in the meadow, it uses the IPCC default MCF value.

N_2O implied emission factor (IEF) for Manure management

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

Table 6.6 shows that the N_2O emissions from Manure management increased between 1990 and 2006, mainly as a consequence of the increase in N_2O IEF. The explanation is that between 1990 and 2006 the proportion of the total solid manure N excretion increased. Compared to the liquid manure system, the N_2O emission factor for the solid system is about 20-fold higher, which explains the increased overall IEF. This increased IEF was not fully counteracted by the decrease in de total N excretion and therefore has led to a small increase in N_2O emissions.

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

6.3.2 Methodological issues

Methane emissions from animal manure

A Tier 2 approach is followed for CH_4 emission calculation. The amounts of manure (in kg) produced are calculated annually for every manure management system per animal category.

Country-specific CH_4 emission factors are calculated for all three manure management systems for every animal category on a Tier 2 level. These calculations are based on country-specific data on:

- manure characteristics: organic matter (OM) and maximum CH_4 producing potential (B0);
- manure management system conditions (storage temperature and period) for liquid manure systems, which determine the methane conversion factor (MCF).

The amount of manure produced is calculated by multiplying manure production factors (in kg per head per year) by animal numbers. Detailed descriptions of the methods can be found on the website www.greenhousegases.nl. More specified data on Manure management are based on statistical information on manure management systems found at http://www.cbs.nl (Van Bruggen, 2008). These data are also documented in Van der Hoek and Van Schijndel (2006) and in van Schijndel and Van der Sluis (2008).

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 probably higher (see Van der Hoek and Van Schijndel, 2006). For this reason the Netherlands set the MCF value for stored solid cattle manure equal to the MCF for stored solid poultry manure. The IPCC guidelines recommend a MCF value of 0.01 for manure produced in the meadow. This value is used in the CH_4 emission calculations.

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

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

Nitrous oxide emissions from animal manure

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

As a result of the in-country review in April 2007, The Netherlands has adjusted the calculation method for N_2O emission from manure management. The total amount of nitrogen excreted from animals is no longer adjusted for N from NH3 volatilization during manure management, which makes the estimate consistent with the IPCC Good Practice Guidance (IPCC, 2001).

6.3.3 Uncertainty and time-series consistency

Uncertainty

The Tier 1 uncertainty analysis shown in Annex 7 provides estimates of uncertainty according to IPCC source categories. The uncertainty in the annual CH_4 and N_2O emissions from manure management from cattle and swine is estimated to be approximately 100% . The uncertainty in the amount of animal manure (10%) is based on a 5% uncertainty in animal numbers and a 5–10% uncertainty in excretion per animal. The resulting uncertainty of 7–11% was rounded off to 10%. The uncertainty in the CH_4 emission factors for Manure management, based on the judgments of experts, is estimated to be 100% (Olivier, 2008).

Time-series consistency

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

6.3.4 Source-specific QA/QC

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

6.3.5 Source-specific recalculations

In 2007 the NIR 2006 was reviewed by an international Expert Review Team (ERT). In the following table documents the sector specific issues raised by the ERT, and the response of The Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
4. Agriculture	All gases	Not applicable		X	

Description of problem identified:

During the review, the ERT found that the Party rounded the values of activity data (AD) and final estimates of emissions before importing them into the CRF tables. This practice can lead to over- or underestimation of emissions in the base year. The ERT also found that the total amount of nitrogen excreted from animals was adjusted for N from NH_3 volatilization during manure management, which is not allowed since the Party uses default IPCC emission factors. This practice can lead to underestimation of emissions in the base year.

Recommendation by ERT:

The ERT recommends that the Party reports the values of AD and emissions in the CRF tables without prior rounding, i.e., with the same number of digits in the values as in the background calculations. The ERT also recommends that the Party adjusts the calculation method for N_2O emission from manure management to make it consistent with the IPCC Good Practice Guidance (IPCC, 2001).

Response / Information by Party:

The Netherlands has incorporated the recommendations of the review team in the CRF leading to an increase of N_2O emissions and a small decrease of CH_4 emissions from manure management (expressed in CO_2 eq. accounting for +0.118 and -0.003 Tg in 1990).

6.3.6 Source-specific planned improvements

A possible technical measure to prevent methane emissions due to Manure management is manure treatment in an anaerobic digester. The Netherlands will examine future needs and possibilities in this area to include anaerobic treatment in the methodology and to extend calculations.

6.4 Agricultural soils [4D]

6.4.1 Source category description

In the Netherlands this source consists of the N_2O source categories specified in Table 6.1:
- Direct soil emissions from the application of synthetic fertilizers, animal manure and sewage sludge to soils, and from N-fixing crops, crop residues and the cultivation of histosols (4D1);
- Animal production – i.e. animal manure produced in the meadow during grazing (4D2);
- Indirect emissions from N leaching and run-off, and from N deposition (4D3).

Overview of shares and trends in emissions

In 2006, agricultural soils contributed 47% to the total greenhouse gas emissions in the agricultural sector. Direct and indirect N_2O emissions, and the emissions from animal production in the meadow contributed 26%, 17% and 4%, respectively, to the total greenhouse gas emissions in the agricultural sector.

Total N_2O emissions from Agricultural soils decreased by 21% between 1990 and 2006 (see Figure 6.5). Direct emissions increased by 4%, while indirect emissions and emissions from animal manure produced in the meadow decreased 36 and 52 %, respectively.

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

Key sources
Both direct and indirect N_2O soil emissions are level and/or trend key sources (see Table 6.1).

Activity data and (implied) emission factors
Detailed information on data sources (for activity data and emission factors) can be found in the following monitoring protocols:
- Protocol 8131: N_2O from Agricultural soils: indirect emissions (4D);
- Protocol 8132: N_2O from Agricultural soils: direct emissions and emissions from animal production (4D).

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

The calculation of N_2O emissions from Agricultural soils is based on various activity data, e.g. animal numbers (see Section 6.1) and nitrogen flows. For an overview of data sources see NIR 2006, the protocols or the background documents (Van der Hoek et al., 2007).

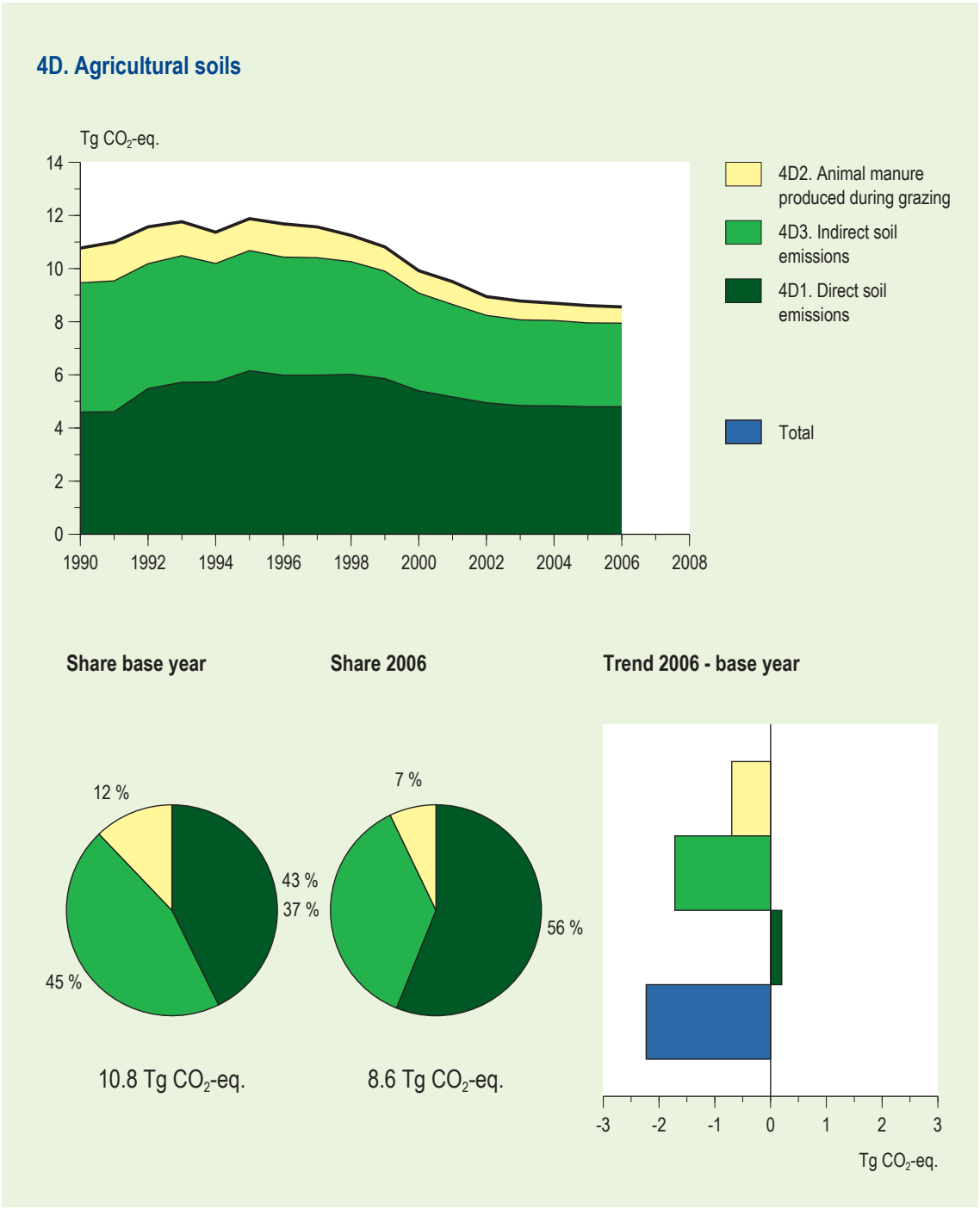


Figure 6.5 N_2O emissions from 4D Agricultural soils, 1990-2006

Nitrogen flows

Table 6.7 presents the N flows from synthetic fertilizers consumption and from animal manure production and application in the Netherlands. About 80–85% of the manure N collected in the stable and in storage is applied to soils. A small portion of the manure N (approximately 1–4%) is exported; while approximately 13-15% is emitted as ammonia during storage.

The total amount of N supply to soil (in manure and fertilizer) applied to agricultural soils (including production of animal manure in the meadow) decreased by approximately 32% between 1990 and 2006. This is explained by the Netherlands manure and fertilizer policy,

aimed at reducing N leaching and run-off. This policy regulates the amount of manure production and its application by the introduction of measures like like pig and poultry production rights and maximum nutrient application standards for manure and fertilizer.

Of the manure N applied to the soil between 1990 and 2006 the part emitted as ammonia (NH_3) decreased from 24 to 10%, due to a change in the method of animal manure application to agricultural soils. Before 1991 manure was applied to soil by spreading on the surface of grasslands and arable land. Initiated by the Netherlands' policy to reduce ammonia emissions, this practice changed in 1991 into manure incorporation into the soil (e.g. shallow injection or ploughing in), resulting in lower NH_3 emissions. Ultimately, between 1990 and 2006 the part of the N in manure and synthetic fertilizer emitted as NH_3 (during storage, grazing and application to the field) decreased from approximately 18% to 13%.

About 30% of the total nitrogen flow to the soil is subject to leaching and run-off (default IPCC Fracleach factor).

The decrease in indirect N_2O emissions is fully explained by the decrease in N lost by atmospheric deposition and by leaching and run-off. The decrease in N_2O emissions from animal manure produced in the meadow is also entirely reflected in the decrease in N-input to soil by this source. The 4% increase in direct N_2O emissions can mainly be explained by the 32% decrease in the direct N-input to soil by manure and chemical fertilizer application in combination with a 53% increase of the IEF.

Table 6.7 Nitrogen flows related to N_2O emissions from soils

	1990	1995	2000	2005	2006	Change 2006 - 1990
Nitrogen fertilizer consumption	412.4	405.8	339.5	279.2	287.8	-30%
of which ammonium fertilizer	3.6	11.2	6.6	30.6	42.9	1101%
NH_3-N emission during application	11.2	10.5	9.2	9.8	10.9	-3%
Net fertilizer to soil	401.1	395.3	330.3	269.4	276.9	-31%
Nitrogen excretion by animals	663.8	657.7	528.1	467.1	459.7	-31%
Nitrogen excretion in animals houses	493.0	501.2	414.9	379.1	377.3	-23%
of which in solid form	61.9	71.6	76.9	73.6	72.2	17%
of which in liquid form	431.2	429.6	338.0	305.5	305.1	-29%
NH_3-N emission in animal houses	73.2	73.5	60.2	49.8	48.6	-34%
Net available manure for application	419.8	427.7	354.7	329.3	328.7	-22%
Nitrogen in manure exported abroad	6.4	22.1	14.7	14.9	15.8	147%
NH_3-N emission during application	98.3	51.4	36.8	32.2	30.6	-69%
Net animal manure to soil	315.1	354.3	303.1	282.2	282.4	-10%
Nitrogen excretion in meadow	170.8	156.5	113.1	88.0	82.4	-52%
NH_3-N emission in meadow	13.0	11.9	8.5	7.1	6.4	-50%
Total nitrogen supply to soil (manure + fertilizer - export)	1069.8	1041.4	852.8	731.4	731.8	-32%
Nitrogen fixation in arable crops	7.8	4.9	4.7	4.5	4.6	-41%
Nitrogen in crop residues left in field	36.4	34.9	34.1	32.1	30.1	-17%
Nitrogen in histosols	52.4	52.4	52.4	52.4	52.4	0%
Nitrogen in sewage sludge on agric. land	5.0	1.5	1.5	1.2	1.2	-76%
Atmospheric deposition agr. NH_3-N em	195.9	147.5	115.1	99.3	96.9	-51%
Nitrogen lost through leaching and run off	320.9	312.4	255.8	219.4	219.5	-32%

Table 6.8 Direct and animal production N_2O implied emission factors for Agricultural soils by CRF category (Units: kg N/kg N-input).

	1990	1995	2000	2001	2002	2003	2004	2005	2006
Nitrogen input from applic. of synthetic fertilizers	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010
Nitrogen input from manure applied to soils	0.011	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Nitrogen input from animal production	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Implied emission factor

Table 6.8 shows the implied emissions factors (IEF) for N_2O emissions from Agricultural soils for the most important sources. For (direct) soil emissions by manure application to soil a 80% increase of the IEF occurs in the period 1990–2006 which is caused by a ammonia policy driven shift from the surface spreading of manure to the incorporation of manure into the soil. Combined with a 10% decrease of net N manure input to soil (see Table 6.7) this explains the 60% increase of N_2O from manure application.

6.4.2 Methodological issues

Direct and indirect N_2O emissions from agricultural soils, as well as N_2O emissions by animal production in the meadow are estimated using country-specific activity data on N-input to soil and 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. (2007), with more details in Kroeze (1994). An overview of the emission factors used is presented in Table 6.9. Default IPCC emission factors are included for comparison.

Direct N_2O emissions

The IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions for two soil types (organic and inorganic soils). Emissions from the application of synthetic fertilizer have been estimated for two types of synthetic fertilizers (ammonium phosphate/sulphate and other synthetic fertilizers). Emissions from animal manure apllication are estimated for two types of manure application methods (surface spreading and incorporation into soil).

Table 6.9 Emission factors for direct N_2O emission from soils, expressed as kg N_2O-N per kg N supplied

Source	Default IPCC	Mineral soils	Organic soils	Reference
Nitrogen fertilizer	0.0125			
- Ammonium fertilizer		0.005	0.01	4
- Other fertilizers		0.01	0.02	1,4
Animal manure application	0.0125			
- Surface spreading		0.01	0.02	1
- Incorporation into soil		0.02	0.02	1
Sewage sludge	0.0125	0.01		2
Biological nitrogen fixation crops	0.0125	0.01		1
Crop residues	0.0125	0.01		2
Cultivation of organic soils (histosols)			0.02	2,3
Animal manure during grazing	0.02			
- Faeces		0.01	0.01	1
- Urine		0.02	0.02	1

References 1 = Kroeze, 1994; 2 = Van der Hoek et al. (2007); 3 = Kuikman et al., 2005; 4 = Kuikman et al., 2006.

The country-specific emission factors are lower for mineral soils (e.g. 0.01 kg N/kg N-input) and higher for organic soils (0.02 kg N/kg N-input) compared to the IPCC default of 0.0125 kgN/kg N-input. A higher emission factor of 0.02 kg N/kg N-input is also used for manure incorporation into soil.

The higher value for incorporation is explained by two mechanisms. Incorporation of animal manure into the soil produces less ammonia emission and hence more reactive nitrogen enters the soil. Furthermore, the animal manure is more concentrated (e.g. hot spots) in comparison with surface spreading and hence the process conditions for nitrification and denitrification can be more suboptimal.

A recent review of the literature showed that in most experiments with simultaneous surface spreading and incorporation the latter produces higher nitrous oxide emissions. It was, however, not possible to derive a new emission factor for incorporation or shallow (sod) injection (Kuikman et al., 2006). Therefore it was decided not to change the existing emission factors.

Animal production

The IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions from animal production. For Animal production a distinction is made between N in urine and N in faeces. The country-specific emission factors are lower for faeces (e.g. 0.01 kg N/kg N-input) and the same for urine (0.02 kg N/kg N-input) compared to the IPCC default of 0.02 kg N/kg N-input. The emission factor for urine is higher than for faeces because the ratio mineral nitrogen/total nitrogen is higher in urine than in faeces, leading to faster nitrification and denitrification in urine-affected spots. Furthermore, urine penetrates faster into the soil than faeces, which enhances the lack of sufficient oxygen in the soil for the nitrification process. Together with the higher mineral nitrogen ratio in urine, it is clear that urine creates a higher potential for suboptimal conditions for nitrification and denitrification than faeces.

Indirect N_2O emissions

The IPCC Tier 1 method is used to estimate indirect N_2O emissions. Indirect N_2O emissions resulting from atmospheric deposition are estimated using country-specific data on NH_3 emissions (estimated at a Tier 3 level). IPCC default values are used for N_2O emission factors because of the lack of country-specific data.

Indirect N_2O emissions resulting from leaching and run-off N emissions are estimated using country-specific data on total N-input into soil (estimated at a Tier 2 level). IPCC default values are used for the fraction of N-input to soil that leaches from the soil and ends up partly as N_2O emissions from groundwater and surface water (Fracleach) and for the N_2O emission factors. The main reason to use IPCC defaults is that direct and indirect N_2O emissions in the Netherlands partially originate from the same soils and sources. In the Netherlands no experimental data are available to evaluate the value of the emission factor for indirect emissions.

6.4.3 Uncertainty and time-series consistency

Uncertainty

The Tier 1 uncertainty analysis, shown in Annex 7, provides estimates of uncertainty according to IPCC source categories. The uncertainty in direct N_2O emissions from Agricultural soils is estimated to be approximately 60%. The uncertainty in indirect N_2O emissions from N used in agriculture is estimated to be more than a factor of 2 (Olivier, 2008).

Time-series consistency

Consistent methodologies are used throughout the time series. The time-series consistency of the activity data is very good due to the continuity in the data provided.

6.4.4 Source-specific QA/QC

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

6.4.5 Source-specific recalculations

In 2007 the NIR 2006 was reviewed by an ERT. In the following table documents the sector specific issues raised by the ERT, and the response of The Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
4. Agriculture	All gases	Not applicable		X	

Description of problem identified:

During the review, the ERT found that the Party rounded the values of activity data (AD) and final estimates of emissions before importing them into the CRF tables. This practice can lead to over- or underestimation of emissions in the base year.

Recommendation by ERT:

The ERT recommends that the Party report the values of AD and emissions in the CRF tables without prior rounding, i.e., with the same number of digits in the values as in the background calculations.

Response / Information by Party:

The Netherlands has incorporated the recommendations of the review team in the CRF (leading to a very minor reduction of N_2O emissions from agricultural soils (expressed in CO2 eq. accounting for 0.003 Tg).

6.4.6 Source-specific planned improvements

The specific characteristics of the Netherlands agricultural soils (with relatively high water tables) justify the calculation of the 'fracleach' and the emission factors on the basis of country-specific data. Therefore, the Netherlands will examine the needs and possibilities of extending calculations in the future in order to improve the methodology.

A higher emission factor than the IPCC default is used for the incorporation of manure into soil. However, the findings of a recent survey on N_2O emission factors for the field-scale application of animal manure abroad did not provide the necessary underpinning for an update of long-term average N_2O emission factors for this source in the Netherlands. Consequently, research is carried out now to gain an insight into this.

7 Land use, land use change and forestry [CRF sector 5]

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 LULUCF sector in the Netherlands is a net source of CO_2 and is responsible for 1.2% of the total greenhouse gas emission in the Netherlands.

Land use in the Netherlands is dominated by agriculture (57%), settlements (13%), forestry (10%, including trees outside forest) and 2% comprises dunes, nature reserves, wildlife areas and heather. The remaining area (19%) in the Netherlands is open water. The soils in the Netherlands are dominated by mineral soils, mainly sandy soils and clay soils (of fluvial or marine origin). Organic soils, used mainly as meadowland of hayfields, are covering about 8% of the land area.

The methodology of the Netherlands to assess the emission from LULUCF is based on the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance: a carbon stock change approach based on inventory data subdivided into appropriate pools and land use types and a wall-to-wall approach for the estimation of area per category of land use. The information on the activities and land use categories used covers the entire territorial (land and water) surface area of the Netherlands. The carbon cycle of a managed forest and wood production system is considered in the calculations of the relevant CO_2 emissions. The carbon stocks in soils from a single stratified measurement campaign for the various types of land use are used to calculate the emissions from land use categories.

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

Major changes in the LULUCF sector compared to the National Inventory Report 2007

Emissions: The emissiondata from LULUCF in 2006 show an increase compared to the data of 2005. The increase in emission reflects the impact of an correction of the emission factor for deforestation, an increase in the deforested area and subsequently a change in the soil emission from land use change.

Key sources: CO_2 emissions from 5A2, Land converted to Forest Land: now key

Methodologies: Changes in methodology have not been made. Recommendations from the Inital Review of 2007 will be incorporated in the CRF and NIR of 2009. A major recommandation is the improvement of the land use maps and the subsequent improvement of the land use matrix. This action could not be finalized within the timeframe available for the NIR 2008.

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 methodology to assess the change in land use has been subject for the ERT review. In chapter 7.7.5 the planned improvements are discussed in more detail.

The national inventory of the 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.

Land use change: 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. The Netherlands has an intensive agricultural system with high inputs of nutrients and organic matter, and much agricultural land is in a rotation (also between grassland and fodder maize). On this basis it is 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 1990–2006. This assumption has been discussed during the ERT review. In chapter 7.7.5 the planned improvements for soil carbon emissions due to land use change are discussed in more detail.

Emissions from liming are also presented in CRF Table 5(iv). Due to the lack of accurate data the available data on the use of limestone and dolomite are presented for all land uses together and not separately for grassland and cropland.

Compared to the NIR 2007 the deforested area has increased (from 1100 ha to 1500 ha), and the emission factor for deforestation has been corrected (from 55,78 to 70,99 Mg C ha^{-1}). The emission factor used now is in accordance with the assumptions made in the background report. The emission factor used in the NIR 2007 was the result of a calculation error. The increase in deforested area and the correction has changed the reported net emission of CO_2 compared with the previous submission. The net change has caused an increase of the yearly LULUCF emission with 244 Gg CO_2-eq. As a consequence of the increase in deforestation the emissions from soils increased slightly. The net impact of this change has caused an increase of the yearly LULUCF emission with 32 Gg CO_2-eq.

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 8133: CO_2 from forest (5A);
- Protocol 8134: CO_2 from total land use categories (5B-5G).

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

Sector/category	Gas	Key	Emissions base year (1990)		Emissions 2006		Contribution to total in 2006 (%)		
Key sources		Level, Trend, Non-Key	Gg	Tg CO_2-eq.	Gg	Tg CO_2-eq.	By sector	Of total gas	Of total CO_2-eq.
5. Total land use categories	CO_2		2,667	2.7	2,574	2.6	100[1)]	1.5	1.2
5A. Forest land	CO_2		-2,518	-2.5	-2,509	-2.5	-31		
5A1. Forest Land remaining Forest Land	CO_2	L,T2	-2,505	-2.5	-2,289	-2.3	-29		
5A2. Land converted to Forest Land	CO_2	T	-13	0.0	-220	-0.2	-3		
5B. Cropland	CO_2		-36	0.0	-36	0.0	-0.4		
5B1. Cropland remaining Cropland	CO_2		NA, NE		NA, NE				
5B2. Land converted to Cropland	CO_2		-36	0.0	-36	0.0	-0.4		
5C. Grassland	CO_2		4,440	4.4	4,440	4.4	56		
5C1 Grassland remaining Grassland	CO_2	L	4,246	4.2	4,246	4.2	53		
5C2. Land converted to Grassland	CO_2		194	0.1	194	0.2	2		
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		750	0.7	750	0.7	9		
5F1 .Other Land remaining Other Land	CO_2		0	0.0	0	0.0	0		
5F2. Land converted to Other Land	CO_2	L	750	0.7	750	0.7	9		
5G. Other	CO_2		183	0.2	81	0.1	1		
Total National Emissions (incl. CO_2 LULUCF)	CO_2		162.023	162.0	172,274	172.3		100	
National Total GHG emissions (incl. CO_2 LULUCF)	All			214.7		213.6			100

1) Absolute value 2006 (sinks and sources total: 7967 Gg)

Sector 5 'Land use, land use change and forestry' (LULUCF) accounted for 1.5% of the total national CO_2 emission in 1990 and 2006. For 1990 and 2006, the total net emissions are estimated to be approximately 2.7 Tg CO_2 respectively 2.6 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'.

Table 7.1 shows the sources and sinks in the LULUCF sector in 1990 and 2006. For 1990 and 2006 the total net emissions were estimated to be approximately 2.7 Tg CO_2–equivalents respectively 2.6 Tg CO_2–equivalents (1.2% in 1990 and 1.2% in 2006 of the total CO_2–equivalents emissions). The key sources are 5A1 (Forest Land remaining Forest Land), 5A2 (Land converted to 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 (-2.3 Tg CO_2-equivalents included in 5A1 Forest Land remaining Forest Land).The net emission from Forest Land converted to Other Land category is 647 Gg CO_2. Of this net emission 75.3% originates from forests (according the definition) and 24,7% 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 (75.3% of 647 Gg CO_2 = 488 Gg CO_2).

These values correspond with the resubmitted CRF data (mid 2007) and have not been updated since (see also chapter 7.2.5 with details on the planned improvements and clarifications).

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 the Netherlands case, 'heather' is included in the forest land 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 8133 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:

$$\Delta C(deadwood)plot = OutC(deadwood)plot - InC(deadwood)plot$$

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

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

with

$\Delta C(deadwood)_{plot}$	Net C flux in dead wood mass per plot (kg C ha-1y-1)
OutC(deadwood)plot	C input into dead wood from dying trees (kg C ha-1y-1)
InC(deadwood)plot	C loss per plot due to decomposition of dead wood (kg C ha-1y-1)
Mtree(t)	Total living tree biomass at time t (kg DW)
Ntree	Number of living trees (ha-1)
Fcarbon	Carbon content of dry mass (kg C kg-1 DW)
Fmortality	Mortality (year-1)
Vdead_sl	Volume of standing/lying dead wood
TBPSL	Period for total decay of dead wood, standing and lying
WDdead	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 assess-

ment 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 (2008) for details.

The uncertainty in implied emission factors of 5A1 Forest Land remaining Forest Land concerns forest and trees outside the forest. As the methodology and data sets used are the same for both sources, the uncertainty calculation is performed for forests and the result is considered to be representative for trees outside forests as well.

The uncertainty in the implied emission factor of increment 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 an average of about 2.500 Gg CO_2 with slightly higher values in 1995 and slightly lower values in 2000 (see Table 7.2). The figures in category 5A1 show the net result of the sequestration in live trees, in trees outside forest and in dead wood and the emission from harvest. The decrease in sink strength is more profound, especially in the net sequestration in 2000 relatively low due to somewhat higher harvest figures. The figures for the period after 2000 are copied from 2000. The figures in category 5A2, afforestation, steadily increase since 1990 and have reached in 2006 a sequestration level of 220 Gg CO_2 per year.

Although different databases have been used for the calculation of the emissions and removels from changes in forest and other woody biomass stocks, the time series shows a stable trend. 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 as well.

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

	1990	1995	2000	2005	2006
5A Forest Land	-2,518	-2,636	-2,432	-2,496	-2,509
5A1 Forest Land remaining Forest Land of which	-2,505	-2,558	-2,289	-2,289	-2,289
Live trees	-4,073	-3912	-3,959	-3,959	-3,959
Harvest	2,110	1,901	2,214	2,214	2,214
Trees outsideForest	-209	-209	-209	-209	-209
Dead wood	-333	-338	-336	-336	-336
5A2 Land converted to Forest Land (Afforestion)	-13	-78	-142	-207	-220

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 planned improvements

The review of the NIR 2006 report in 2007 (and the Initial Review), the judgement of the re-submitted data and the adjustment made clear that several topics of our inventory were according to the reviewers not in agreement with the LULUCF guidelines.

Section 7.9 presents an elaborated overview of the review, the re-submission and the adjustment, and the acceptation of the adjustment. The identified problems, recommendations and responses by the Netherlands are discussed in that section.

Based on the recommendations and discussions during and after the review, the LULUCF experts planned several activities in 2008 for methodological improvements, to be addressed and clarified in the CRF and NIR of 2009. Following topics will be addressed:

- Improvements to land use and land use change area estimates;
- Carbon emissions from soil as land use changes;
- Forests soil from Tier 1 reporting (no stock change assumed) to Tier 2 reporting;
- Agricultural soil from Tier 1 (no stock change assumed) to Tier 2 and rotation of grassland;
- Inherited emissions 1970-1990;
- Improvements in dealing with missing data for 'Forest remaining forest';
- Harvest data before and after 2000: consistency of estimates;
- Periodic updating of estimates for 'Forest remaining forest' with new NFI data;
- Improvements in calculation methods for land use changes to and from forest and other wooded areas.

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:

$SOC_{(1990\text{-}2000),sl}$	Soil org.matter in period 1990–2000 for soil unit S1 in ton C ha^{-1}
Os	Organic substance level in dry ground (%)
Bulk densitity	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:

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

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})
$SOC_{(0\text{-}T)}$	SOC 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 8133 and 8134 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 (2008) 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 annual 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 planned improvements

See section 7.2.5 for information on the planned improvements and clarifications of the land use and land use change maps and other specified improvements

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 8133 and 8134 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 (2008) 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 emission of CO_2 due to the conversion of forest land and 'other land' to grassland (the net sum of an emission due to deforestation and a sink due to conversion from 'other land' to grassland) is 194 Gg CO_2 (see also the remark about error correction in section 7.1).

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 planned improvements

See also section 7.2.5 for information on the planned improvements and clarifications of the land use and land use change maps and other specified improvements.

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 8133 and 8134 on the website 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 planned improvements

See section 7.2.5 for information on the planned improvements and clarifications of the land use and land use change maps and other specified improvements.

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 8134). 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 8133 and 8134 on the website www.greenhousegases.nl, as indicated in section 7.1.

7.6.3 Uncertainty and time-series consistency

Uncertainties
Uncertainty estimates are provided in section 7.3.3, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency
The 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 planned improvements

See section 7.2.5 for information on the improvements and clarifications of the land use and land use change maps and other specified improvements.

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 8133 and 8134 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 750 Gg CO_2. (see also the remark about corrections in chapter 7.1). 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 planned improvements

See section 7.2.5 for information on the improvements and clarifications of the land use and land use change maps and other specified improments.

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: 1990–2005). 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 8134). 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 8133 and 8134 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

(see Table 7.3). The methodology used to calculate CO_2 emissions from limestone and dolomite for the period 1990-2006 is consistent over time. Since 1990 the use of chalk containing fertilizer in the Netherlands is decreasing from 265 million kg to 145 million kg in 2006. Over that period the proportion limestone doubled since 1990 from about 12% in 1990 up to almost 23% in 2006 and the proportion dolomite decreased since 1990 from about 35 to 40% to levels below 24% in 2006.

In 2006 the amount of chalk containing fertilizer used in the Netherlands was less compared to 2005, but because of the relative increase in both the use of dolomite (increase of 10% compared to 2005) and limestone (increase of 5% compared to 2005) the final CO_2 emission was 7% higher in 2006 compared to 2005.

7.8.4 Source-specific QA/QC and verification

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

7.8.5 Source-specific planned improvements

There are no source-specific improvements planned.

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

	1990	1995	2000	2001	2002	2003	2004	2005	2006
5G Other (liming of agricultural soils)	183	98	98	80	85	86	79	75	81

7.9 Information on the results of the 2007 Review

In 2007 the NIR 2006 was reviewed by an ERT. Based on the comments during the review the Netherlands resubmitted LULUCF data medio 2007. The following tables document the LULUCF specific issues raised by the ERT, and the response of The Netherlands.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/ non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
5B.2.1 / 5C.2.1 / 5D.2.1 / 5E.2.1 / 5F.2.1	CO_2	Not estimated	X	X	

Description of problem identified:

The estimates of net carbon stock changes of the categories relating to forest land converted to different land uses (cropland, settlement, grassland, wetland, other land) are affected by two main problems related to the measurement and reporting of the activity data:

- Incoherence between some elements in the methodologies of map classification (e.g. definition of land categories) applied for the 1990 and the 2000 maps, which resulted in an inconsistency of the land-use change matrix data;
- The absence of a time series of deforested areas from 1971, which resulted in non-estimation of carbon stock changes in these areas for the base year.

The incoherence between methodologies caused high overestimation of changes in land uses throughout the classes and, consequently, of the area deforested. Also, the non-reporting of inherited areas (the areas deforested from 1971 to 1989) has an effect in overestimating net emissions since carbon stock changes due to the vegetation regrowth (or still in place after the use change) have not been considered.

Recommendation by ERT:

Considering the short time available to the Party to prepare a comprehensive revision of the whole estimate, the ERT suggests the following:

- Reconstructing the time series of deforested areas from 1971 by a linear extrapolation of the values from 1990 back to 1971;
- Discounting the area reported under the categories relating to forest land converted to different land uses (cropland, settlement, grassland, wetland, other land) on the basis of additional conservative assumptions;
- Using the National Forest Inventory (NFI) data for carbon stock changes in living biomass;
- Using the data on litter that has been collected in 1990, in order to report carbon stock changes in this pool as a consequence of tree coverage loss, if any.

Finally, the ERT is in agreement with the application, for this recalculation only, of the assumption made by the Party that 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), since it makes the deforestation estimates more conservative.

Response / Information by Party:

- The Netherlands continues to use its methodology to use topographical maps for determination of land use and land use change. The topographical maps are based on aerial photography supplemented with validation by frequent site inspection. The methodology will be more and more refined in the future and updates will be made available on a continuous basis. This methodology allows the Netherlands to report on a wall – to – wall basis and account for the whole territory in 1990, while any other methodology covers only part of the country in 1990. It is therefore the most cost effective and cost efficient methodology to back-calculate land use in 1990 and before without major changes in methodology or loss of information.
- As the emissions from land use change in relation to the conversion of forest is part of the calculation of the Dutch assigned amount (in accordance with article 3.7 of the Kyoto protocol), we have concentrated our efforts to this element of the land use change matrix. Due to time constraints, the Netherlands has re-assessed the land use change from forest to other land uses (deforestation) in one of two of the validation regions. By re-assessing the region with the lowest accuracy of deforestation estimates (the region 'Overloon'), the new estimates are conservative. The re-assessment was made at the pixel level (25 by 25 m) rather than at the plot or parcel level as was done in the previous validation. The re-assessment (see Annex 1 for details) has shown that we have not over- but underestimated the deforestation of area forest under the Kyoto Protocol definition (was 44.1% of observed changes and now is 61.4% of the observed changes).
- As a result the emissions of C as result of deforestation will increase to 487,562 Gg CO_2. The changes are included in the new CRF tables to comply with our re-assessment.
- The carbon contained in forests living and dead biomass and changes therein in 1990 are calculated on the basis of National Forest Inventory data. For the biomass carbon in 1990 the data from the HOSP database have been used and these were recorded between 1988 and 1992 and reflect 1990 best. This HOSP inventory data is base on sampling to represent the Dutch forest including newly planted plots in the period 1970 – 1990 and therefore include the effect of ageing on the basis of age dependent growth curves. Therefore, an additional reconstruction of the deforestation time series has no additional value for the calculation of carbon stocks in forest in 1990 .
- The Netherlands has reported stocks of carbon in litter but no stock changes in forest remaining forest. For deforestation the Netherlands account for the loss of carbon stocks in litter. The Netherlands has not sufficient data from monitoring activities to report on changes and therefore keeps stocks constant over time. This conclusion is supported by the AFFOREST project data. In the course of 2008 and 2009 more data will be available on litter stocks.

Adjustment

According to the ERT the resubmitted data were still not in agreement with IPCC guidelines. This observation resulted in an adjustment of the Assigned Amount. The Netherlands disagreed that its inventory is not in full compliance with IPCC GPG and further stated that the adjustment did not follow the intent it was originally designed for, nor was the adjusted amount reached by a process of mutual consultation. A compromise recalculation was proposed but could not be allowed in this stage of the process. Finally, the Netherlands accepted the adjustment and is currently improving its approach.

Response to the adjustment

As response to the adjustment the Netherlands has taken several actions in order to improve our approach and to become fully in compliance with the IPCC GPG. Although, the experts are cooperative and eager to improve the approach, we had to be realistic and accepted the fact that the time span available to implement the improvements in the NIR 2008 is far too short. Therefore, is planned that all improvements and results of ongoing research will be implemented in the NIR 2009 and submitted in de CRF 2009. In this NIR only minor improvements are included and therefore the results will not deviate much from the figures resubmitted mid 2007.

Annex 1 (refers to the table that documents the LULUCF specific issues raised by the ERT, and the response of The Netherlands)

Reassessment of land use change from forest to other land uses (deforestation)

Methods and derived accuracy in the NIR for field validation of April 2005

As described in the NIR and the background reports (Nabuurs et al. 2005, Van den Wyngaert et al.2007) a digital overlay was made of the topographical maps of 1: 25000 for 1990 and 2000. These maps are widely acknowledged as the most accurate available for the Netherlands. This produced a land use change matrix as given in Table 6.1 in Nabuurs et al. 2005.

Because many single cell land use changes (25x25 m) showed up in the change map, we had the impression that methodological problems might still exist in the overlay. Therefore a field validation was carried out in two small regions. This with the aim to be as conservative as possible with our deforestation emission estimate. Regions were selected to represent the higher areas of the Netherlands (where most of the forests are), a small scale landscape, and the selected areas were areas where we had abundant field information. A field crew was provided the change map and a detailed topographical map, so they could be sure about their position in the field down to 5 meters (also within forests, Netherlands has a dense road network). Based on what they experienced in the field (April 2005), the field crew judged whether a land use change had taken place.

The field validation took into account only changes in forest according to the Kyoto Protocol definition, and a change e.g. from ‘forest according to the definition’ towards ‘trees outside the forest’ was also marked as a deforestation. Thus, the percentages correctness calculated are valid for ‘forests according to the definition’, and were also used for ‘trees outside the forest’ for lack of better information. Each single event of a land use change (no matter whether it was a single cell, or groups of cells), was counted as ’1’. We call this the validation by number of occurrences. Table 1 gives the results.

The values used were the simple average between the results of two test sites.

Table 1 Correctness percentages for afforestation and deforestation by number of occurrences (VandenWyngaert et al.2007)

	Afforestation	Deforestation
Hengelo-Ruurlo	73.7 %	46.8 %
Overloon	54.1 %	41.4 %
Average (NL)	63.9 %	44.1 %

New type validation (May 2007)

As there was concern that the results were biased by a high number of very small errors near roads and forest edges, a further distinction is made here based on the situation whether or not the land use change event is part of a forest edge, and the size of the event (we call this the validation by patch size). The analysis as presented here is based solely on the results for 'Overloon'. This was chosen due to time constraints and because this was the most conservative estimate.

Patches were classified as forest edges if they were connected to other types of land use on one side and to forest on the other, and were often small (few pixels) or, if larger, narrow. Patches were classified as forests if they either were large and wide patches or were one or a few pixels completely surrounded by forest.

The higher reliability of land use change of large patches is reflected in Table 2. This difference is small for forest edges (mean size between 1 and 2 pixels), but large for forests (mean size of 8.3 pixels per event for afforestation and 19 for deforestation). The weight of forest edges in the total value is also much smaller if corrected for surface. Thus the correctness percentages are about 20% higher if corrected for surface, because now larger patches (with higher accuracy) weigh more in the total accuracy.

Table 2 Correctness percentages for afforestation and deforestation by the two validation methods (nr of occurrences, and patch size)

	Afforestation		Deforestation	
	Nr of occurrences	Patch size of single event	Nr of occurrences	Patch size of single event
Forest	61.7	89.7	60.0	70.2
Forest edges	51.4	52.2	38.0	43.3
Total	54.1	78.1	41.1	61.4

Thus, the new validation yielded a higher accuracy. In the new submission a 61.4 and 78.1% accuracy level will be applied for deforestation and afforestion, respectively.

During the re-assessment we also discovered that in the calculations to estimate the deforestation emissions we used the correctness factors twice instead of once. In the resubmission of the CRF we have corrected this as well.

This gives an emission of 400.33 Gg CO_2 in 1990 for deforestation (Kyoto Protocol forest) and a sink of -10.31 Gg CO_2/yr in 1990 from afforestation.

8 Waste [CRF sector 6]

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 8101: CO_2 from Waste incineration (included in 1A1a);
- Protocol 8135: CH_4 from Waste disposal (6A1);
- Protocol 8136: CH_4, N_2O from Wastewater treatment (6B);
- Protocol 8137: CH_4, N_2O from Industrial composting (6D);
- Protocol 8139: CO_2 CH_4 N_2O from Biomass (1A),
- The Waste sector accounted for 3% of total national emissions (without LULUCF) in 2006 compared with 6% in 1990, with the emissions of CH_4 and N_2O accounting for 93% and 7% of CO_2-equivalent emissions from the sector, respectively. Emissions of CH_4 from waste – almost all (89%) from Landfills (6A) – accounted for 34% of the national total CH_4 emissions in 2006. The N_2O emissions from the Waste sector stem from domestic and commercial wastewater. The fossil-fuel related emissions from waste incineration, mainly CO_2 , are included in the fuel combustion emissions from the Energy sector (1A1) since all large-scale incinerators also produce electricity and/or heat for energetic purposes.

Emissions from the Waste sector decreased by 52% between 1990 and 2006 (see Figure 8.1), mainly due to a 55% reduction in CH_4 from Landfills (6A1 'Managed waste disposal on land).

Major changes in *Waste* sector compared to the National Inventory Report 2007

Emissions: In 2006,the total greenhouse gas emissions in this sector decreased further. Emissions in the period 1990-2006 did not change compared to the previous NIR.

Key sources: There are no changes in the key source allocation in this sector.

Methodologies: There have been no methodological changes in this sector

Between 2005 and 2006 the CH_4 emissions from landfills decreased by about 9%. The decreased methane emission from 'Landfills' since 1990 is the result of: (1) the considerable 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 13% in 2006) (see SenterNovem, 2007).

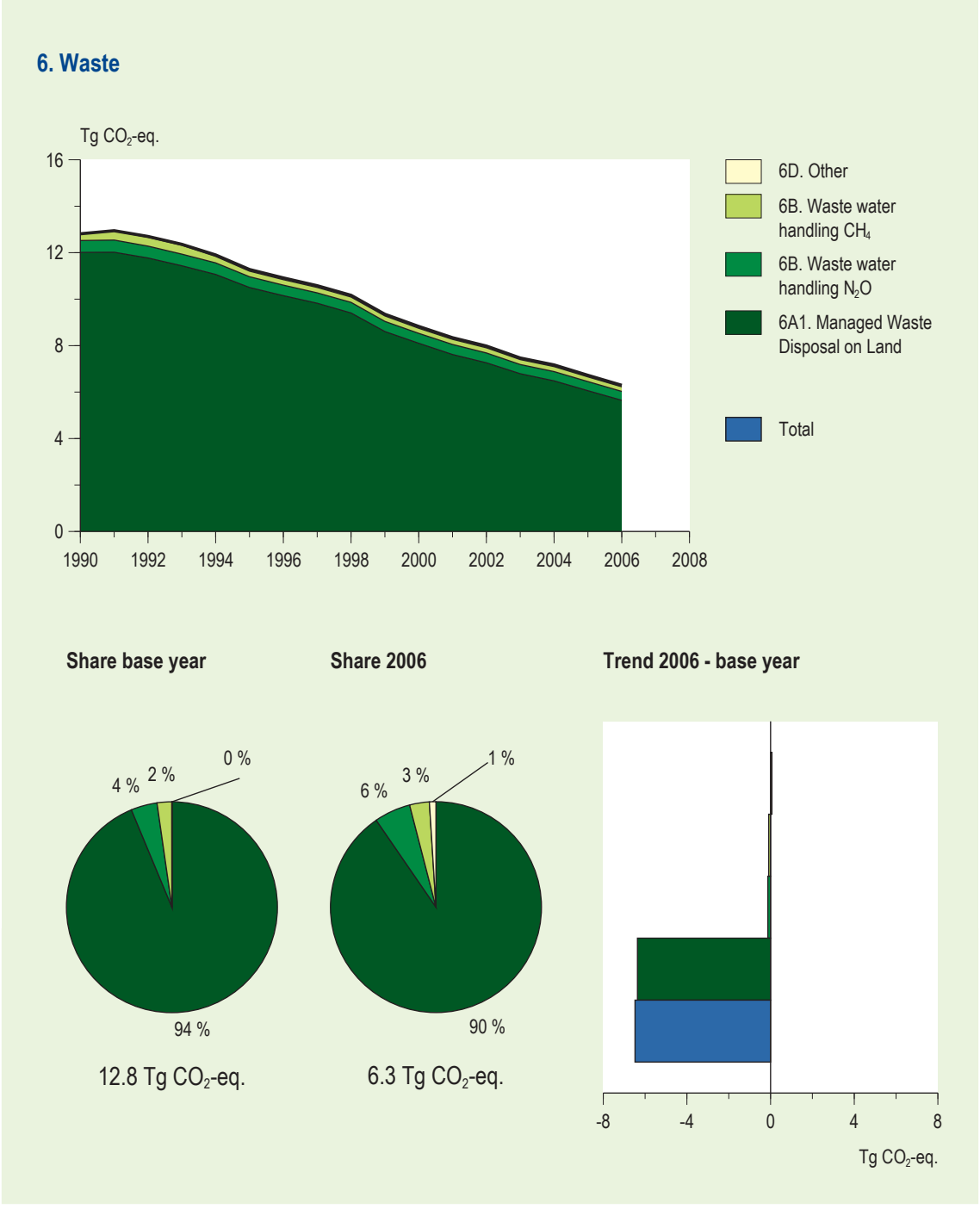


Figure 8.1 Sector 6 'Waste': trend, emission levels and share of source categories in emissions of 6 'Waste', 1990-2006

Table 8.1 Contribution of main categories and key sources in sector 6 Waste

Sector/category	Gas	Key	Emissions base-year		Emissions 2005		Emissions 2006		Change 2006–2005	Contribution to total in 2006 (%)		
		Level, Trend	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Gg	Tg CO_2-eq	Tg CO_2-eq	By sector	Of total gas	Of total CO_2-eq
6 Waste	CH_4		585.8	12.3	301.55	6.3	281.56	5.9	-20.0	93	36	3
	N_2O		1.7	0.5	1.4	0.4	1.4	0.4	0.0	7	2	0.2
	All			12.8		6.8		6.3	-430.6	100		3
6A. Solid Waste Disposal on Land	CH_4		571.9	12.0	288.5	6.1	268.9	5.6	-19.7	89	35	3
6A1. Managed Waste Disposal on Land	CH_4	L,T	571.9	12.0	288.5	6.1	268.9	5.6	-19.7	89	35	3
6B Waste water handling	N_2O		1.7	0.5	1.3	0.4	1.2	0.4	0.0	6	2	0.2
	CH_4		13.8	0.3	9.8	0.2	9.6	0.2	-0.2	3	1	0.1
	All			0.8		0.6		0.6	-13.9	9		0.3
6D. Other	CH_4		0.06	0.0	3.2	0.1	3.1	0.1	-0.1	1	0.4	0.0
Total National Emissions	CH_4		1,211.3	25.4	802.1	16.8	775.4	16.3	-26.8			
	N_2O		64.3	19.9	55.2	17.1	54.7	16.9	-0.6		100	
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.0		211.8		207.5	-4,277.6			100

Table 8.1 shows the contribution of the emissions from the Waste sector to the total greenhouse gas emissions in the Netherlands and also presents the key sources in this sector specified by level, trend or both. The list of all (key- and non-key) sources in the Netherlands is shown in Annex 1. Total greenhouse gas emissions from the Waste sector decreased from 12.8 Tg CO_2-eq. in 1990 to 6.3 Tg CO_2-eq. in 2006. This decrease is mainly due to (SenterNovem, 2007):

- 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).

8.2 Solid waste disposal on land [6A]

8.2.1 Source category description

In 2006 there were 23 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).

The share of CH_4 emissions from Landfills in the total national inventory of greenhouse gas emissions was 6% in 1990 and 3% in 2006. Between 1990 and 2006 CH_4 emissions have decreased by 55% to 257 Gg. This decrease is due to the increase in recovered CH_4 – from about 5% in 1990 to 13% in 2006 – but also to the decrease in methane produced in solid waste disposal sites.

In 2006 solid waste disposal on land accounted for 89% 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 waste landfilled. 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 million tonnes in 1990 to 4 million tonnes in 2006.

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 8135 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 (2007). This document also contains the amount of CH_4 recovered from landfill sites yearly.

The (implied) emission factors correspond with the IPCC default values.

8.2.2 Methodological issues

A more detailed description of the method used and emission factors can be found in the protocol 8135 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).

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	1995	2000	2001	2002	2003	2004	2005	2006
Waste generation rate[1] (kg/cap/day)	1.52	1.50	1.69	1.68	1.70	1.67	1.70	1.70	1.70
Fraction MSW disposed to SWDS	0.38	0.29	0.09	0.08	0.08	0.03	0.01	0.01	0.01
Fraction DOC in MSW	0.13	0.13	0.11	0.10	0.10	0.09	0.08	0.08	0.07
Fraction of waste incinerated	0.08	0.09	0.12	0.12	0.13	0.13	0.13	0.12	0.12
Fraction of waste recycled	0.63	0.75	0.80	0.80	0.80	0.81	0.83	0.84	0.84
CH_4 generation rate constant (k)	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
Number of SWDS recovering CH_4	45	50	55	47	51	50	50	50	50
Waste incineration[2] (Tg)	3.9	4.7	7.1	7.5	8.2	8.2	7.9	7.1	7.1

1) Waste generation rate refers to MSW (muncipal solid waste), excluding inorganic industrial waste such as construction or demolition waste.

2) Waste incineration refers to the total amount of waste incinerated: municipal solid waste, industrial waste, commercial waste, sewage sludge e.a.

Parameters used in the landfill emissions model are (Until 2001 the fraction of methane in landfill gas was set at 60%. From 2002 and onwards the average fraction of CH_4 is determined yearly based on the composition of landfill gas at all sites with CH_4 recovery.):

- Total amount of land-filled waste;
- Fraction of degradable organic carbon (DOC) (see Table 8.2 for a detailed time-series);
- CH_4 generation (i.e. decomposition) rate constant (k): 0.094 up to and including 1989, decreasing to 0.0693 in 1995 and constant thereafter; this corresponds to half-life times of 7.4 and 10 years, respectively (see Table 8.2 for a detailed time-series); (to be updated)
- CH_4 oxidation factor: 10%;
- Fraction of DOC actually dissimilated (DOCF): 0.58; (see also (Oonk, 1994))
- CH_4 conversion factor (IPCC parameter): 1.0.

Trend information on IPCC Tier 2 method parameters that change over time is provided in Table 8.2. The change in DOC values is due to such factors as the prohibition 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.

8.2.3 Uncertainty and time-series consistency

Uncertainty

The Tier 1 uncertainty analysis shown in Tables A7.1 and A7.2 of Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in CH_4 emissions of solid waste disposal sites is estimated to be approximately 35% in annual emissions. The uncertainty in the activity data and the emission factor are estimated to be 30% and 15%, respectively. For a more detailed analysis of these uncertainties, see Olivier and Brandes, 2008.

Time-series consistency

The estimates for all years are calculated from the same model, which means that the methodology is consistent throughout the time-series. The time-series consistency of the activity data is very good due to the continuity in the data provided. Since 2002 the fraction of CH_4 in landfill gas is determined yearly based on the composition of the landfill gas of the sites recovering CH_4. It is expected that this will reflect the average fraction of CH_4 in the landfill gas better than the default used in previous inventories and slightly reduces uncertainties in the emission estimations of the post-2001 period. This 'new' CH_4 fraction is only used to estimate methane in the recovered biogas and not for the generation of methane within the landfill site.

8.2.4 Source-specific QA/QC and verification

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

8.2.5 Source-specific recalculations

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

In 2007 the NIR 2006 was reviewed by an ERT (see for the issues addressed by the ERT the table below. This table also includes the reaction of the Netherlands). During the review, the ERT suggested that the assumption that all sites have been managed since 1945 may have been wrong. As a result of this assumption it was suggested to recalculate the methane production based on a MCF value for unmanaged disposal sites until 1970. Based on the provided documents the ERT concluded that these documents are sufficient to justify the use of an MCF for managed landfill sites since 1945.

Secondly the ERT recommended to use the normalization factor in the first order decay model, in accordance to the IPCC good practice guidance. However the parameters used in the model are derived from a validation study where the model was fit to the actual annual generation of methane. The estimated parameters for methane rate constant (k) and the degradable organic carbon dissimilated (DOCf) therefore compensate for the mathematical error in the model. The ERT concluded that this clarification was sufficient, and that the use of the normalization factor is not needed.

Besides the response to the review we corrected some minor errors in the CH_4 emissions from waste disposal on land, category 6A (2003 onwards).

8.2.6 Source specific planned improvements

During the review of the NIR 2006 by the ERT (in 2007) it was recommended to investigate the composition of soils in order to verify the fraction of organic carbon present and to include this fraction in the estimation of CH_4 emissions. In 2008 a study is done for (among others) contaminated soils at landfill sites.

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.

Sector, category, sub-category (with code)	Gas	KC (e.g. L,T)/ non-KC	Identified inventory problem in terms of:		
			Missing estimate	Estimate provided but not in line with GPG	Estimate provided but lack of transparency
6.A. Solid Waste Disposal on Land	CH4	Not L,T		X	

Description of problem identified:

In estimating CH_4 emissions from source category 6.A. Solid Waste Disposal on Land, the normalization factor ($A = \frac{1 - e^{-k}}{k}$) was not used in the first order decay (FOD) model, contrary to the IPCC Good Practice Guidance.
Ignoring this factor leads to an overestimation of base year emissions by approximately 3%.

Recommendation by ERT:

The ERT recommends correcting the estimation of CH_4 emissions from SWD on land by accounting for the normalization factor (A) defined above in the FOD model.

Response / Information by Party:

Function of the normalization factor

The normalization factor is meant to correct a mathematical problem of the model compared to the (assumed!) first order decay. The model without the factor calculates the methane production *after* each year and uses this result for the whole year. This approach is mathematically not correct as is shown in the figure. The (assumed) first-order formation is presented by the dotted line whereas the results of the model is presented by the rectangular blocks. The model leads to an underestimation of the methane production since every year the triangle between the dotted line and the rectangular block is not accounted for. The normalization factor is meant to correct this mathematical error.

The model used in the Netherlands

In the Netherlands the parameters used in the model, especially the DOCf and k, were determined in a model validation study in the nineties. In this study the model was fitted (best-fit) on the expected methane production of a few landfill-sites of which the amount of methane produced could accurately be predicted. In this validation-study no normalization-factor was used (did not exist at that time; introduced in GPG2000). It is important to realize that this fit was done based on the actual formation of gas over the year and not on the calculated formation after a year. The result of this procedure is shown in the figure beside the text. As becomes clear in this case the underestimation by ignoring the triangle from the first figure is not present. The mathematical difference between the (assumed) actual first order decay and the IPCC1996-model (based on yearly values, instead of a full integration) is in the Dutch approach corrected via the parameters DOCf (mainly) and k. If the validation had been carried out using the GPG2000 normalization factor other values for these parameters had been found. Using the GPG2000-factor the DOCf-value found would have been higher, together leading to the same result as the model we use now.

Conclusion

The conclusion so far is that the model used in the Netherlands (without the GPG2000 normalization factor) does not overestimate the methane production since the values of the other parameters used (especially DOCf) already compensate for the mathematical problems of the IPCC1996-model. In fact the Netherlands use parameter-values that are determined especially for the Dutch situation which in general is to be preferred over using IPCC-defaults and is therefore in line with IPCC-guidelines.
The use of the normalization factor in the Dutch model would only introduce an unnecessary correction, thus only creating extra difference between the results of the model and the (assumed) first order decay instead of decreasing the difference. The only way to overcome the introduction of an error while introducing the normalization factor is to change the value of DOCf simultaneously, thus compensating for the introduction of the GPG2000-factor. The resulting emission would then remain unchanged.

Impact of validation of model parameters of CH_4 production

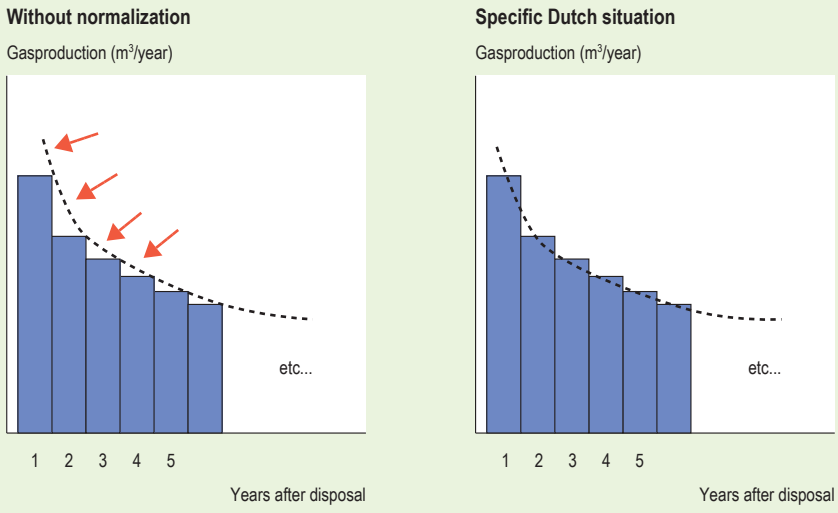


Table 8.3 Wastewater handling emissions of CH_4 and N_2O (Units: Gg/year)

	1990	1995	2000	2001	2002	2003	2004	2005	2006
CH_4 industrial wastewater	0.25	0.33	0.34	0.35	0.36	0.34	0.34	0.36	0.33
CH_4 domestic & commercial wastewater	9.07	7.90	7.96	8.15	8.55	7.99	8.50	8.20	8.12
CH_4 septic tanks	4.47	3.25	2.20	1.98	1.81	1.73	1.46	1.22	1.11
Net CH_4 emissions	13.79	11.48	10.50	10.47	10.72	10.06	10.31	9.78	9.56
CH_4 recovered and/or flared	33.0	39.2	40.4	39.6	43.3	43.2	44.0	41.9	43.7
Recovery/flared (% gross emission)	0.71	0.77	0.79	0.79	0.80	0.81	0.81	0.81	0.82
N_2O domestic & commercial wastewater	0.81	0.84	0.85	0.86	0.86	0.84	0.84	0.85	0.86
N_2O from human sewage	0.85	0.65	0.53	0.54	0.51	0.44	0.44	0.41	0.37
Total N_2O emissions	1.66	1.49	1.38	1.39	1.37	1.28	1.29	1.26	1.23

N_2O emissions from waste water treatment (see Table 8.1) contributed about 2% to total N_2O emissions in 2006 (as well as in 1990) and 0.2% in total CO_2-eq. N_2O emissions from waste water handling decreased by 22% during the period 1990–2006. 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 2006 was 1%. Since 1993, CH_4 emissions from wastewater treatment plants have decreased due to the introduction in 1990 of a new sludge stabilization system in one of the largest wastewater treatment plants. As the operation of the plant took a few years to optimize, venting 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.

Table 8.3 shows the trend in greenhouse gas emissions from the different sources of wastewater handling.

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 8136 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 2006. 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.

Table 8.4 Activity data of domestic and commercial wastewater handling (Gg/year), total volume of treated urban waste water (Mm^3/year) and percentage of population connected to septic tanks(%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Wastewater DOC[1)]	933	940	948	960	970	921	921	916	930	915	921	937	939	924	949	943	938
Sludge DOC	254	263	248	246	251	269	283	270	279	282	281	299	290	290	296	298	317
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	28.3	28.3
Treated volume	1,711	1,683	1,836	1,897	2,062	1,908	1,681	1,717	2,194	2,034	2,034	2,169	2,083	1,791	1,791	1,791	1,872
% Inhabitants with septic tanks	4.0	3.7	3.4	3.1	2.9	2.8	2.6	2.4	2.3	2.0	1.9	1.6	1.5	1.4	1.2	1.1	1.0

1) DOC, Degradable organic component.

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; see Table 8.4).

8.3.2 Methodological issues

A full description of the methodology is provided in the monitoring protocol 8136 (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_0) 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 as discussed in chapter 1.

8.3.5 Source-specific recalculations

There are no source-specific recalculations compared to the previous submission.
During the compilation of the CRF's we corrected some minor errors in the CH_4 and N_2O emissions from wastewater handling, category 6B (2004 onwards).

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 and/or heat used for energetic purposes. According to the IPCC Guidelines (IPCC, 2001), these are included in category 1A1a: Public electricity and heat production: other fuels (see section 3.2.1).

Activity data and emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 8101on the website www.greenhousegases.nl.

The activity data for the amount of waste incinerated are mainly based on the annual survey performed by the Working Group on Waste Registration at all 11 waste incinerators in the Netherlands. Data can be found on the website www.uitvoeringafvalbeheer.nl and in a background document (SenterNovem, 2007).

8.4.2 Methodological issues

A more detailed description of the method used and the emission factors can be found in the protocol 8101 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 from incineration with SCR. For Incineration with SNCR an emission of 100 g/ton is applied. The percentage SCR increased from 6% in 1990 to 36% in 2005.

Table 8.5 Composition of incinerated waste: carbon fraction and fossil fraction (%). In 2005 the carbon fraction of household waste fraction and the percentage fossil of these fractions are determined. These values are used for the calculation of the fossil and not fossil emissions from household waste. For the other fraction still the older values are used. (Bosselaar and Gerlagh, 2006)

	Non household waste		Household Waste	
Waste type	Carbon fraction	Fossil fraction	Carbon fraction	Fossil Fraction
WIP[1]: paper/cardboard (%)	30	0	30	23
WIP: wood (%)	45	0	37	6
WIP: other organic (%)	20	0	22	6
WIP: plastics (%)	54	100	45	86
WIP: other combustible (%)	32	50	32	50
WIP: non-combustible (%)	1	100	1	100

1) WIP, Waste incineration plant; listed are the residential waste fractions; for waste fractions of other waste types (considered fixed in time), see Joosen and De Jager (2003).

Table 8.6 Composition of incinerated waste

	1990	1995	2000	2001	2002	2003	2004	2005	2006
Total waste incinerated (Gg)	2.8	2.9	4.9	4.7	5.0	5.0	5.2	5.5	5.5
of wich residential waste (Gg):	2.3	2.1	3.1	3.4	3.6	3.6	3.6	3.6	3.6
Of which:									
WIP[1]: paper/cardboard (%)	25	29	27	28	27	26	26	26	26
WIP: wood (%)	2	4	6	5	5	5	5	5	5
WIP: other organic (%)	46	33	32	32	32	32	32	32	32
WIP: plastics (%)	9	10	13	13	13	15	15	15	15
WIP: other combustible (%)	8	11	10	10	10	10	10	10	10
WIP: non-combustible (%)	11	12	12	12	13	13	13	13	13
Energy content (MJ/kg)	8.2	9.8	10.2	10.3	10.3	10.6	10.6	10.6	10.6
Fraction organic (%)	58	54	51	50	49	47	47	47	47
Amount of fossil carbon	162	221	405	408	435	477	477	477	477
Amount of organic carbon	530	563	929	897	932	924	924	924	924

1) WIP, Waste incineration plant (Not included incineration plant for specific waste streams as sewage sludge or hazardous waste.), listed are the residential waste fractions; for waste fractions of other waste types (considered fixed in time), see Joosen and De Jager (2003).

8.4.3 Uncertainties and time-series consistency

Uncertainties
The Tier 1 uncertainty analysis in shown in Tables A7.1 and A7.2 in Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in annual CO_2 emissions from Waste incineration is estimated at 11%. The main factors influencing these emissions are the total amount being incinerated, the fractions of different waste components used for calculating the amounts of fossil and organic carbon in the waste (from their fossil and organic carbon fraction) and the corresponding amounts of fossil and organic carbon in the total waste incinerated. The uncertainty in the amounts of incinerated fossil waste and the uncertainty in the corresponding emission factor are estimated to be 10% and 5%, respectively. These figures are based on expert judgment.

Time-series consistency
The time series are based on consistent methodologies for this source category. The time-series consistency of the activity data is considered to be very good due to the continuity of the data provided by Statistics Netherlands.

8.4.4 Source-specific QA/QC and verification

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

8.4.5 Source-specific recalculations

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

8.4.6 Source specific planned improvements

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

8.5 Other waste handling [6D]

8.5.1 Source category description

General description of the source category
This source category, which consists of the CH_4 and N_2O emissions from composting separately collected organic waste from households, is not considered to be a key source. Emissions from small-scale composting of garden waste and food waste by households are not estimated as these are assumed to be negligible. It should be noted that non-CO_2 emissions from the combustion of biogas at wastewater treatment facilities are allocated to category 1A4 Fuel combustion – Other sectors because this combustion is partly used for heat or power generation at the plant.

The amount of composted organic waste from households increased from nearly 0 million tonnes up to 1.3 million tonnes in 2006. In 2006 there were 23 industrial composting sites in operation; these accounted for 1% of the emissions in the Waste sector in that year (see Table 8.1).

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 8137 on the website www.greenhousegases.nl.

The activity data for the amount of organic waste composted at industrial composting facilities are mainly based on the annual survey performed by the Working Group on Waste Registration at all industrial composting sites in the Netherlands. Data can be found on the website www.uitvoeringafvalbeheer.nl and in a background document (SenterNovem, 2007). This document 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). Recently the emission factors have been measured again (at three facilities, 1 measurement per facility) in the Netherlands. The average of these three measurements for methane was much lower than the applied emission factor, with a wide range. Because of the small number of measurements and the wide range of values these new insights have not been used.

8.5.2 Methodological issues

A more detailed description of the method used and the emission factors can be found in protocol 8137 on the website www.greenhousegases.nl as indicated in section 8.1.

A country-specific methodology is used for estimating the industrial composting of organic food and garden waste from households. Since this source is not considered to be a key source, the present methodology level complies with the general IPCC Good Practice Guidance (IPCC, 2001). No mention is made of a method for estimating the industrial composting of organic waste in the Good Practice Guidance.

8.5.3 Uncertainties and time-series consistency

Uncertainty
The emissions of this source category are calculated using an average emission factor that has been obtained from the literature. Given the large scatter in reported emission factors the uncertainty is estimated to be more than 100%.

Time-series consistency
The time-series consistency of the activity data is very good due to the continuity in the data provided.

8.5.4 Source specific QA/QC and verification

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

8.5.5 Source specific recalculations

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

8.5.6 Source-specific planned improvements

In 2007 the NIR 2006 was reviewed by an ERT. As a result of the review, the ERT recommended to investigate the application of compost to land and report the emissions from this application. In 2008 a study will be started to collect this information. After finalizing this study the emissions from the application of compost to land will be reported.

9 Other [CRF sector 7]

The Netherlands allocates all emissions in sectors 1 to 6; there are no sources of greenhouse gas emissions included in sector 7.

10 Recalculations and improvements

10.1 Explanation and justification for the recalculations

For this submission (NIR 2008), the Netherlands uses the CRF reporter software 3.2.1. The present CRF tables are based on improved methodologies after the UNFCCC review in 2007. These improved methodologies are also described in the (updated) monitoring protocols 2008 (see annex 6). In addition, several recommendations and suggestions of the ERT as presented in the IRR and ARR are incorporated in the NIR/CRF 2008.

This chapter summarizes the relevant changes in emission figures compared to the NIR 2007 (and CRF version 1.3). A distinction is made between:

- Methodological changes: new emission data are reported resulting from revised or new estimation methods; improved emission factors or activity data are also captured in recalculations as a result of methodological changes;
- Allocation: changes in the allocation of emissions to different sectors (only affecting the totals per category or sector);
- Error corrections: correction of incorrect data.

10.1.1 Methodological changes

The following methodological changes (and their effect on the base year 1990) were implemented, after the review:

- Recalculation of N_2O emissions from waste incineration (new emission factor), category 1A1. Effect: +11.48 Gg CO_2-eq;
- Recalculation of CO_2 from glass production (new plant specific emission factor) category 2A. Effect: -33.65 Gg CO_2-eq;
- Recalculation of N_2O from caprolactam production (new emission factor and activity data), category 2B. Effect: -473.57 Gg CO_2-eq;
- Removal of Indirect N_2O emissions from category 2G. Effect: -935.04 Gg CO_2-eq. in 1990.
- Recalculation of N_2O from manure management (adjustment for NH3 volatilization is removed) category 4B. Effect: +118.32 Gg CO_2-eq.;
- Recalculation of CO_2 emissions from the LULUCF sector, Category 5A+5C+5F total +275.45 Gg CO_2-eq.

Major changes compared to the National Inventory Report 2007

This chapter addresses some changes in emissions compared to the previous submission reported by Brandes et al. (2007). The Netherlands' 2006 inventory was reviewed 'in-country' by the UNFCCC in 2007 (including he review of the annual inventory and the Initial review). This submission documents the (results of the) methodological changes made as a response to the comments and recommendations of the ERT after that review. An updated CRF (version 2006, 1.4), including the results of methodological changes, was already submitted by June 2007. For the submission of this NIR 2008, the data for the most recent year (2006) was added to that CRF.

Also some more general recommendations from the ERT in the IRR and ARR were elaborated and included in this report. For more details on the effect and justification of the recalculations, the reader is referred to chapters 3–8.

The total changes for 1990 compared to last NIR amount to -1,312.63 Gg CO_2-eq. (excluding LULUCF) and -1,037.18 Gg CO_2-eq (including LULUCF). Emissions for the baseyear as calculated after the methodological changes mentioned above, are included in the June 2007 resubmitted CRF version 1.4 (update of CRF version 1.3 as applied for the NIR 2007). This update is applied for the calculation of the Assigned Amount for the Netherlands. The methodological changes affect the whole time series. Details can be found in the CRF for each year. Effects for 2005 are summarized in section 10.2; implications for the trend are described in section 10.3.

10.1.2 Source allocation

No changes in source allocations were performed.

10.1.3 Error correction

During the compilation of the CRF based on the PRTR inventory for 2006 a few minor errors were detected in the emissions reported in the CRF. These include:

- Rounding errors of emission figures of CH_4 emissions from waste combustion and agriculture are now eliminated (result of the review of the national system); negligible effect on emission in 1990 in category 1A1 and for agriculture -3,15 Gg CO_2-eq. compared to previous NIR;
- Correction of rounding of figures for N_2O from agricultural soils, category 4D. Effect: +2.98 Gg CO_2-eq.;
- Summary table ES.3 as well as table 10.1 in this NIR 2008 reflect the correct emissiondata for HFC's in 2003 and 2004. The NIR 2007 reflected the correct values in chapter 4, but included errors in the summary tables for HFC emissions in 2003 and 2004;
- As a result of the review, the calculation of N_2O emissions from waste incineration (1A1) was improved (new emission factor; see above). However, an error in the calculation was detected. The correct value (11.48 Gg CO_2-eq.) is included in this CRF/NIR, where 11.6 Gg CO_2-eq. was submitted as revised calculation after the review.
- In the last submission (from 2003 onwards) the CO_2 emissions in category 3 were based on incorrect NMVOC data. These were replaced by revised figures resulting in a decrease of the CO_2 emissions of 8.4 Gg CO_2-eq. in 2005.

10.2 Implications for emission levels

This chapter outlines and summarizes 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 3-8.

10.2.1 Effect of recalculations on base year and 2005 emission levels

In section 10.1 the effect of the recalculations on the base year (1990) is shown. The changes as mentioned in section 10.1 and other changes (error corrections and revised activity data) compared tot the NIR2007 amount for the year 2005 to:

Resulting from the Initial review:

- Recalculation of N_2O emissions from waste incineration, category 1A1, +99.60 Gg CO_2-eq;
- Recalculation of CO_2 from glass production, category 2A +30.11 Gg CO_2-eq;
- Recalculation of N_2O from caprolactam production; category 2B 0 Gg CO_2-eq;
- Removal of Indirect N_2O emissions from category 2G, -618.07 Gg CO_2-eq.;
- Recalculation of N_2O from manure management, adjustment for NH3 volatilization is removed, Category 4B +112.79 Gg CO_2-eq.;
- Recalculation of CO_2 emissions from the LULUCF sector, Category 5A +5C+5F; total +240.12 Gg CO_2–eq;

Resulting from error corrections and improved activity data (for the year 2005):

- Recalculation of CO_2 from categories 1A1 (other fuels from waste incineration from 1990 onwards), 1A3 (revised fuel data navigation from 1991 onwards), 1A4 (revised fuel data natural gas, from 2005 onwards (error correction)), total -1.11 Gg CO_2-eq;
- Recalculation of CH_4 from categories 1A (see CO_2), 1A2f (revised fuel data for biomass from 1991 onwards), 1A3 (see CO_2) to 1A4, (revised fuel data biomas from 1991 onwards), total +7.46 Gg CO_2-eq;
- Recalculation of N_2O from categories 1A2f (see CH_4),1A3 (see CO_2) and 1A4 (see CH_4), total -29.02 Gg CO_2-eq;
- Correction of rounding of figures for CH_4 for agriculture in category 4 -2.06 Gg CO_2 eq;
- Correction of rounding of figures for N_2O from agricultural soils, Category 4D -1.92 Gg CO_2-eq;
- Recalculation of fluorinated gasses (from 1998 onwards) based on data (measurements) from industry, total -87.42 Gg CO_2-eq;
- Recalculation of CH_4 from waste disposal on land category 6A (2003 onwards), +128.40 Gg CO_2-eq;
- Recalculation of CH_4 from wastewater handling category 6B (2004 onwards), +0.48 Gg CO_2-eq;
- Recalculation of N_2O from wastewater handling category 6B (2004 onwards), -10.72 Gg CO_2-eq;

The total changes for 2005 compared to last NIR amount to -431.65 Gg CO_2-eq (excluding LULUCF) and -191.54 Gg CO_2-eq (including LULUCF).

10.3 Implications for emission trends, including time-series consistency

In general, the recalculations improve both the accuracy and the time-series consistency of the estimated emissions. Table 10.1 presents the changes in this NIR compared to the previous submission for emission levels per compound per year for the period 1990–2005. Table 10.2 presents the changed trends in the greenhouse gas emissions during this period due to the recalculations that were carried out.

Table 10.1 Differences between NIR 2007 and NIR 2008 for the period 1990–2005 due to recalculations (unit: Tg CO_2-eq.; for F-gases: Gg CO_2-eq.)

Gas	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CO_2 [Tg]	NIR2007	161.8	166.7	164.6	169.0	168.9	172.8	179.9	173.5	175.6	170.0	172.0	177.6	178.1	182.0	183.6	178.2
Incl. LUCF	NIR2008	162.0	166.9	164.9	169.2	169.2	173.1	180.2	173.8	175.9	170.4	172.3	177.9	178.4	182.3	183.7	178.5
	Difference	*0.1%*	*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%*	*0.0%*	*0.1%*
CO_2 [Tg]	NIR2007	159.4	164.4	162.4	166.8	166.7	170.6	177.7	171.1	173.2	167.7	169.6	175.2	175.7	179.6	181.3	175.9
Excl. LUCF	NIR2008	159.4	164.4	162.4	166.8	166.8	170.6	177.7	171.2	167.8	167.8	169.6	175.2	175.8	179.7	181.1	181.1
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*-3.1%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*-0.1%*	*2.9%*
CH_4 [Tg]	NIR2007	25.4	25.7	25.2	24.9	24.1	23.8	23.0	22.0	21.2	20.1	19.3	18.9	18.0	17.5	17.3	16.7
	NIR2008	25.4	25.7	25.2	24.9	24.1	23.8	23.0	22.0	21.1	20.1	19.2	18.8	18.0	17.5	17.3	16.8
	Difference	*0.0%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.1%*	*-0.2%*	*0.0%*	*0.0%*	*-0.3%*	*0.8%*
N_2O [Tg]	NIR2007	21.2	21.6	22.4	23.1	22.3	22.4	22.2	21.9	21.7	20.9	19.9	18.8	18.0	17.4	17.7	17.6
	NIR2008	19.9	20.3	21.0	21.8	21.2	21.3	21.1	20.9	20.7	19.9	19.0	17.9	17.1	16.8	17.3	17.1
	Difference	*-6.0%*	*-6.2%*	*-6.0%*	*-5.7%*	*-4.8%*	*-4.8%*	*-4.7%*	*-4.7%*	*-4.6%*	*-5.2%*	*-4.2%*	*-4.8%*	*-4.9%*	*-3.2%*	*-2.2%*	*-2.5%*
PFCs [Gg]	NIR2007	2264	2245	2043	2068	1990	1938	2155	2344	1829	1471	1581	1489	2186	620	285	265
	NIR2008	2264	2245	2043	2068	1990	1938	2155	2344	1829	1472	1582	1489	2187	621	286	266
	Difference	*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%*	*0.2%*	*0.3%*	*0.3%*
HFCs [Gg]	NIR2007	4432	3452	4447	4998	6480	6020	7678	8300	9341	4859	3824	1469	1541	1380	1515	1354
	NIR2008	4432	3452	4447	4998	6480	6020	7678	8300	9341	4859	3824	1469	1541	1379	1511	1353
	Difference	*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%*	*-0.3%*	*-0.1%*
SF_6 [Gg]	NIR2007	217	134	143	150	191	301	312	345	329	317	335	356	332	309	328	337
	NIR2008	217	134	143	150	191	301	312	345	329	317	320	325	286	248	251	250
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*-4.6%*	*-8.6%*	*-13.9%*	*-19.9%*	*-23.5%*	*-25.9%*
Total	NIR2007	213.0	217.6	216.6	222.0	221.8	225.1	233.0	226.0	227.6	215.4	214.4	216.2	215.7	216.8	218.4	212.1
[Tg CO_2-eq.]	*NIR2008*	214.3	218.7	217.7	223.1	223.1	226.4	234.5	227.7	229.2	217.0	216.3	217.9	217.5	218.9	220.3	214.3
Incl. LUCF	*Difference*	*0.6%*	*0.5%*	*0.5%*	*0.5%*	*0.6%*	*0.6%*	*0.6%*	*0.7%*	*0.7%*	*0.7%*	*0.9%*	*0.8%*	*0.8%*	*1.0%*	*0.9%*	*1.0%*
Total	NIR2007	215.4	219.9	218.8	224.2	223.9	227.3	235.3	228.5	229.9	217.8	216.8	218.6	218.1	219.2	220.8	214.5
[Tg CO_2-eq.]	NIR2008	211.7	216.2	215.2	220.7	220.7	224.0	232.0	225.0	226.6	214.4	213.6	215.3	214.9	216.3	217.7	211.8
Excl. LUCF	*Difference*	*-1.7%*	*-1.7%*	*-1.6%*	*-1.6%*	*-1.4%*	*-1.4%*	*-1.4%*	*-1.5%*	*-1.4%*	*-1.5%*	*-1.5%*	*-1.5%*	*-1.5%*	*-1.3%*	*-1.4%*	*-1.3%*

Note: base year values as applied for the calculation of the Assigned Amount are indicated in bold.

Table 10.2 Differences between NIR 2007 and NIR 2008 with respect to emission trends during the period 1990–2005 (Units: Gg CO_2-eq, rounded)

Gas	Trend (absolute)			Trend (percentage)		
CO_2-eq. [Gg] [1]	NIR 2007	NIR 2008	Difference	NIR 2007	NIR 2008	Difference
CO_2	16,516	16,570	*54*	10.4%	10.4%	*0.0%*
CH_4	-8,730	-8,593	*137*	-34.3%	-33.8%	*0.5%*
N_2O	-3,657	-2,829	*828*	-17.2%	-14.2%	*3.1%*
HFCs	-3,078	-3,079	*-1*	-69.5%	-69.5%	*0.0%*
PFCs	-1,999	-1,998	*1*	-88.3%	-88.2%	*0.0%*
SF_6	120	33	*-87*	55.2%	15.0%	*-40.2%*
Total	-829	103	*933*	-0.4%	0.0%	*0.4%*

1) Excluding LULUCF

10.4 Recalculations, response to the review process and planned improvements

10.4.1 Recalculations

No recalculations are anticipated in the next submission of the CRF.

10.4.2 Response to the review process

Public and peer review
Drafts of the NIR are subject to an annual process of general public review and a peer review. No remarks were received from the public on the draft *NIR 2008* of January 2008. In the peer review all chapters were checked. In addition, a separate study (Monteny, 2008) focused on the agricultural sector, but also comments have been made on relating chapters of the draft *NIR 2008* and the CRF-tables.

In general, the conclusion of the peer review is that the Dutch *NIR 2008* adequately describes the way that the Netherlands calculates the emissions of greenhouse gases. The *NIR 2008* follows the format for reporting and CRF to a great extent. Deviations from the format are well documented and underpinned. The information presented provides clear insight in the development of the emissions of greenhouse gases during the period from 1990 onward, with in general clear graphs and tables.

The major recommendations from the peer review are concerned with the readability of the *NIR 2008* by providing more and more clear explanations and by improving the way of reasoning. In addition, the peer review gives suggestions for textual and layout improvement. Many of these recommendation are implemented in the present *NIR 2008*.

UNFCCC reviews
The NIR 2006 was reviewed in the spring of 2007. Remarks and suggestions for improvement made by the ERT are presented in the IRR and ARR and are dealt with in chapter 1 and the sectoral chapters 3 – 8. Some of the suggested improvements (like reconsidering what information to be included in the NIR report and what information in protocols/ background documents) will be further elaborated in the next few years.

As recommended by the ERT, the documentation in the NIR and the protocols on sector specific QC will be further elaborated. A start has been made. In the NIR 2009 it will be further improved. The recommendations of the ERT with respect to LULUCF will be further elaborated in 2008 and are not yet implemented; the results will be presented in the NIR 2009.

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 sludge application on land (4D4), due to missing activity data;
- CH_4 from enteric fermentation of 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 negligible amounts have been found. Since no regular monitoring data are available, these sources are not included. The Netherlands will evaluate these minor sources during the next few years.

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'.

Following the review, special attention has been paid to completeness of the CRF: mainly focussed on the notation keys applied in the CRF tables.

10.4.5 Planned improvements

By the end of 2005, the Netherlands National System was established, in line with the requirements under the Kyoto Protocol and under the EU Monitoring Mechanism. The establishment of the National System was a result of the implementation of a monitoring improvement programme (see section 1.6). In 2007 the system was reviewed during the initial review. The review team concluded that the Netherlands' national system has been established in accordance with the guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (decision 19/CMP.1) and that it meets the requirements for implementation of the general

functions of the national system as well the specific functions of inventory planning, inventory preparation and inventory management.

Monitoring improvement
The national system includes an annual evaluation and improvement process. The evaluation is based on experiences in previous years, results of UN reviews, peer reviews, audits, etc. Improvements – if needed – are considered as part of the regularly (annually) updated QA/QC programme (SenterNovem, 2007).

One of the recent improvement actions relates to the EF for natural gas. In the NIR 2006 an updated EF was used. This new factor (56.8) has been established based on detailed assessments for the base year and for 2004. Both years showed the same EF; however given time constraints the EF for intermediate years could be analysed only roughly and it was assumed that no significant fluctuations occurred during these intermediate years. In an ongoing study this is analysed further and if necessary, time series will be corrected accordingly. This will not affect the base year emissions (to be updated).

As a result of the initial review it was decided to re-assess the basic data on deforestation. Results are expected during 2008. Where and when needed, the resulting improvements will be included in the NIR 2009.

Monitoring protocol and QAQC programme
The Netherlands uses monitoring protocols that describe the methodology, data sources (and the rationale for their selection). These protocols are available on the website www.greenhousegases.nl. The protocols were given a legal basis in December 2005. The monitoring protocols are assessed annually and –when needed– updated. The initial review recommended that some of the protocols should include more details (i.e. inclusion of some additional information that now is included only in background documents). For 2008 the Netherlands has included this recommendation in its QAQC programme and will improve the 'balance' between NIR, protocols and background reports. The results are expected in the NIR2009.

The QA/QC programme for this year (SenterNovem, 2007) furthermore continues the assessment of improvement options on the longer term, among other based on consequences of the new 2006 IPCC guidelines. This will provide a basis for a possible improvement programme for the longer term.

The review team recommended to further centralize the archiving of intermediate calculations. Most documentation and archiving was already centralized, with exception of some intermediate/supporting data calculations archived at task force level. This recommendation will also be considered during the data process in the coming years.

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Annex 1 Key sources

A1.1 Introduction

As explained in the *Good Practice Guidance* (IPCC, 2001), a key source category is 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 the indentification 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. Emissions in other IPCC sectors are disaggregated as suggested by IPCC.

The IPCC Tier 1 method consists of ranking the list of source category/gas combinations, both for the contribution, to the national total annual emissions and to the national total trend. The darker green areas at the top of the tables in this Annex are the largest sources of which the total adds up to 95% of the national total: 32 sources for annual level assessment (emissions in 2006) and 31 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, 2007). The results of the Tier 1 and Tier 2 level and trend assessments are summarized in *Table A1.1* and show a total of 41 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, 4 more sources are added to the list of 37 Tier 1 level and trend key sources:

- N_2O emissions from mobile combustion: road vehicles (Tier 2 trend)
- Non CO_2 emissions from stationary combustion (CH_4, Tier 2 level)
- CO_2 emissions manufacturing other chemical products (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, which gives an overall total of 45 key sources, see also Table A1.1. In this report, the key source assessment is based on emission figures from CRF 2008 version 1.2, be submitted to EU in March 2008.

Table A1.1 Key source list identified by the Tier 1 and 2 level and trend assessments (based on CRF tables 2008 version 1.2. Level assessment for 2006 emissions)

Category	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
ENERGY							
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: liquids	Key(L1,T1)	1	1	0	**0**
1A1a	CO_2	Stationary combustion: Public Electricity and Heat Production: solids	Key(L,T1)	1	1	1	0
1A1a	CO_2	Stationary combustion : Public Electricity and Heat Production: gases	Key(L,T)	1	1	1	1
1A1a	CO_2	Stationary combustion : Public Electricity and Heat Production: waste incineration	Key(L,T)	1	1	1	1
1A1b	CO_2	Stationary combustion : Petroleum Refining: liquids	Key(L,T)	1	1	1	1
1A1b	CO_2	Stationary combustion : Petroleum Refining: gases	Key(L1,T1)	1	1	0	0
1A1c	CO_2	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	Non key	0	0	0	0
1A1c	CO_2	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	Key(L,T)	1	1	1	1
1A2	CO_2	Emissions from stationary combustion : Manufacturing Industries and Construction, liquids	Key(L,T1)	1	1	1	0
1A2	CO_2	Emissions from stationary combustion : Manufacturing Industries and Construction, solids	Key(L,T1)	1	1	1	0
1A2	CO_2	Emissions from stationary combustion : Manufacturing Industries and Construction, gases	Key(L,T)	1	1	1	1
1A3	CO_2	Mobile combustion: road vehicles: gasoline	Key(L,T1)	1	1	1	0
1A3	CO_2	Mobile combustion: road vehicles: diesel oil	Key(L,T)	1	1	1	1
1A3	CO_2	Mobile combustion: road vehicles: LPG	Key(L1,T)	1	1	0	1
1A3	CO_2	Mobile combustion: water-borne navigation	Key(L1,T1)*	1	1	0	0
1A3	CO_2	Mobile combustion: aircraft	Non key	0	0	0	0
1A3	CO_2	Mobile combustion: railways	Non key	0	0	0	0
1A3	CH_4	Mobile combustion: other	Non key	0	0	0	0
1A3	N_2O	Mobile combustion: other	Non key	0	0	0	0
1A3	CH_4	Mobile combustion: road vehicles	Non key	0	0	0	0
1A3	N_2O	Mobile combustion: road vehicles	Key(T2)*	0	0	0	1
1A4	CO_2	Stationary combustion : Other Sectors, solids	Non key	0	0	0	0
1A4a	CO_2	Stationary combustion : Other Sectors: Commercial/Institutional, gases	Key(L,T)	1	1	1	1
1A4b	CO_2	Stationary combustion : Other Sectors, Residential, gases	Key(L,T1)	1	1	1	0
1A4c	CO_2	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	Key(L,T1)	1	1	1	0
1A4c	CO_2	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	Key(L)	1	0	1	0
1A4	CO_2	Stationary combustion : Other Sectors, liquids excl. From 1A4c	Key(T)	0	1	0	1
1A5	CO_2	Military use of fuels (1A5 Other)	Non key	0	0	0	0
1A	CH_4	Emissions from stationary combustion: non-CO_2	Key(L2)	0	0	1	0
1A	N_2O	Emissions from stationary combustion: non-CO_2	Non key	0	0	0	0
1B1	CH_4	Coal mining	Not occuring				
1B1b	CO_2	Coke production	Non key	0	0	0	0
1B2	CO_2	Fugitive emissions from venting/flaring: CO_2	Key(T)	0	1	0	1
1B2	CH_4	Fugitive emissions venting/flaring	Key(T)	0	1	0	1
1B2	CH_4	Fugitive emissions from oil and gas: gas distribution	Non key	0	0	0	0
1B2	CH_4	Fugitive emissions from oil and gas operations: other	Non key	0	0	0	0
INDUSTRIAL PROCESSES							
2A1	CO_2	Cement production	Non key	0	0	0	0
2A3	CO_2	Limestone and dolomite use	Non key	0	0	0	0
2A7	CO_2	Other minerals	Key(T1)*	0	1	0	0
2B1	CO_2	Ammonia production	Key(L1)	1	0	0	0
2B2	N_2O	Nitric acid production	Key(L,T)	1	1	1	1
2B5	N_2O	Caprolactam production	Key(L1)	1	0	0	0

Category	Gas	Category name	Key source?	Tier 1 Level	Tier 1 Trend	Tier 2 Level	Tier 2 Trend
2B5	CO_2	Other chemical product manufacture	Key(L)	1	0	1	0
2C1	CO_2	Iron and steel production (carbon inputs)	Key(L1,T1)	1	1	0	0
2C3	CO_2	CO_2 from aluminium production	Non key	0	0	0	0
2C3	PFC	PFC from aluminium production	Key(T)	0	1	0	1
2F	SF_6	SF_6 emissions from SF_6 use	Non key	0	0	0	0
2F	HFC	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	Key(L,T)	1	1	1	1
2E	HFC	HFC-23 emissions from HCFC-22 manufacture	Key(T)	0	1	0	1
2E	HFC	HFC by-product emissions from HFC manufacture	Non key	0	0	0	0
2F	PFC	PFC emissions from PFC use	Non key	0	0	0	0
2G	CO_2	Other industrial: CO_2	Non key	0	0	0	0
2G	CH_4	Other industrial: CH_4	Non key	0	0	0	0
2G	N_2O	Other industrial: N_2O	Non key	0	0	0	0
2G	N_2O	Indirect N_2O from non-agricultural sources	Non key	0	0	0	0
2G	N_2O	Indirect N_2O from NO2 from combustion and industrial processes	Non key**	0	0	0	0
SOLVENTS AND OTHER PRODUCT USE							
3	CO_2	Indirect CO_2 from solvents/product use	Non key	0	0	0	0
3	CH_4	Solvents and other product use	IE in 2G				
AGRICULTURAL SECTOR							
4A1	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: cattle	Key(L,T)	1	1	1	1
4A8	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: swine	Non key	0	0	0	0
4A	CH_4	CH_4 emissions from enteric fermentation in domestic livestock: other	Non key	0	0	0	0
4B	N_2O	Emissions from manure management	Key(L)	1	0	1	0
4B1	CH_4	Emissions from manure management : cattle	Key(L,T2)	1	0	1	1
4B8	CH_4	Emissions from manure management : swine	Key(L,T2)	1	0	1	1
4B9	CH_4	Emissions from manure management : poultry	Key(T2)	0	0	0	1
4B	CH_4	Emissions from manure management : other	Non key	0	0	0	0
4C	CH_4	Rice cultivation	Not occuring				
4D1	N_2O	Direct N_2O emissions from agricultural soils	Key(L,T)	1	1	1	1
4D3	N_2O	Indirect N_2O emissions from nitrogen used in agriculture	Key(L,T)	1	1	1	1
4D2	N_2O	Animal production on agricultural soils	Key(L,T)	1	1	1	1
WASTE SECTOR							
6A1	CH_4	CH_4 emissions from solid waste disposal sites	Key(L,T)	1	1	1	1
6B	CH_4	Emissions from wastewater handling	Non key	0	0	0	0
6B	N_2O	Emissions from wastewater handling	Non key	0	0	0	0
6C	CO_2	Emissions from waste incineration	IE in 1A1				
	CH_4	Misc. CH_4	Non key	0	0	0	0
	N_2O	Misc. N_2O	Non key	0	0	0	0
KEY SOURCE CATEGORIES (EXCL. LULUCF)			41	**32**	**31**	**26**	**24**
LAND USE, LAND USE CHANGE AND FORESTRY							
5A1	CO_2	5A1. Forest Land remaining Forest Land	Key(L,T2)	1	0	1	1
5A2	CO_2	5A2. Land converted to Forest Land	Key(T)*	0	1	0	1
5B2	CO_2	5B2. Land converted to Cropland	Non key	0	0	0	0
5C1	CO_2	5C1. Grassland remaining Grassland	Key(L)	1	0	1	0
5C2	CO_2	5C2. Land converted to Grassland	Non key	0	0	0	0
5E2	CO_2	5E2. Land converted to Settlements	Non key	0	0	0	0
5F2	CO_2	5F2. Land converted to Other Land	Key(L)	1	0	1	0
5G	CO_2	5G. Other (liming of soils)	Non key	0	0	0	0
5A1	N_2O	5A1. Forest Land remaining Forest Land	Non key	0	0	0	0
TOTAL KEY SOURCE CATEGORIES (INCL. LULUCF)			45	**35**	**34**	**29**	**27**

A1.2 Changes in key sources compared to previous submission

Due to the use of emission data for 2006 in the key source analysis, the following changes occured compared to the previous NIR:

- CO_2 emissions from 1A3 mobile combustion: water-borne navigation: now key;
- N_2O emissions from 1A3 Mobile combustion: road vehicles: now key;
- CO_2 emissions from 2A7 Other minerals: now key;
- Indirect N_2O emissions in category 2G: now non-key. This emission source is removed as a result of the in-country review.
- CO_2 emissions from 5A2 Land converted to Forest Land: now key.

A1.3 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 2006 annual emissions total and to the base year to 2006 trend, respectively. This resulted in 32 level key sources and 31 trend key sources (indicated in the darker green part at the top).

Table A1.2 Source ranking using IPCC Tier 1 level assessment 2006 (amounts in Gg CO_2-EQ)

IPCC	Category	Gas	CO_2 eq last year	Share (%)	Cum. Share (%)
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23617	11	11
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	22846	11	22
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20696	10	32
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	17123	8	41
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	14644	7	48
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13206	6	54
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	10309	5	59
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	8959	4	63
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8392	4	67
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7469	4	71
6A1	CH_4 emissions from solid waste disposal sites	CH_4	5646	3	74
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	5641	3	76
2B2	Nitric acid production	N_2O	5597	3	79
4D1	Direct N_2O emissions from agricultural soils	N_2O	4801	2	81
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4451	2	84
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3146	2	85
2B1	Ammonia production	CO_2	3071	1	87
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	2646	1	88
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2556	1	89
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2115	1	90
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1927	1	91
4B1	Emissions from manure management : cattle	CH_4	1453	1	92
2C1	Iron and steel production (carbon inputs)	CO_2	1410	1	92
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1231	1	93
1A3b	Mobile combustion: road vehicles: LPG	CO_2	977	0	93
4B8	Emissions from manure management : swine	CH_4	927	0	94
4B	Emissions from manure management	N_2O	852	0	94
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	734	0	95
2B5	Caprolactam production	N_2O	662	0	95
2B5	Other chemical product manufacture	CO_2	646	0	95
1A3	Mobile combustion: water-borne navigation	CO_2	626	0	96
4D2	Animal production on agricultural soils	N_2O	611	0	96
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	577	0	96

IPCC	Category	Gas	CO_2 eq last year	Share (%)	Cum. Share (%)
1A	Emissions from stationary combustion: non-CO_2	CH_4	547	0	96
2A7	Other minerals	CO_2	474	0	97
1A3	Mobile combustion: road vehicles	N_2O	451	0	97
1B1b	CO_2 from coke production	CO_2	449	0	97
2C3	CO_2 from aluminium production	CO_2	414	0	97
2A1	Cement production	CO_2	400	0	98
1A5	Military use of fuels (1A5 Other)	CO_2	381	0	98
6B	Emissions from wastewater handling	N_2O	381	0	98
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	358	0	98
2G	Other industrial: CO_2	CO_2	352	0	98
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	312	0	98
1A	Emissions from stationary combustion: non-CO_2	N_2O	308	0	99
2A3	Limestone and dolomite use	CO_2	299	0	99
2G	Other industrial: CH_4	CH_4	297	0	99
1B2	Fugitive emissions venting/flaring	CH_4	291	0	99
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	281	0	99
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	274	0	99
2F	SF6 emissions from SF6 use	SF6	215	0	99
6B	Emissions from wastewater handling	CH_4	201	0	99
2F	PFC emissions from PFC use	PFC	194	0	100
1B2	Fugitive emissions from oil and gas operations: other	CH_4	143	0	100
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	138	0	100
3	Indirect CO_2 from solvents/product use	CO_2	135	0	100
3, 6D	OTHER N_2O	N_2O	126	0	100
1A3	Mobile combustion: other (railways)	CO_2	97	0	100
6D	OTHER CH_4	CH_4	66	0	100
2C3	PFC from aluminium production	PFC	62	0	100
4B9	Emissions from manure management : poultry	CH_4	62	0	100
1A3	Mobile combustion: road vehicles	CH_4	49	0	100
2E	HFC by-product emissions from HFC manufacture	HFC	48	0	100
1A4	Stationary combustion : Other Sectors, solids	CO_2	41	0	100
1A3	Mobile combustion: aircraft	CO_2	41	0	100
4B	Emissions from manure management : other	CH_4	17	0	100
2G	Other industrial: N_2O	N_2O	7	0	100
1A3	Mobile combustion: other (non-road)	N_2O	2	0	100
1A3	Mobile combustion: other (non-road)	CH_4	1	0	100
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	0	0	100
2G	Indirect N_2O from NH3 from combustion and industrial processes	N_2O	0	0	100
2G	Indirect N_2O from NO2 from combustion and industrial processes	N_2O	0	0	100

Table A1.3. Source ranking using IPCC Tier 1 trend assessment (amounts in Gg CO_2-eq.)

IPCC	Category	Gas	CO_2 eq last year	Share (%)	Cum. Share (%)
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	22846	15	15
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20696	14	29
6A1	CH_4 emissions from solid waste disposal sites	CH_4	5646	9	39
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	281	8	47
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	14644	6	53
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	10309	6	59
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13206	4	63
2C3	PFC from aluminium production	PFC	62	3	66
1A3b	Mobile combustion: road vehicles: LPG	CO_2	977	3	68
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	2646	3	71
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3146	2	73
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2115	2	76
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23617	2	78

IPCC	Category	Gas	CO_2 eq last year	Share (%)	Cum. Share (%)
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	17123	2	80
2C1	Iron and steel production (carbon inputs)	CO_2	1410	2	81
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1231	2	83
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	5641	1	84
1B2	Fugitive emissions venting/flaring	CH_4	291	1	86
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	577	1	87
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	8959	1	88
4D2	Animal production on agricultural soils	N_2O	611	1	89
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7469	1	90
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	138	1	91
2B2	Nitric acid production	N_2O	5597	1	92
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	734	1	93
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4451	1	93
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1927	1	94
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8392	1	95
4D1	Direct N_2O emissions from agricultural soils	N_2O	4801	0	95
1A3	Mobile combustion: water-borne navigation	CO_2	626	0	96
2A7	Other minerals	CO_2	474	0	96
1A3	Mobile combustion: road vehicles	N_2O	451	0	96
4B8	Emissions from manure management : swine	CH_4	927	0	96
4B9	Emissions from manure management : poultry	CH_4	62	0	97
3	Indirect CO_2 from solvents/product use	CO_2	135	0	97
1A5	Military use of fuels (1A5 Other)	CO_2	381	0	97
2F	PFC emissions from PFC use	PFC	194	0	98
1A4	Stationary combustion : Other Sectors, solids	CO_2	41	0	98
6B	Emissions from wastewater handling	N_2O	381	0	98
3, 6D	OTHER N_2O	N_2O	126	0	98
1A3	Mobile combustion: road vehicles	CH_4	49	0	98
1A	Emissions from stationary combustion: non-CO_2	N_2O	308	0	98
2B5	Caprolactam production	N_2O	662	0	99
6B	Emissions from wastewater handling	CH_4	201	0	99
2F	SF6 emissions from SF6 use	SF6	215	0	99
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2556	0	99
4B1	Emissions from manure management : cattle	CH_4	1453	0	99
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	358	0	99
6D	OTHER CH_4	CH_4	66	0	99
4B	Emissions from manure management	N_2O	852	0	99
1B1b	CO_2 from coke production	CO_2	449	0	99
2B5	Other chemical product manufacture	CO_2	646	0	100
2B1	Ammonia production	CO_2	3071	0	100
2G	Other industrial: CO_2	CO_2	352	0	100
1A	Emissions from stationary combustion: non-CO_2	CH_4	547	0	100
2E	HFC by-product emissions from HFC manufacture	HFC	48	0	100
2A3	Limestone and dolomite use	CO_2	299	0	100
2C3	CO_2 from aluminium production	CO_2	414	0	100
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	274	0	100
1B2	Fugitive emissions from oil and gas operations: other	CH_4	143	0	100
1A3	Mobile combustion: other (railways)	CO_2	97	0	100
2G	Other industrial: CH_4	CH_4	297	0	100
4B	Emissions from manure management : other	CH_4	17	0	100
2A1	Cement production	CO_2	400	0	100
2G	Other industrial: N_2O	N_2O	7	0	100

IPCC	Category	Gas	CO_2 eq last year	Share (%)	Cum. Share (%)
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	312	0	100
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	0	0	100
1A3	Mobile combustion: aircraft	CO_2	41	0	100
1A3	Mobile combustion: other (non-road)	N_2O	2	0	100
1A3	Mobile combustion: other (non-road)	CH_4	1	0	100
2G	Indirect N_2O from NH3 from combustion and industrial processes	N_2O	0	0	100
2G	Indirect N_2O from NO2 from combustion and industrial processes	N_2O	0	0	100

A1.4 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 2006 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 (26 and 24 respectively instead of 32 and 31).

Table A1.4 Source ranking using IPCC Tier 2 level assessment 2006 (in Gg CO_2-eq.)

IPCC	Category	Gas	CO_2-eq last year	Share	Uncer-tainty estim.	Level * Uncer-tainty	Share L*U	Cum. Share L*U
				%	%	%	%	%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3146	2	206	3	21	21
4D1	Direct N_2O emissions from agricultural soils	N_2O	4801	2	61	1	9	30
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	10309	5	20	1	7	36
6A1	CH_4 emissions from solid waste disposal sites	CH_4	5646	3	34	1	6	42
4B1	Emissions from manure management : cattle	CH_4	1453	1	100	1	5	47
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	8959	4	14	1	4	51
2B2	Nitric acid production	N_2O	5597	3	22	1	4	55
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20696	10	5	0	3	58
4B8	Emissions from manure management : swine	CH_4	927	0	100	0	3	61
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	5641	3	16	0	3	64
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	17123	8	5	0	3	67
4B	Emissions from manure management	N_2O	852	0	100	0	3	69
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7469	4	10	0	2	72
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23617	11	3	0	2	74
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1231	1	51	0	2	76
4D2	Animal production on agricultural soils	N_2O	611	0	100	0	2	78
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2556	1	20	0	2	80
2B5	Other chemical product manufacture	CO_2	646	0	71	0	1	81
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4451	2	10	0	1	83
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8392	4	5	0	1	84
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1927	1	21	0	1	85
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	14644	7	2	0	1	86
1A	Emissions from stationary combustion: non-CO_2	CH_4	547	0	50	0	1	87
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13206	6	2	0	1	88
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	22846	11	1	0	1	89
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2115	1	11	0	1	90

IPCC	Category	Gas	CO_2-eq last year	Share	Uncer-tainty estim.	Level * Uncer-tainty	Share L*U	Cum. Share L*U
				%	%	%	%	%
1A3	Mobile combustion: road vehicles	N_2O	451	0	50	0	1	90
1B1b	CO_2 from coke production	CO_2	449	0	50	0	1	91
6B	Emissions from wastewater handling	N_2O	381	0	54	0	1	92
2B5	Caprolactam production	N_2O	662	0	28	0	1	92
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	358	0	50	0	1	93
1A	Emissions from stationary combustion: non-CO_2	N_2O	308	0	50	0	0	93
2G	Other industrial: CH_4	CH_4	297	0	51	0	0	94
1A3	Mobile combustion: water-borne navigation	CO_2	626	0	20	0	0	94
2A7	Other minerals	CO_2	474	0	25	0	0	95
2F	SF6 emissions from SF6 use	SF6	215	0	56	0	0	95
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	577	0	20	0	0	95
1A3b	Mobile combustion: road vehicles: LPG	CO_2	977	0	10	0	0	96
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	312	0	30	0	0	96
2C1	Iron and steel production (carbon inputs)	CO_2	1410	1	6	0	0	96
1B2	Fugitive emissions from oil and gas operations: other	CH_4	143	0	54	0	0	96
1A5	Military use of fuels (1A5 Other)	CO_2	381	0	20	0	0	97
2A3	Limestone and dolomite use	CO_2	299	0	25	0	0	97
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	734	0	10	0	0	97
1B2	Fugitive emissions venting/flaring	CH_4	291	0	25	0	0	97
2G	Other industrial: CO_2	CO_2	352	0	21	0	0	98
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	138	0	50	0	0	98
2B1	Ammonia production	CO_2	3071	1	2	0	0	98
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	274	0	25	0	0	98
3, 6D	OTHER N_2O	N_2O	126	0	54	0	0	98
6B	Emissions from wastewater handling	CH_4	201	0	32	0	0	99
4B9	Emissions from manure management : poultry	CH_4	62	0	100	0	0	99
2F	PFC emissions from PFC use	PFC	194	0	25	0	0	99
2A1	Cement production	CO_2	400	0	11	0	0	99
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	281	0	14	0	0	99
3	Indirect CO_2 from solvents/product use	CO_2	135	0	27	0	0	99
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	2646	1	1	0	0	99
1A3	Mobile combustion: road vehicles	CH_4	49	0	60	0	0	100
2C3	CO_2 from aluminium production	CO_2	414	0	5	0	0	100
6D	OTHER CH_4	CH_4	66	0	32	0	0	100
1A4	Stationary combustion : Other Sectors, solids	CO_2	41	0	50	0	0	100
1A3	Mobile combustion: aircraft	CO_2	41	0	50	0	0	100
4B	Emissions from manure management : other	CH_4	17	0	100	0	0	100
2C3	PFC from aluminium production	PFC	62	0	20	0	0	100
2E	HFC by-product emissions from HFC manufacture	HFC	48	0	22	0	0	100
1A3	Mobile combustion: other (railways)	CO_2	97	0	5	0	0	100
2G	Other industrial: N_2O	N_2O	7	0	71	0	0	100
1A3	Mobile combustion: other (non-road)	N_2O	2	0	112	0	0	100
1A3	Mobile combustion: other (non-road)	CH_4	1	0	112	0	0	100
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	0	0	20	0	0	100
2G	Indirect N_2O from NH3 from combustion and industrial processes	N_2O	0	0	206	0	0	100
2G	Indirect N_2O from NO2 from combustion and industrial processes	N_2O	0	0	201	0	0	100

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	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncer-tainty estimate	Trend * uncer-tainty	Contr. to trend	Cum.
					%	%	%	%	%	%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	4863	3146	2	1	206	2	26	26
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	5646	3	3	34	1	16	42
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	6634	10309	5	2	20	0	6	48
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	281	0	3	14	0	6	54
4D2	Animal production on agricultural soils	N_2O	1307	611	0	0	100	0	5	60
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1231	1	0	51	0	4	64
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11832	20696	10	5	5	0	4	67
2C3	PFC from aluminium production	PFC	1901	62	0	1	20	0	3	70
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	138	0	0	50	0	2	72
1B2	Fugitive emissions venting/flaring	CH_4	1252	291	0	0	25	0	2	74
4D1	Direct N_2O emissions from agricultural soils	N_2O	4600	4801	2	0	61	0	2	76
4B8	Emissions from manure management: swine	CH_4	1140	927	0	0	100	0	1	77
4B9	Emissions from manure management: poultry	CH_4	242	62	0	0	100	0	1	79
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1476	577	0	0	20	0	1	80
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	592	2115	1	1	11	0	1	81
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2738	977	0	1	10	0	1	83
4A1	CH_4 emissions from enteric fermenta-tion in domestic livestock: cattle	CH_4	6769	5641	3	0	16	0	1	84
2B2	Nitric acid production	N_2O	6330	5597	3	0	22	0	1	85
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	8959	4	0	14	0	1	86
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	22846	11	5	1	0	1	87
1A3	Mobile combustion: road vehicles	N_2O	271	451	0	0	50	0	1	88
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	1927	1	0	21	0	1	88
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19020	14644	7	2	2	0	1	89
4B1	Emissions from manure management: cattle	CH_4	1571	1453	1	0	100	0	1	90
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	41	0	0	50	0	1	90
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	8328	7469	4	0	10	0	1	91
6B	Emissions from wastewater handling	N_2O	513	381	0	0	54	0	1	91
3, 6D	OTHER N_2O	N_2O	250	126	0	0	54	0	1	92
1A3	Mobile combustion: road vehicles	CH_4	157	49	0	0	60	0	0	92
4B	Emissions from manure management	N_2O	813	852	0	0	100	0	0	93
2C1	Iron and steel production (carbon inputs)	CO_2	2514	1410	1	1	6	0	0	93
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	17123	8	1	5	0	0	94
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	734	0	0	10	0	0	94
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10902	13206	6	1	2	0	0	94
2A7	Other minerals	CO_2	275	474	0	0	25	0	0	95
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	23617	11	1	3	0	0	95

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncer-tainty estimate	Trend * uncer-tainty	Contr. to trend	Cum.
					%	%	%	%	%	%
3	Indirect CO_2 from solvents/product use	CO_2	316	135	0	0	27	0	0	96
1A3	Mobile combustion: water-borne navigation	CO_2	405	626	0	0	20	0	0	96
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5033	4451	2	0	10	0	0	96
1A	Emissions from stationary combustion: non-CO_2	N_2O	226	308	0	0	50	0	0	97
2F	SF6 emissions from SF6 use	SF6	301	215	0	0	56	0	0	97
2F	PFC emissions from PFC use	PFC	37	194	0	0	25	0	0	97
2B5	Other chemical product manufacture	CO_2	606	646	0	0	71	0	0	98
4A8	CH_4 emissions from enteric fermenta-tion in domestic livestock: swine	CH_4	438	358	0	0	50	0	0	98
1A5	Military use of fuels (1A5 Other)	CO_2	566	381	0	0	20	0	0	98
1B1b	CO_2 from coke production	CO_2	403	449	0	0	50	0	0	98
6B	Emissions from wastewater handling	CH_4	290	201	0	0	32	0	0	99
2B5	Caprolactam production	N_2O	766	662	0	0	28	0	0	99
6D	OTHER CH_4	CH_4	1	66	0	0	32	0	0	99
1A	Emissions from stationary combustion: non-CO_2	CH_4	522	547	0	0	50	0	0	99
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8993	8392	4	0	5	0	0	99
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	2646	1	1	1	0	0	99
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2544	2556	1	0	20	0	0	100
2G	Other industrial: CO_2	CO_2	305	352	0	0	21	0	0	100
2E	HFC by-product emissions from HFC manufacture	HFC	12	48	0	0	22	0	0	100
1B2	Fugitive emissions from oil and gas operations: other	CH_4	162	143	0	0	54	0	0	100
2A3	Limestone and dolomite use	CO_2	276	299	0	0	25	0	0	100
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	274	0	0	25	0	0	100
4B	Emissions from manure management: other	CH_4	12	17	0	0	100	0	0	100
2G	Other industrial: CH_4	CH_4	297	297	0	0	51	0	0	100
2G	Other industrial: N_2O	N_2O	3	7	0	0	71	0	0	100
2C3	CO_2 from aluminium production	CO_2	395	414	0	0	5	0	0	100
2B1	Ammonia production	CO_2	3096	3071	1	0	2	0	0	100
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0	0	112	0	0	100
2A1	Cement production	CO_2	416	400	0	0	11	0	0	100
1A3	Mobile combustion: aircraft	CO_2	41	41	0	0	50	0	0	100
4A	CH_4 emissions from enteric fermenta-tion in domestic livestock: other	CH_4	319	312	0	0	30	0	0	100
1A3	Mobile combustion: other (railways)	CO_2	91	97	0	0	5	0	0	100
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0	0	112	0	0	100
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	0	0	0	20	0	0	100
2G	Indirect N_2O from NH3 from combustion and industrial processes	N_2O	0	0	0	0	206	0	0	100
2G	Indirect N_2O from NO2 from combustion and industrial processes	N_2O	0	0	0	0	201	0	0	100

Annex 2 Detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion

In this Annex '**The Netherlands list of fuels and standard CO_2 emission factors**' version August 2006 is included. This list was first 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 of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) and of page 1.6 of the IPCC Good Practice Guidance for National Greenhouse Gas Inventories Workbook. In addition, section A2.2.5 describes in which source categories of the national emission inventory the Netherlands standard emission factors and source-specific CO_2 emission factors are applied. For a description of the methodology and activity data used for the calculation of CO_2 emissions from fossil fuel combustion we refer to the monitoring protocols (see Annex 6, protocols no. 8101 and 8111 for stationary sources and no. 8103-8110 for mobile sources).

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 annex is meant for people using the Netherlands' list. It contains the starting points for this list and indicates how it should be used for various objectives, e.g. national monitoring of greenhouse gas emissions, the European CO_2 emissions trade, and the e-MJV. It also includes background 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.

A2.3 The Netherlands' list

A study was carried out in 2002 with respect to specific Netherlands' CO_2 emission factors (TNO, 2002). This study showed that, for a limited number of Dutch fuels, their situations deviated such that national values needed to be determined. For a number of fuels the previously defined data was available to update national values (Spakman et al., 2003) but, for others, new values were required.

In 2006 a study was commissioned to research methods to determine the CO_2 emission factor for natural gas (Heslinga and van Harmelen, 2006). This resulted in an advice to use natural gas a country specific factor from the year 1990 onwards (Vreuls, 2006). In its meeting 25 April 2006 the Steering Group for Emissions Registration agreed with this advise and approved an update of the National list.

A specific Netherlands standard CO_2 emissions factor has been determined for the following fuels, which does not appear in the 1996 IPCC guidelines or in the EC's Directive 2004/156/EG, but has been added as 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. Oxygen furnace gas;
10. Phosphorus furnace gas;
11. Natural 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 (WWTP) 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.

A2.4 Fact sheets

A fact sheet (consisting of at least two sections) has been drawn up for each energy carrier:

1. General information:
   a. Name of the energy carrier, in Dutch and English;
   b. Other names used (Dutch and English);
   c. Description;
   d. Codes (in Dutch) used to specify the energy carrier;
   e. Unit.

2. Specific values and substantiation:
   a. Heating value;
   b. Carbon content;
   c. CO_2 emissions factor;
   d. Density (if relevant), converting from weight to volume or converting from gases to 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).

A2.5 The Netherlands list in national monitoring, European CO_2 emissions trade and in e-MJV

National monitoring

The 1996 IPCC guidelines are among those valid for national monitoring under the UNFCCC framework, which is reported annually in the NIR (National Inventory Report). This includes the default CO_2 emission factors shown in Table 1-1 (chapter 1 of the Reference Manual, volume 3 of the 1996 IPCC guidelines) and Table 1-2 (Module 1 of the Workbook, volume 2 of the 1996 IPCC guidelines). With respect to the specification at national level: '...default assumptions and data should be used only when national assumptions and data are not available.' (Overview of the Reporting Instructions, volume 1 of the 1996 IPCC guidelines) and '...because fuel qualities and emission factors may differ markedly between countries, sometimes by as much as 10% for nominally similar fuels, national inventories should be prepared using local emission factors and energy data where possible.' (Chapter 1, section 1.1 of the Reference Manual, volume 3 of the 1996 IPCC guidelines).

With respect to documentation: 'When countries use local values for the carbon emission factors they should note the differences from the default values and provide documentation supporting the values used in the national inventory calculations' (chapter 1, section 1.4.1.1 of the Reference Manual, volume 3 of the 1996 IPCC guidelines). Exactly when and how the Netherlands list should be used in the national monitoring process is further described in the 1996 IPCC guidelines. The Netherlands list is included in the country's national report to the UNFCCC on greenhouse gas emissions.

Monitoring European CO_2 emissions trade

The EC Directive 2004/156/EG covers the monitoring under the framework of the European CO_2 emissions trade. This directive serves as a starting point for the Netherlands monitoring system for trading in emission rights. With respect to the CO_2 emission factors and the calculations of CO_2 emissions at level 2a, the directive states: 'The operator should use the relevant fuel caloric values that apply in that country, e.g. as indicated in the relevant Member State's latest national inventory, which has been submitted to the secretariat of the UNFCCC (EC Directive 2004/156/EG, Appendix II, section 2.1.1.1).

With respect to the reports, this states that: 'Fuels, and the resulting emissions must be reported in accordance with the IPCC standard format for fuels.... this is based on the definitions set out by the IEA (International Energy Agency). If the Member State (relevant to the operator) has already published a list of fuel categories, including definitions and emission factors, which is consistent with the latest national inventory such as submitted to the UNFCCC secretariat, these categories and the accompanying emission factors should be used, if these have been approved within the framework of the relevant monitoring methodology.' (EC Directive 2004/156/EG, Appendix I, section 5).

Exactly when and how the Netherlands list should be used in the monitoring process under the framework of the EU CO_2 emissions trading is further explained in EC Directive 2004/156/EG and the Netherlands system for monitoring the trade in emission rights.

Table A2.1 Netherlands fuels and standard CO_2 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
Smeeroliën	Lubricants	kg	41.4	73.3
Petroleumcokes	Petroleum Coke	kg	35.2	100.8
Raffinaderijgrondstoffen	Refinery Feedstocks	kg	44.8	73.3
Raffinaderijgas	Refinery Gas	kg	45.2	66.7
Chemisch restgas	Chemical Waste Gas	kg	45.2	66.7
Overige oliën	Other Oil *	kg	40.2	73.3
	B. Solid Fossil, Primary Fuels			
Antraciet	Anthracite	kg	26.6	98.3
Cokeskolen	Coking Coal	kg	28.7	94.0
Cokeskolen (cokeovens)	Coking Coal (used in coke oven)	kg	28.7	95.4
Cokeskolen (basismetaal)	Coking Coal (used in blast furnaces)	kg	28.7	89.8
(Overige bitumineuze) steenkool	Other Bituminous Coal	kg	24.5	94.7
Sub-bitumineuze kool	Sub-bituminous Coal	kg	20.7	96.1
Bruinkool	Lignite	kg	20.0	101.2
Bitumineuze leisteen	Oil Shale	kg	9.4	106.7
Turf	Peat	kg	10.8	106.0
	Solid Fossil, Secondary Fuels			
Steenkool- en bruinkoolbriketten	BKB & Patent Fuel	kg	23.5	94.6
Cokesoven/ gascokes	Coke Oven/Gas Coke	kg	28.5	111.9
Cokesovengas	Coke Oven gas	MJ	1.0	41.2
Hoogovengas	Blast Furnace Gas	MJ	1.0	247.4
Oxystaalovengas	Oxygen Furnace Gas	MJ	1.0	191.9
Fosforovengas	Phosphorus Furnace Gas	Nm^3	11.6	149.5
	C. Gaseous Fossil Fuels			
Aardgas	Natural Gas (dry)	Nm^3 ae	31.65	56.8
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	Nm^3	21.8	90.8
RWZI biogas	Wastewater biogas	Nm^3	23.3	84.2
Stortgas	Landfill gas	Nm^3	19.5	100.7
Industrieel fermentatiegas	Industrial organic waste gas	Nm^3	23.3	84.2
	D. Other fuels			
Afval (niet biogeen)	Waste (not biogenic)	kg	34.4	73.6

* biomass: the value of the CO_2 emission factor is shown as a memo item in reports for the climate agreement; the value is zero for emissions trading and for the Kyoto Protocol.

Table A2.2 Comparison of emission factors in the allocation of CO_2 emission rights with the National list

Energy carrier	Unit	Allocation		National list	
		Heating value (GJ/unit)	CO_2 emission factor (kg/GJ)	Heating value (GJ/unit)	CO_2 emission factor (kg/GJ)
LPG	ton	46.00	63.00	45.2	66.7 [1)]
Heavy oil	ton	41.00	77.30	41.0	77.4 [2)]
Light oil	ton	42.50	73.00	42.7	74.3 [1)]
Coal	ton	29.30	94.50	24.5	94.7 [3)]

1) Country-specific factor (Olivier, 2004)
2) IPCC default value
3) Country-specific factor (TNO, 2002)

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.

(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.

A2.6 Defining and maintaining the Netherlands list

The Ministry of VROM (Spatial Planning, Housing and the Environment) initiated the compilation of the Netherlands list, as it is responsible for the national monitoring of greenhouse gas emissions under the UNFCCC framework. This list has been prepared in consultation with those national institutes that are involved in the national monitoring activities, i.e. MNP, 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. This annex was updated in November 2005 with some editorial changes. This annex as well as the Netherlands' list is updated in 2006 based on research for methods to determine the CO_2 emission factor for natural gas in the Netherlands.

A2.7 Application of the Netherlands standard and source-specific CO_2 emission factors in the national emission inventory

For the mostly used fuels (natural gas, coal, coal products, diesel, petrol) country-specific standard CO_2 emission factors are used; otherwise default IPCC emission factors are used (see Table A2.1). However, for some of the derived fuels the chemical composition and thus the CO_2 emission factor is highly variable between source categories and over time.

Thus, for blast furnace gas and oxygen furnace gas, refinery gas, chemical waste gas (separately from liquids and from solids) and solid waste (separately the biogenic and fossil carbon part) mostly source-specific (or plant-specific) emission factors have been used, that may also change over time. In addition, for raw natural gas combustion by the oil and gas production industry a source-specific (or company-specific) CO_2 emission factor is used. This refers to the so-called 'own use' of unprocessed natural gas used by the gas and oil production industry, of which the composition may differ significantly from that of treated standard natural gas supplied to end users. These emission factors are based on data submitted by industries in their Annual Environmental Report (MJV). These fuels are used in the subcategories 'Public electricity and heat production' (1A1a), 'Refineries' (1A1b) and 'Other energy industries' included in 1A1c (see Table A2.3).

Fossil-based CO_2 emissions from waste incineration are calculated from the total amount of waste that is incinerated, per waste stream split into six waste types, each with a specific carbon content and fraction of fossil carbon in total carbon (see section 8.4.2 for more details).

More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see Annex 6).

A2.8 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	Netherlands Statistics (CBS):	Fuels in questionnaire form for crude oil statistics: 10+11+14 Fuels in NEH under table numbers 4.3.6; 4.3.9
	ER/TNO	
	MJA	
	CO_2 trade	
	EMJV	Petrol/motorbenzine
Names used in previous lists	ER/TNO	Petrol
	MJA	Petrol
	Benchmark	
	Kg	
Unit		

Specific values and substantiation

Heating value (MJ/[unit])	44.0
Substantiation of heating value	NEH
Carbon content (ton C/TJ)	19.6
Substantiation of carbon content	Calculated based on the C-content % mass and energy conversion factor
CO_2 emissions factor (ton **CO_2**/TJ)	72.0
CEF IPCC default	*69.3*
Substantiation of CO_2 emissions factor	The Netherlands deviates here from the IPCC default. The basis for this is the report 'Netherlands' CO_2 emission factors for petrol, diesel and LPG' MNP Memorandum on the Netherlands CO_2 emission factors, Olivier (2004). At the request of the Ministry of VROM, in 2004 ITS Caleb Brett 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

- A detailed description of methodologies per source/ sink category can be found in protocols on the website www.greenhousegases.nl, including country-specific emission factors;
- Annex 6 provides an overview of the available monitoring protocols at this site.

Annex 4 CO_2 Reference Approach and comparison with Sectoral Approach

A4.1 Comparison of CO_2 emissions

The IPCC Reference Approach (RA) for CO_2 from energy use uses apparent consumption data per fuel type to estimate CO_2 emissions from fossil fuel use. This has been used as a means of verifying the sectoral total CO_2 emissions from fuel combustion (IPCC, 2001). For the Reference Approach energy statistics (production, imports, export, stock changes) were provided by Statistics Netherlands (CBS); national default, partly country-specific, CO_2 emission factors (see Annex 2.1, Tables A2.1 and A2.2) and constant carbon storage fractions based on the average of annual carbon storage fractions calculated per fossil fuel type for 1995-2002 from reported CO_2 emissions in the sectoral approach. Also, bunker fuels were corrected for the modification made to include fisheries, internal navigation 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 1990-2006 and compared with the official national total emissions reported as fuel combustion (source category 1A). The annual difference calculated from the direct comparison varies between 4.5% for 1991 and 1992; and 0.6% for 2006. 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	2005	2006
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	53.8	56.5	54.9	55.2	54.6
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	32.2	30.2
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	83.5	85.3	81.8	79.6
Others	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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	169.7	174.1	173.7	169.2	164.4
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	55.6	55.1	57.3	56.8	56.5	56.3
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	30.1	28.1
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	78.5	77.0
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	2.1	2.1
Total NA	150.0	155.0	153.7	158.4	157.6	161.5	169.3	162.2	164.7	159.3	161.4	167.6	167.3	171.1	172.5	167.3	163.5
Difference [3] (%)																	
Liquid fuels	-0.2%	1.5%	2.0%	-0.6%	0.2%	-1.7%	-0.7%	-1.1%	-2.9%	-2.6%	-1.1%	-1.7%	-2.4%	-1.5%	-3.3%	-2,4%	-3.0%
Solid fuels	9.8%	11.0%	9.3%	8.1%	8.8%	7.2%	8.0%	8.7%	6.6%	7.0%	6.1%	4.5%	5.8%	7.1%	5.9%	6.9%	7.6%
Gaseous fuels	4.8%	4.9%	5.1%	4.8%	5.3%	5.2%	4.6%	5.2%	5.3%	5.2%	5.5%	4.6%	4.4%	4.1%	4.0%	4.2%	3.4%
Other	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Total	**3.8%**	**4.5%**	**4.5%**	**3.2%**	**3.8%**	**2.8%**	**2.9%**	**3.0%**	**2.0%**	**1.9%**	**2.4%**	**1.6%**	**1.4%**	**1.7%**	**0.7%**	**1.2%**	**0.6%**

1) Specification of national fuel types used in the IPCC fuel type categories:
Gasoline: jetfuel, gasoline basis; aviation gasoline; motor gasoline; *Other Kerosene*: petroleum; Other Oil: oil aromates; other light oils; other oil products; *Other Bituminous Coal*: all hard coal; lignite/brown coal; *BKB and Patent Fuel*: coal derivatives.

2) Fossil-fuel component of waste combustion in waste incineration that also produce heat and electricity for energy purposes. Last year accidentally the figures included the CO**2** from the organic carbon in the waste.

3) Defined as: (RA-NA)/NA.

The Reference Approach (RA) and National Approach (NA) data show a 10% RA vs. 13% NA increase in emissions from liquid fuels (1990-2006) and a 10.7% RA vs. 12.2% NA increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period by 11% in the RA vs. an decrease of 9% 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 2006. However, as will be discussed below, these numbers cannot be compared well since the RA includes sources not in included in the NA and vice versa. Therefore, a corrected comparison will be made below.

A4.2 Causes of differences between the two approaches

There are five main reasons for differences in the two approaches, of which two are *inherent to the comparison method* itself (see Table A4.2):

1. The CO_2 from *incineration of waste* that contains fossil carbon (reported under 6C or 1A1a) is not included in the Reference Approach;
2. The fossil-fuel related emissions reported as *process emissions (*sector 2) and *fugitive emissions* (sector 1B), which are not included in the Sectoral Approach total of sector 1A. The most significant are gas used as feedstock in ammonia production (2B1) and losses from coke/coal inputs in blast furnaces (2C1);

and others are *country-specific*:

3. In addition, the country-specific *carbon storage factors* used in the Reference Approach are multi-annual averages, so the RA calculation for a specific year will deviate somewhat from the factors that could be calculated from the specific mix of feedstock/non-energy uses of different fuels;
4. The use of *plant-specific emission factors* in the NA vs. national defaults in the RA;
5. Other differences could – in principle – be due to the presence of *statistical differences* between apparent consumption and total sectoral fuel use and/or to differences between total sectoral fuel use as used in the emission inventory and as included in the national energy statistics in cases where *plant-specific fuel use data* have been used.

However, the latter is not applicable to the Netherlands: the national statistics are compiled in such a way that no statistical difference occurs (initial differences are removed by shifting to the most uncertain fuel entry). Moreover, the calculations are all based on the official sectoral energy statistics from Statistics Netherlands (CBS), which guarantees that the activity data in the inventory are identical to the national energy statistics.

Correction of inherent differences

The correction terms for the RA/NA total are for the Netherlands:

- waste incineration (in the Netherlands included in 1A1a, as 'other fuels');
- selected CRF sector 2 components listed in Table A4.2 and selected fugitive CO_2 emissions included in CRF sector 1B.

If the RA is corrected by including the fossil waste and the NA by including selected sector 1B and sector 2 emissions that should be added to the 1A total before the comparison is made (see Table A4.2), then a much smaller difference remains between the approaches. Remaining differences are generally below ±1%: between +0.6% in 2003 and -2.1% in 2006, with a direct average of (-0.7±0.3) % vs. (2.5±0.6) % in the uncorrected comparison.

The corrected RA and NA comparison per fuel type is presented in Table A4.3. This shows that the largest differences do not concentrate in a particular corner of the period. The corrected

1990-2006 trends also differ only slightly: 10.6% for the corrected National Approach (NA) (= sum of sectoral emissions in source category 1A plus selected 1B and 2 minus fossil waste) and 9.6 for the corrected Reference Approach. We conclude that in total annual emissions the remaining differences are now all between about -1.5% and +0.5%, except for 2006 which shows a -2.1% difference.

The corrected approaches show differences in emissions from liquid fuels up to -5% for a single year vs. -3% for uncorrected comparisons; for solid fuels differences are up to 2% vs. 11% and for gaseous fuels -1% vs. +5%, respectively, if corrections are made for 2G (non energy uses of lubricants and waxes) in NA-liquids, 1B (coke production), 2A ('Soda Ash'), 2B5, 2C1 (blast furnaces) and 2D in NA-solids; and 1B2 (gas flaring, refineries) and 2B1 (ammonia) in NA-gases (Table A4.2). Remaining differences must be due to the use of one multi-annual average carbon storage factor per fuel type for all years (see section A4.3) and plant-specific emission factors in some cases as discussed in section A4.4 (for more details see Annex 2, Table A2.2).

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	2005	2006
Difference RA-NA	5.7	7.0	6.9	5.0	6.1	4.5	4.9	4.9	3.2	3.0	3.9	2.6	2.4	3.0	1.2	1.9	0.9
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	169.7	174.1	173.7	169.2	164.4
Other: fossil waste cf. NA	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	2.1	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	171.2	175.9	175.7	171.3	166.6
Diff. RAincl.Waste-NA:	5.1	6.4	6.3	4.3	5.4	3.7	3.9	3.6	1.9	1.5	2.4	1.1	0.8	1.2	-0.9	-0.2	-1.2
National Approach:	150.0	155.0	153.7	158.4	157.6	161.5	169.3	162.2	164.7	159.3	161.4	167.6	167.3	171.1	172.5	167.3	163,5
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	0.5	0.4
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	0.1	0.1
1B2a-iv Oil refining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9
CO_2 fossil in sector 2:	6.2	6.2	5.7	5.5	6.0	6.0	5.5	6.0	5.7	5.6	5.4	4.8	4.8	4.9	4.9	4.9	5.1
A. Mineral Products																	
Soda Ash Production	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
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	3.1	3.1
5. Other, excl. act. carbon	0.6	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
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	0.8	1.1
D. Other Production																	
2. 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	0.0	0.0
G. Other (please specify)																	
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	0.2	0.2	0.2
Not in NA-1A:	7.0	7.0	6.6	6.3	6.8	6.8	6.3	6.8	6.3	6.1	6.0	5.3	6.2	6.4	6.4	6.4	6.6
NA+1B+Ind. Proc.	157.0	162.0	160.3	164.7	164.4	168.3	175.6	169.0	171.0	165.5	167.4	172.9	173.5	177.5	178.8	173.7	170.1
RA+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	171.2	175.9	175.7	171.3	166.6
New difference (abs)	-0.8	0.5	0.9	-0.5	-0.1	-1.5	-0.3	-0.6	-1.7	-1.7	-0.6	-1.2	-2.3	-1.6	-3.1	-2.4	-3.5
New difference (%)	0.5%	0.3%	0.1%	0.9%	0.2%	0.4%	1.0%	1.0%	0.4%	0.7%	1.3%	0.9%	1.7%	1.4%	2.1%	0.3%	0.6%

** Comprises lubricants and waxes.

Table A.4.3 Comparison of CO_2 emissions: differences between *corrected* Reference Approach (RA) versus *corrected* National Approach [(RA-NA)/NA)] (in %)

Fuel type *	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Liquids	0.6%	1.0%	1.5%	-1.0%	0.3%	-2.1%	-1.1%	-1.4%	-3.2%	-2.9%	-1.4%	-2.0%	-4.3%	-3.3%	-5.0%	-4.4%	-5.0%
Solids	0.8%	1.3%	1.8%	1.1%	0.9%	-0.2%	1.0%	0.9%	0.4%	0.3%	0.5%	-0.4%	0.6%	1.4%	0.9%	2.2%	1.7%
Gas	-1.0%	-0.3%	-0.4%	-0.4%	-0.3%	-0.3%	0.0%	0.2%	-0.1%	-0.1%	0.1%	0.2%	0.0%	-0.2%	-0.5%	-0.5%	1.4%
Total (incl. waste)	-0.5%	0.3%	0.6%	-0.3%	-0.1%	-0.9%	-0.2%	-0.4%	-1.0%	-1.0%	-0.4%	-0.7%	-1.3%	-0.9%	-1.7%	-1.4%	-2.1%

* Liquids incl. 2G; Solids incl. 1B1,2A,2B5,2C1,2D; Gaseous incl. 1B2, 2B1; Total incl. fossil waste.

A4.3 Other country-specific data used in the Reference Approach

Apart from different *storage fractions* of non-energy use of fuels as presented in Table A4.5 other country-specific information used in the RA is found in:

carbon contents (i.e. CO_2 emission factors) used
For the fuels used in the Reference Approach the factors used are listed in Table A.2.1. These are the national defaults. For 'other bituminous coal' and 'BKB & Patent fuel' the values are used of bituminous coal and coal bitumen respectively;

fuel consumption in international marine and aviation bunkers
Some changes were made in the national energy statistics of total apparent consumption, mainly for diesel, jet kerosene and residual fuel oil, due the reallocation for the emissions inventory of part of the bunker fuels to domestic consumption (e.g fisheries and inland naviation). This explains the difference between the original bunker statistics in the national energy statistics (and as reported to international agencies such as the IEA) and the bunker fuel data used in the Reference Approach calculation.

A4.4 Feedstock component in the CO_2 Reference Approach

Feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for CO_2 from fossil fuel use. The fraction of carbon not oxidised during the use of these fuels during product manufacture or other uses is subtracted from total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidised have been calculated as three average values, one for gas, liquid and solid fossil fuels:

- 77.7±2 % for liquid fuels;
- 55.5±13 % for solid fuels;
- 38.8±4 % for natural gas.

These were calculated from all processes for which emissions are calculated in the NA, either by assuming a fraction oxidised, e.g. ammonia, or by accounting for by-product gases (excluding emissions from blast furnaces and coke ovens). (In Table A.4.4 of the NIR 2005 the calculation of annual oxidation fractions for 1995-2002 are presented and the average values derived from them.) It shows indeed that the factors show significant interannual variation, in particular for solid fuels.

The use of one average oxidation factor per fuel type for all years, whereas in the derivation of the annual oxidation figures differences up to a few per cent points can be observed, are one reason for differences between the RA and the corrected NA.

In Table A.4.4 the total CO_2 calculated as emitted from the oxidation of the non-energy uses in the Reference Approach are presented per fuel type. According to the Reference Approach dataset, the CO_2 emissions of this group of sources increased by about 28% or 2.5 Tg CO_2 (from 8.9 to 11.4 Tg CO_2), of which most are due to changes in emissions from liquid fuels (Table 3.34). In Table A.4.6 and A4.5 the carbon storage in the RA calculation is shown. Its shows, that in the Netherlands about 25 to 55 Tg CO_2 or about 15 to 30% of all carbon in the apparent consumption of fossil fuels is stored.

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	...	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Trend
Liquids [1)2)]	5.0		5.2	4.9	5.1	5.0	5.6	6.1	6.6	6.8	7.8	7.9	8.8	8.1	3.1
Solids [3)]	0.4		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	-0.1
Gaseous	3.5		3.8	3.7	3.9	3.7	3.7	3.9	3.5	3.4	3.2	3.4	3.5	3.0	-0.5
Total	**8.9**		**9.4**	**9.0**	**9.5**	**9.2**	**9.8**	**10.4**	**10.5**	**10.6**	**11.4**	**11.7**	**12.7**	11.4	2.5
As % of RA	5.7%		5.7%	5.1%	5.7%	5.5%	6.0%	6.3%	6.2%	6.3%	6.6%	6.8%	6.9%	6.9%	

1) Using country-specific carbon Oxidation Factors (multi-year average, fuel type averaged).
2) Excluding refineries.
3) Coal oils and tars (from coking coal), coke and other bituminous coal only; excluding emissions from blast furnaces and coke ovens.

Table A4.5 Carbon storage in the IPCC Reference Approach for CO_2 from fossil fuel use (in Tg CO_2)

Fuel type	1990	...	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Trend
Liquids	20.5		22.4	21.1	22.0	24.8	29.4	35.3	38.3	40.7	42.9	44.1	52.1	49.4	28.9
Solids	0.6		0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.4	-0.2
Gaseous	2.2		2.4	2.3	2.5	2.4	2.4	2.5	2.2	2.1	2.0	2.1	2.2	1.9	-0.3
Total	**23.3**		**25.3**	**24.0**	**25.1**	**27.9**	**32.4**	**38.3**	**41.1**	**43.4**	**45.5**	**46.8**	**54.9**	**51.8**	28.5
% gross RA[1)]	15%		15%	14%	15%	17%	20%	23%	24%	26%	26%	27%	31%		

1) Expressed as part of total carbon in apparent consumption of fossil fuels (without subtracting the stored part).

Annex 5 Assessment of completeness and (potential) sources and sinks

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 Enteric fermentation 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.
- Based on recommendations by the ERT, completeness will be re-evaluated in the next few years.

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:

Table A6.1 Methodological description (monitoring protocols 2008, from 15 April 2008 available at the website)

Protocol	IPCC-code	Description	Gas(es)
8100	All	Reference approach	CO_2
8101	1A1 1A2 1A4	Stationary combustion (fossil) *	CO_2 N_2O CH_4
8102	1A1b 1B1b 1B2aiv 2A4i 2B1 2B4i 2B5i 2B5vii 2B5viii 2C1vi 2D2 2Giv	Process emissions (fossil)	CO_2 N_2O CH_4
8103	1A2f 1A4c	Mobile equipment	CO_2 N_2O CH_4
8104	1A3a	Inland aviation	CO_2 N_2O CH_4
8105	1A3b	Road transport	CO_2
8106	1A3b	Road transport	N_2O
8107	1A3b	Road transport	CH_4
8108	1A3c	Rail transport	CO_2 N_2O CH_4
8109	1A3d	Inland navigation	CO_2 N_2O CH_4
8110	1A4c	Fisheries	CO_2 N_2O CH_4
8111	1A5	Defence	CO_2 N_2O CH_4
8112	1B2	Oil & gas production	CO_2 CH_4
8113	1B2	Oil & gas distribution/transport	CO_2 CH_4
8114	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
8115	2B2	Nitric acid	N_2O
8116	2B5	Caprolactam	N_2O
8117	2C3	Aluminium production	PFC
8118	2E1	HCFK-22 production	HFC
8119	2E3	HFC by-product emissions	HFC
8120	2F1	Stationary refrigeration	HFC
8121	2F1	Mobile refrigeration	HFC
8122	2F2	Hard foams	HFC
8123	2F4	Aerosols	HFC
8124	2F8	Sound proof windows	SF_6
8125	2F8	Semi-conductors	SF_6 PFC
8126	2F8	Electrical equipment	SF_6
8127, 8128	4A	Enteric fermentation,	CH_4
8129	4B	Manure management	N_2O
8130	4B	Manure management	CH_4
8131	4D	Agricultural soils, indirect	N_2O
8132	4D	Agricultural soils, direct	N_2O
8133	5A	Forest	CO_2
8134	5D-5G	Soil	CO_2
8135	6A1	Waste disposal	CH_4
8136	6B	Waste water treatment	CH_4 N_2O
8137	6D	Large-scale composting	CH_4 N_2O
In addition to the emissions described in the protocols, two memo items are included in the National System			
8139	1A, (CO_2 memo item)	Biomass	CO_2 CH_4 N_2O
8138	Memo item	International bunker emissions	CO_2 N_2O CH_4

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, 2008: Estimate of annual and trend uncertainty for Dutch sources of greenhouse gas emissions using the IPCC Tier 1 approach. MNP, 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

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.
- Hoek, K. W. van der and M. W. van Schijndel, 2005: Methane and nitrous oxide emissions from animal manure management, including an overview of emissions 1990-2003. Background document for the Dutch National Inventory Report. RIVM report 680.125.002, Bilthoven.
- Hoek, K.W. van der, M.W. van Schijndel, P.J. Kuikman, 2006. Direct and indirect nitrous oxide emissions from agricultural soils, 1990 - 2003. Background document on the calculation method for the Dutch National Inventory Report. RIVM Report No. 68012.003./2007 MNP Report No. 500080003/2007 Bilthoven, the Netherlands.
- Nabuurs, G.J., I.J. van den Wyngaert, W.D. Daamen, A.T.F. Helmink, W de Groot, W.C. Knol, H. Kramer, P Kuikman, 2005: National System of Greenhouse Gas Reporting for Forest and Nature Areas under UNFCCC in the Netherlands - version 1.0 for 1990–2002. Alterra, Wageningen. Alterra rapport 1035-I.
- Peek, K., 2008. Greenhouse gas emissions; temperature correction and national categories. MNP, Bilthoven. In prep.

A6.3 Documentation of Quality Assurance and Quality Control for national greenhouse gas inventory compilation and reporting

- DHV, 2002: Quality Assurance and Quality Control for the Dutch National Inventory Report; report on phase 1, January 2002, report no. ML-BB-20010367. DHV, Amersfoort.
- Ruyssenaars, 2005: Werkplan Emissie Registratie 2007 – 2008. MNP, Bilthoven, 2007.
- Coenen, P.W.H.G., Memorandum on recalculations as presented in the CRF submission 2006. TNO, Apeldoorn.
- SenterNovem, the Netherlands National System:QA/QC programme 2007/2008 Version 3.0 Autumn 2007.

Annex 7 Tables 6.1 and 6.2 of the IPCC Good Practice guidance

As described in section 1.7, a Tier 1 uncertainty assessment was made to estimate the uncertainty in total national greenhouse gas emissions and in their trend. Tier 1 here means that non-Gaussian uncertainty distributions and correlations between sources have been neglected[1)]. The uncertainty estimates for activity data and emission factors as listed in *Table A7.2.* were also used for a Tier 1-trend uncertainty assessment as 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 3% decrease
CO_2	±3%	±3%-points of 8% increase
CH_4	±25%	±10%-points of 36% decrease
N_2O	±50%	±16%-points of 15% decrease
F-gases	±50%	±8%-points of 75% decrease

Details on this calculation can be found in Table A7.2 and in Olivier (2008). 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.

1) We note that a Tier 2 uncertainty assessment and a comparison with a Tier 1 uncertainty estimate based on similar data showed that in the Dutch circumstances the errors made in the simplified Tier 1 approach for estimating uncertainties are quite small (Olsthoorn and Pielaat, 2003 and Ramírez-Ramírez et al., 2006). This conclusion holds for both annual uncertainties and the trend uncertainty (see section 1.7 for more details).

Table A7.2 Tier 1 level and trend uncertainty assessment 1990-2006 (for F-gases with base year 1995) with the categories of the IPCC potential key source list (without adjustment for correlation sources)

IPCC	Category	Gas	CO2-eq base year	CO2-eq last year	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensi-tivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty 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	CO_2	207	734	1	10	10	0.0	0.3	0	0.0	0.0	0.0
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	25776	23617	1	3	3	0.4	-0.7	11	0.0	0.2	0.2
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	13348	22846	1	1	1	0.1	4.6	11	0.0	0.1	0.1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	592	2115	10	5	11	0.1	0.7	1	0.0	0.1	0.1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	9999	8959	10	10	14	0.6	-0.4	4	0.0	0.6	0.6
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	1042	2646	1	1.00	1	0.0	0.8	1	0.0	0.0	0.0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	0	20	2	20	0.0	0.0	0	0.0	0.0	0.0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	1927	20	5	21	0.2	0.2	1	0.0	0.3	0.3
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	8993	8392	1	5	5	0.2	-0.2	4	0.0	0.1	0.1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	5033	4451	2	10	10	0.2	-0.2	2	0.0	0.1	0.1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	19020	14644	2	1	2	0.2	-1.8	7	0.0	0.2	0.2
1A4	Stationary combustion: Other Sectors, solids	CO_2	189	41	50	5	50	0.0	-0.1	0	0.0	0.0	0.0
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	6634	10309	20	1	20	1.0	1.8	5	0.0	1.4	1.4
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	18696	17123	5	1	5	0.4	-0.5	8	0.0	0.6	0.6
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	8328	7469	10	1	10	0.4	-0.3	4	0.0	0.5	0.5
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2544	2556	20	2	20	0.2	0.0	1	0.0	0.3	0.3
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	1476	577	20	2	20	0.1	-0.4	0	0.0	0.1	0.1
1A5	Military use of fuels (1A5 Other)	CO_2	566	381	20	2	20	0.0	-0.1	0	0.0	0.1	0.1
1A	Emissions from stationary combustion: non-CO_2	CH_4	522	547	3	50	50	0.1	0.0	0	0.0	0.0	0.0
1A	Emissions from stationary combustion: non-CO_2	N_2O	226	308	3	50	50	0.1	0.0	0	0.0	0.0	0.0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10902	13206	2	0	2	0.1	1.2	6	0.0	0.2	0.2
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11832	20696	5	0	5	0.5	4.3	10	0.0	0.7	0.7
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2738	977	10	0	10	0.0	-0.8	0	0.0	0.1	0.1
1A3	Mobile combustion: water-borne navigation	CO_2	405	626	20	0	20	0.1	0.1	0	0.0	0.1	0.1
1A3	Mobile combustion: aircraft	CO_2	41	41	50	1	50	0.0	0.0	0	0.0	0.0	0.0
1A3	Mobile combustion: other (railways)	CO_2	91	97	5	0	5	0.0	0.0	0	0.0	0.0	0.0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	50	100	112	0.0	0.0	0	0.0	0.0	0.0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	50	100	112	0.0	0.0	0	0.0	0.0	0.0
1A3	Mobile combustion: road vehicles	CH_4	157	49	3	60	60	0.0	0.0	0	0.0	0.0	0.0
1A3	Mobile combustion: road vehicles	N_2O	271	451	5	50	50	0.1	0.1	0	0.0	0.0	0.0
1B2	Fugitive emissions venting/flaring	CH_4	1252	291	2	25	25	0.0	-0.4	0	-0.1	0.0	0.1
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	274	2	25	25	0.0	0.0	0	0.0	0.0	0.0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	162	143	20	50	54	0.0	0.0	0	0.0	0.0	0.0
1B1b	CO_2 from coke production	CO_2	403	449	50	2	50	0.1	0.0	0	0.0	0.1	0.1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	138	50	2	50	0.0	-0.3	0	0.0	0.0	0.0
2A1	Cement production	CO_2	416	400	5	10	11	0.0	0.0	0	0.0	0.0	0.0
2A3	Limestone and dolomite use	CO_2	276	299	25	5	25	0.0	0.0	0	0.0	0.0	0.0
2A7	Other minerals	CO_2	275	474	25	5	25	0.1	0.1	0	0.0	0.1	0.1
2B1	Ammonia production	CO_2	3096	3071	2	1	2	0.0	0.0	1	0.0	0.0	0.0
2B2	Nitric acid production	N_2O	6330	5597	10	20	22	0.6	-0.3	3	-0.1	0.4	0.4
2B5	Caprolactam production	N_2O	766	662	20	20	28	0.1	0.0	0	0.0	0.1	0.1

IPCC	Category	Gas	CO2-eq base year	CO2-eq last year	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensi-tivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
					%	%	%	%	%	%	%	%	%
2B5	Other chemical product manufacture	CO_2	606	646	50	50	71	0.2	0.0	0	0.0	0.2	0.2
2C1	Iron and steel production (carbon inputs)	CO_2	2514	1410	3	5	6	0.0	-0.5	1	0.0	0.0	0.0
2C3	CO_2 from aluminium production	CO_2	395	414	2	5	5	0.0	0.0	0	0.0	0.0	0.0
2C3	PFC from aluminium production	PFC	1901	62	2	20	20	0.0	-0.8	0	-0.2	0.0	0.2
2F	SF_6 emissions from SF6 use	SF_6	301	215	50	25	56	0.1	0.0	0	0.0	0.1	0.1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	249	1231	10	50	51	0.3	0.5	1	0.2	0.1	0.2
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	281	10	10	14	0.0	-2.5	0	-0.3	0.0	0.3
2E	HFC by-product emissions from HFC manufacture	HFC	12	48	10	20	22	0.0	0.0	0	0.0	0.0	0.0
2F	PFC emissions from PFC use	PFC	37	194	5	25	25	0.0	0.1	0	0.0	0.0	0.0
2G	Other industrial: CO_2	CO_2	305	352	5	20	21	0.0	0.0	0	0.0	0.0	0.0
2G	Other industrial: CH_4	CH_4	297	297	10	50	51	0.1	0.0	0	0.0	0.0	0.0
2G	Other industrial: N_2O	N_2O	3	7	50	50	71	0.0	0.0	0	0.0	0.0	0.0
2G	Indirect N_2O from NH_3 from combustion and industrial processes	N_2O	0	0	50	200	206	0.0	0.0	0	0.0	0.0	0.0
2G	Indirect N_2O from NO_2 from combustion and industrial processes	N_2O	0	0	15	200	201	0.0	0.0	0	0.0	0.0	0.0
2G	Indirect CO_2 from solvents/product use	CO_2	316	135	25	10	27	0.0	-0.1	0	0.0	0.0	0.0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: cattle	CH_4	6769	5641	5	15	16	0.4	-0.4	3	-0.1	0.2	0.2
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	358	5	50	50	0.1	0.0	0	0.0	0.0	0.0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	319	312	5	30	30	0.0	0.0	0	0.0	0.0	0.0
4B	Emissions from manure management	N_2O	813	852	10	100	100	0.4	0.0	0	0.0	0.1	0.1
4B1	Emissions from manure management: cattle	CH_4	1571	1453	10	100	100	0.7	0.0	1	0.0	0.1	0.1
4B8	Emissions from manure management: swine	CH_4	1140	927	10	100	100	0.4	-0.1	0	-0.1	0.1	0.1
4B9	Emissions from manure management: poultry	CH_4	242	62	10	100	100	0.0	-0.1	0	-0.1	0.0	0.1
4B	Emissions from manure management: other	CH_4	12	17	10	100	100	0.0	0.0	0	0.0	0.0	0.0
4D1	Direct N_2O emissions from agricultural soils	N_2O	4600	4801	10	60	61	1.4	0.2	2	0.1	0.3	0.3
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	4863	3146	50	200	206	3.1	-0.7	1	-1.5	1.0	1.8
4D2	Animal production on agricultural soils	N_2O	1307	611	10	100	100	0.3	-0.3	0	-0.3	0.0	0.3
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	5646	30	15	34	0.9	-2.8	3	-0.4	1.1	1.2
6B	Emissions from wastewater handling	CH_4	290	201	20	25	32	0.0	0.0	0	0.0	0.0	0.0
6B	Emissions from wastewater handling	N_2O	513	381	20	50	54	0.1	-0.1	0	0.0	0.1	0.1
6D	OTHER CH_4	CH_4	1	66	20	25	32	0.0	0.0	0	0.0	0.0	0.0
6D	OTHER N_2O	N_2O	250	126	20	50	54	0.0	-0.1	0	0.0	0.0	0.0
			212995	**207477**				**4.1**					**3.0**

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	CO_2-eq. 1990	CO_2-eq. 2005	AD uncertainty	EF uncertainty	EM uncertainty estimate
5A1	Forest Land remaining Forest Land	CO_2	-2.505	-2.289	25,0%	61,8%	67%
5A2	Land converted to Forest Land	CO_2	-13	-220	25,0%	57,9%	63%
5B2	Land converted to Cropland	CO_2	-36	-36	25,0%	50,0%	56%
5C1	Grassland remaining Grassland	CO_2	4.246	4.246	25,0%	50,0%	56%
5C2	Land converted to Grassland	CO_2	194	194	25,0%	61,2%	66%
5E2	Land converted to Settlements	CO_2	-152	-152	25,0%	50,0%	56%
5F2	Land converted to Other Land	CO_2	750	750	25,0%	50,0%	56%
5G	Other (liming of soils)	CO_2	183	81	25,0%	1,0%	25%
5A1	Forest Land remaining Forest Land	N_2O	0	0	25,0%	20,0%	32%

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 2005

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	**162,023.13**	**1,211.32**	**64.33**	**NA,NE,NO**	**4,432.03**	**C,NA,NE,NO**	**2,264.48**	**C,NA,NE,NO**	**0.01**	**544.66**	**1,066.83**	**455.55**	**190.00**
1. Energy	**151,157.72**	**111.84**	**1.61**							**528.74**	**935.70**	**242.10**	**178.78**
A. Fuel Combustion — Reference Approach [2]	155,641.19												
A. Fuel Combustion — Sectoral Approach [2]	149,980.32	32.36	1.61							528.61	934.12	194.79	171.25
1. Energy Industries	52,492.33	3.40	0.45							105.18	11.74	2.58	105.84
2. Manufacturing Industries and Construction	33,045.44	2.70	0.11							88.55	153.67	8.98	45.90
3. Transport	26,009.02	7.51	0.88							250.68	683.26	166.35	13.18
4. Other Sectors	37,867.81	18.70	0.14							76.48	85.46	16.87	6.33
5. Other	565.72	0.05	0.03							7.73	IE	IE	IE
B. Fugitive Emissions from Fuels	1,177.40	79.48	0.00							0.13	1.58	47.31	7.52
1. Solid Fuels	402.67	1.44	NA,NO							IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NO
2. Oil and Natural Gas	774.73	78.04	0.00							0.13	1.58	47.31	7.52
2. Industrial Processes	**7,881.68**	**14.13**	**22.90**	**NA,NE,NO**	**4,432.03**	**C,NA,NE,NO**	**2,264.48**	**C,NA,NE,NO**	**0.01**	**12.01**	**129.20**	**82.79**	**7.06**
A. Mineral Products	966.78	NO	NO							1.28	3.51	1.03	6.29
B. Chemical Industry	3,701.53	12.13	22.89	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	3.52	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	0.01	NA,NO	NO	NA,NO	NO	NO	NO	1.50	6.91	34.37	0.77

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**	**128.93**	**NO**
4. Agriculture		**499.57**	**37.44**							**NA,NO**	**NA,NO**	**0.16**	**NO**
A. Enteric Fermentation		358.36											
B. Manure Management		141.21	2.62									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils [4]		NE,NO	34.82									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] **2,667.30**	**NA,NE,NO**	**NA,NE,NO**							**IE,NE**	**IE,NE**	**NE**	**NE**
A. Forest Land	[5] -2,518.38	NE,NO	NE,NO							IE,NE	IE,NE	NE	
B. Cropland	[5] -35.57	NA,NE	NA,NE							NE	NE	NE	
C. Grassland	[5] 4,439.99	NE	NE							NE	NE	NE	
D. Wetlands	[5] NE	NE	NE							NE	NE	NE	
E. Settlements	[5] -151.54	NE	NE							NE	NE	NE	
F. Other Land	[5] 749.65	NE	NE							NE	NE	NE	
G. Other	[5] 183.15	NE	NE							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	[6] NA,NO	571.93								NA,NO	NA,NO	1.45	
B. Waste-water Handling		13.79	1.66							NO	NO	NO	
C. Waste Incineration	[6] 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

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	**173,104.71**	**1,132.08**	**68.74**	**882.40**	**6,019.54**	**C,NA,NE,NO**	**1,937.82**	**C,NA,NE,NO**	**0.01**	**448.90**	**803.66**	**316.25**	**127.80**
1. Energy	**162,480.50**	**110.23**	**2.34**							**440.13**	**736.72**	**161.69**	**124.49**
A. Fuel Combustion — Reference Approach[2]	166,049.92												
A. Fuel Combustion — Sectoral Approach[2]	161,522.34	31.11	2.34							439.60	734.14	128.40	114.30
1. Energy Industries	61,513.04	4.29	0.54							83.70	11.05	3.90	68.89
2. Manufacturing Industries and Construction	28,155.34	2.31	0.07							61.73	155.81	5.48	27.74
3. Transport	29,176.36	4.71	1.56							196.51	485.85	103.34	12.63
4. Other Sectors	42,165.50	19.75	0.14							90.51	81.43	15.68	5.04
5. Other	512.10	0.05	0.03							7.16	IE	IE	IE
B. Fugitive Emissions from Fuels	958.16	79.12	IE,NA,NO							0.53	2.59	33.28	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	33.28	10.19
2. Industrial Processes	**7,916.77**	**14.14**	**22.86**	**882.40**	**6,019.54**	**C,NA,NE,NO**	**1,937.82**	**C,NA,NE,NO**	**0.01**	**6.39**	**66.54**	**52.98**	**3.05**
A. Mineral Products	1,467.57	NO	NO							1.31	2.45	0.41	2.73
B. Chemical Industry	3,973.80	12.13	22.85	NA,NO	NA,NO	NA,NO	NA,NO	NA	NA	4.69	IE,NA,NO	17.87	IE,NA,NO
C. Metal Production	2,184.13	IE,NA,NO	NO				1,900.79		NO	0.00	61.32	2.66	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	0.02	NA,NO	NO	NA,NO	NO	NO	NO	0.39	2.76	24.71	0.31

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**	**99.66**	**NO**
4. Agriculture		**492.73**	**41.26**							**NA,NO**	**NA,NO**	**0.16**	**NO**
A. Enteric Fermentation		347.91											
B. Manure Management		144.82	2.93									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils[4]		NE,NO	38.34									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] **2,465.16**	**NA,NE,NO**	**NA,NE,NO**							**IE,NE**	**IE,NE**	**NE**	**NE**
A. Forest Land	[5] -2,635.58	NE,NO	NE,NO							IE,NE	IE,NE	NE	
B. Cropland	[5] -35.57	NA,NE	NA,NE							NE	NE	NE	
C. Grassland	[5] 4,439.99	NE	NE							NE	NE	NE	
D. Wetlands	[5] NE	NE	NE							NE	NE	NE	
E. Settlements	[5] -151.54	NE	NE							NE	NE	NE	
F. Other Land	[5] 749.65	NE	NE							NE	NE	NE	
G. Other	[5] 98.20	NE	NE							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	[6] NA,NO	500.07								NA,NO	NA,NO	1.27	
B. Waste-water Handling		11.48	1.49							NO	NO	NO	
C. Waste Incineration	[6] 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	**42,982.73**	**1.24**	**0.34**							**NE**	**NE**	**NE**	**NE**
Aviation	7,584.14	0.36	0.06							NE	NE	NE	NE
Marine	35,398.58	0.88	0.28							NE	NE	NE	NE
Multilateral Operations	**IE**	**IE**	**IE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**4,272.73**												

Table A8.3 Emissions of greenhouse gases in the Netherlands; IPCC Table 7A; Year: 2006

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	**174,793.61**	**775.37**	**54.66**	**NA,NE,NO**	**1,559.41**	**C,NA,NE,NO**	**256.54**	**C,NA,NE,NO**	**0.01**	**316.51**	**543.51**	**163.14**	**64.43**
1. Energy	**165,018.15**	**62.16**	**2.46**							**315.90**	**500.76**	**78.86**	**63.48**
A. Fuel Combustion — Reference Approach [2]	164,439.05												
A. Fuel Combustion — Sectoral Approach [2]	163,500.44	28.44	2.46							311.32	495.99	60.54	44.60
1. Energy Industries	61,912.74	6.46	0.77							49.87	8.57	2.05	24.49
2. Manufacturing Industries and Construction	27,486.78	2.24	0.08							48.15	123.30	4.41	15.52
3. Transport	35,643.78	2.37	1.46							141.10	293.66	40.56	1.40
4. Other Sectors	38,076.11	17.33	0.13							68.13	70.46	13.52	3.18
5. Other	381.03	0.04	0.02							4.07	IE	IE	IE
B. Fugitive Emissions from Fuels	1,517.71	33.73	IE,NA,NO							4.58	4.77	18.32	18.88
1. Solid Fuels	449.32	1.08	NA,NO							IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NO
2. Oil and Natural Gas	1,068.39	32.64	IE,NA,NO							4.58	4.77	18.32	18.88
2. Industrial Processes	**7,066.19**	**14.12**	**20.21**	**NA,NE,NO**	**1,559.41**	**C,NA,NE,NO**	**256.54**	**C,NA,NE,NO**	**0.01**	**0.60**	**42.73**	**24.11**	**0.95**
A. Mineral Products	1,172.87	NO	NO							0.52	1.67	0.09	0.93
B. Chemical Industry	3,717.56	12.33	20.19	NA,NO	NA,NO	NA,NO	NA,NO	NA	NA	IE,NA,NO	0.00	7.81	IE,NA,NO
C. Metal Production	1,823.81	IE,NA,NO	NO				62.08		NO	IE,NO	37.58	0.92	IE,NO
D. Other Production [3]	19.70									NO	NO	4.83	NO
E. Production of Halocarbons and SF_6					328.71		NO		NO				
F. Consumption of Halocarbons and SF_6				NE,NO	1,230.70	C,NE,NO	194.46	C,NE	0.01				
G. Other	332.25	1.79	0.02	NA,NO	NA,NO	NA,NO	NO	NO	NO	0.08	3.47	10.45	0.02

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	**134.90**		**0.26**							**NO**	**NO**	**59.23**	**NO**
4. Agriculture		**417.53**	**30.37**							**NA,NO**	**NA,NO**	**0.16**	**NO**
A. Enteric Fermentation		300.50											
B. Manure Management		117.03	2.75									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils [4]		NE,NO	27.62									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] **2,574.36**	**NA,NE,NO**	**NA,NE,NO**							**IE,NE**	**IE,NE**	**NE**	**NE**
A. Forest Land	[5] -2,509.28	NE,NO	NE,NO							IE,NE	IE,NE	NE	
B. Cropland	[5] -35.57	NA,NE	NA,NE							NE	NE	NE	
C. Grassland	[5] 4,439.99	NE	NE							NE	NE	NE	
D. Wetlands	[5] NE	NE	NE							NE	NE	NE	
E. Settlements	[5] -151.54	NE	NE							NE	NE	NE	
F. Other Land	[5] 749.65	NE	NE							NE	NE	NE	
G. Other	[5] 81.12	NE	NE							NE	NE	NE	NE
6. Waste	**IE,NA,NO**	**281.56**	**1.35**							**0.01**	**0.02**	**0.77**	**0.00**
A. Solid Waste Disposal on Land	[6] NA,NO	268.87								NA,NO	NA,NO	0.68	
B. Waste-water Handling		9.56	1.23							NO	NO	NO	
C. Waste Incineration	[6] IE	IE	IE							IE	IE	IE	IE
D. Other	NA	3.12	0.12							0.01	0.02	0.10	0.00
7. Other *(please specify)* [7]	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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	**67,132.98**	**1.81**	**0.52**							**NE**	**NE**	**NE**	**NE**
Aviation	10,974.60	0.52	0.08							NE	NE	NE	NE
Marine	56,158.38	1.29	0.44							NE	NE	NE	NE
Multilateral Operations	**IE**	**IE**	**IE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**8,786.65**												

A8.2 Recalculation tables for base years 1990 and 2005

For this submission (NIR 2007), the Netherlands uses the CRF reporter software 3.2.1. The recalculation table is included in chapter 10.

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**	**156,133.59**	**154,780.47**	**159,413.44**	**158,630.23**	**162,480.50**	**170,300.61**	**163,200.49**	**165,452.49**	**159,981.62**
A. Fuel Combustion (Sectoral Approach)	149,980.32	154,995.39	153,707.33	158,392.59	157,563.22	161,522.34	169,265.92	162,201.36	164,650.42	159,317.05
1. Energy Industries	52,492.33	53,103.44	53,076.55	55,243.94	58,024.91	61,513.04	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	26,291.35	27,571.59	28,185.26	28,659.31	29,176.36	29,917.91	30,314.34	31,054.15	32,047.80
4. Other Sectors	37,867.81	42,578.16	39,441.04	42,143.83	39,693.23	42,165.59	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	1,138.19	1,073.14	1,020.84	1,067.01	958.16	1,034.69	999.14	802.07	664.57
1. Solid Fuels	402.67	430.02	431.50	445.73	558.50	516.87	650.57	504.53	492.20	445.62
2. Oil and Natural Gas	774.73	708.17	641.64	575.12	508.51	441.29	384.12	494.60	309.87	218.94
2. Industrial Processes	**7,881.68**	**7,986.07**	**7,422.94**	**7,187.84**	**7,906.13**	**7,916.27**	**7,228.97**	**7,787.61**	**7,635.46**	**7,617.07**
A. Mineral Products	966.78	1,356.16	1,296.64	1,290.05	1,508.15	1,467.57	1,025.50	1,048.68	1,128.53	1,264.37
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]	**2,667.30**	**2,577.62**	**2,462.30**	**2,432.20**	**2,428.03**	**2,465.16**	**2,493.16**	**2,674.34**	**2,574.35**	**2,575.88**
A. Forest Land	-2,518.38	-2,571.67	-2,681.05	-2,704.64	-2,670.29	-2,635.58	-2,619.93	-2,438.18	-2,532.16	-2,511.01
B. Cropland	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57
C. Grassland	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99
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	749.65	749.65	749.65	749.65	749.65	749.65	749.65	749.65	749.65	749.65
G. Other	183.15	146.76	140.82	134.31	95.79	98.20	110.56	109.99	103.99	84.37
6. Waste	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 emissions including net CO_2 from LULUCF	**162,023.13**	**166,935.89**	**164,881.01**	**169,241.05**	**169,178.76**	**173,104.71**	**180,216.71**	**173,836.74**	**175,851.44**	**170,371.43**
Total CO_2 emissions excluding net CO_2 from LULUCF	**159,355.83**	**164,358.27**	**162,418.71**	**166,808.85**	**166,750.72**	**170,639.56**	**177,723.55**	**171,162.40**	**173,277.08**	**167,795.55**
Memo Items:										
International Bunkers	**38,897.84**	**40,171.14**	**41,240.19**	**43,084.42**	**41,493.05**	**42,982.73**	**44,254.29**	**47,150.51**	**48,404.77**	**49,990.82**
Aviation	4,540.46	4,844.86	5,648.73	6,214.34	6,534.56	7,584.14	8,079.78	8,739.60	9,560.09	9,852.32
Marine	34,357.38	35,326.28	35,591.45	36,870.08	34,958.50	35,398.58	36,174.51	38,410.91	38,844.69	40,158.49
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	3,877.95	3,795.79	3,832.30	4,055.68	3,940.42	4,272.73	4,865.00	5,290.55	5,501.20	5,727.80

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	2005	2006	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**162,097.07**	**168,204.49**	**168,834.04**	**172,658.86**	**173,980.41**	**168,798.79**	**165,018.15**	**9.17**
A. Fuel Combustion (Sectoral Approach)	161,408.32	167,622.29	167,282.98	171,148.58	172,473.09	167,267.73	163,500.44	9.01
1. Energy Industries	63,527.49	67,705.26	67,071.29	68,538.18	70,041.22	67,364.18	61,912.74	17.95
2. Manufacturing Industries and Construction	26,794.78	26,095.27	26,815.93	27,414.37	27,165.67	27,181.60	27,486.78	-16.82
3. Transport	32,409.38	32,911.67	33,617.25	34,294.63	34,654.69	34,675.24	35,643.78	37.04
4. Other Sectors	38,093.48	40,436.13	39,279.46	40,464.72	40,174.83	37,671.41	38,076.11	0.53
5. Other	583.19	473.96	499.05	436.67	436.67	375.30	381.03	-32.65
B. Fugitive Emissions from Fuels	688.75	582.20	1,551.06	1,510.28	1,507.32	1,531.06	1,517.71	28.90
1. Solid Fuels	421.71	412.17	430.32	464.43	508.82	456.97	449.32	11.58
2. Oil and Natural Gas	267.04	170.04	1,120.73	1,045.85	998.50	1,074.09	1,068.39	37.91
2. Industrial Processes	**7,382.22**	**6,861.07**	**6,769.04**	**6,885.00**	**6,977.06**	**6,991.87**	**7,066.19**	**-10.35**
A. Mineral Products	1,193.78	1,282.29	1,209.82	1,167.71	1,186.24	1,173.22	1,172.87	21.32
B. Chemical Industry	4,076.89	3,503.26	3,400.77	3,412.11	3,657.29	3,745.83	3,717.56	0.43
C. Metal Production	1,764.79	1,736.94	1,820.90	1,968.35	1,791.37	1,691.97	1,823.81	-37.30
D. Other Production	48.98	42.82	31.79	46.09	41.17	33.45	19.70	-72.84
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	347.40	332.25	43.22
3. Solvent and Other Product Use	169.23	157.84	159.98	143.65	133.31	135.22	134.90	-57.37
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]	**2,668.58**	**2,638.02**	**2,629.68**	**2,618.52**	**2,598.14**	**2,580.93**	**2,574.36**	**-3.48**
A. Forest Land	-2,431.57	-2,444.52	-2,457.47	-2,470.42	-2,483.37	-2,496.34	-2,509.28	-0.36
B. Cropland	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	-35.57	0.00
C. Grassland	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	4,439.99	0.00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	0.00
E. Settlements	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54	-151.54	0.00
F. Other Land	749.65	749.65	749.65	749.65	749.65	749.65	749.65	0.00
G. Other	97.62	80.01	84.62	86.41	78.98	74.74	81.12	-55.71
6. Waste	**IE,NA,NO**	**IE,NA,NO**	**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	NA,NO	NA,NO	0.00
B. Waste-water Handling								
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**172,317.10**	**177,861.41**	**178,392.74**	**182,306.02**	**183,688.93**	**178,506.81**	**174,793.61**	**7.88**
Total CO_2 emissions excluding net CO_2 from LULUCF	**169,648.52**	**175,223.40**	**175,763.06**	**179,687.50**	**181,090.79**	**175,925.89**	**172,219.25**	**8.07**
Memo Items:								
International Bunkers	**52,431.45**	**56,530.67**	**56,410.82**	**53,125.93**	**57,596.57**	**64,966.88**	**67,132.98**	**72.59**
Aviation	9,749.35	9,538.72	9,981.87	9,817.17	10,503.13	10,875.58	10,974.60	141.71
Marine	42,682.10	46,991.95	46,428.95	43,308.76	47,093.45	54,091.31	56,158.38	63.45
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass	6,177.77	6,519.96	7,116.82	6,788.48	7,601.07	8,830.31	8,786.65	126.58

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)
1. Energy	111.84	112.04	110.10	110.83	109.72	110.23	107.59	80.01	79.49	71.56
A. Fuel Combustion (Sectoral Approach)	32.36	32.53	30.74	31.62	30.49	31.11	34.25	30.99	29.97	29.12
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	2.57	2.59	2.49	2.46	2.31	2.40	2.31	2.32	2.29
3. Transport	7.51	5.89	5.53	5.24	4.93	4.71	4.42	4.01	3.71	3.47
4. Other Sectors	18.70	20.23	18.88	19.78	19.09	19.75	22.46	19.39	18.63	18.07
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	79.51	79.36	79.22	79.24	79.12	73.35	49.01	49.51	42.43
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	78.07	77.92	77.78	77.79	77.67	71.89	47.56	48.10	41.27
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	**499.57**	**505.55**	**494.30**	**496.56**	**480.06**	**492.73**	**475.88**	**470.56**	**450.95**	**447.48**
A. Enteric Fermentation	358.36	363.87	355.53	357.63	346.78	347.91	333.24	328.35	319.17	318.10
B. Manure Management	141.21	141.67	138.77	138.93	133.28	144.82	142.64	142.21	131.78	129.38
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	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	**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	1E	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**
Total CH_4 emissions including CH_4 from LULUCF	**1,211.32**	**1,223.21**	**1,198.79**	**1,186.22**	**1,146.99**	**1,132.08**	**1,095.62**	**1,047.06**	**1,006.80**	**957.59**
Total CH_4 emissions excluding CH_4 from LULUCF	**1,211.32**	**1,223.21**	**1,198.79**	**1,186.22**	**1,146.99**	**1,132.08**	**1,095.62**	**1,047.06**	**1,006.80**	**957.59**
Memo Items:										
International Bunkers	1.06	1.10	1.15	1.18	1.15	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	0.88	0.92	0.94	0.96
Multilateral Operations	IE	IE	IE	1E	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	2005	2006	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	69.06	69.18	67.06	66.28	64.54	66.57	62.16	-44.42
A. Fuel Combustion (Sectoral Approach)	29.67	30.41	29.86	29.31	29.63	29.56	28.44	-12.12
1. Energy Industries	5.26	5.61	5.93	5.71	6.39	7.19	6.46	90.00
2. Manufacturing Industries and Construction	2.28	2.19	2.24	2.23	2.22	2.21	2.24	-17.14
3. Transport	3.11	3.00	2.89	2.74	2.53	2.45	2.37	-68.43
4. Other Sectors	18.96	19.58	18.76	18.59	18.44	17.68	17.33	-7.31
5. Other	0.06	0.05	0.05	0.04	0.04	0.04	0.04	-31.28
B. Fugitive Emissions from Fuels	39.39	38.77	37.20	36.97	34.91	37.01	33.73	-57.57
1. Solid Fuels	1.06	1.11	1.06	1.08	1.10	1.12	1.08	-24.86
2. Oil and Natural Gas	38.33	37.66	36.14	35.89	33.80	35.89	32.64	-58.17
2. Industrial Processes	**14.32**	**14.24**	**14.69**	**15.04**	**14.87**	**14.88**	**14.12**	**-0.11**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	12.42	12.39	12.89	13.20	13.10	13.11	12.33	1.72
C. Metal Production	IE,NA,NO	IE,NA,NO	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	1.76	1.79	-11.12
3. Solvent and Other Product Use								
4. Agriculture	**432.43**	**437.25**	**414.79**	**417.61**	**419.68**	**419.14**	**417.53**	**-16.42**
A. Enteric Fermentation	305.22	312.94	294.45	302.33	302.30	302.06	300.50	-16.15
B. Manure Management	127.21	124.32	120.34	115.28	117.38	117.09	117.03	-17.12
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Prescribed Burning of Savanas	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0.00**
A. Forest Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
C. Grassland	NE	NE	NE	NE	NE	NE	NE	0.00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	0.00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	0.00
F. Other Land	NE	NE	NE	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**399.90**	**376.49**	**359.81**	**336.58**	**322.44**	**301.55**	**281.56**	**-51.93**
A. Solid Waste Disposal on Land	385.72	362.68	345.67	323.29	308.71	288.54	268.87	-52.99
B. Waste-water Handling	10.50	10.47	10.72	10.06	10.31	9.78	9.56	-30.64
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	3.67	3.34	3.42	3.23	3.42	3.23	3.12	5,420.12
7. Other *(as specified in Summary 1.A)*	NA	NA	NA	NA	NA	NA	NA	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**915.71**	**897.16**	**856.36**	**835.52**	**821.52**	**802.14**	**775.37**	**-35.99**
Total CH_4 emissions excluding CH_4 from LULUCF	**915.71**	**897.16**	**856.36**	**835.52**	**821.52**	**802.14**	**775.37**	**-35.99**
Memo Items:								
International Bunkers	1.48	1.57	1.58	1.48	1.59	1.76	1.81	71.34
Aviation	0.46	0.45	0.47	0.47	0.50	0.52	0.52	141.71
Marine	1.02	1.12	1.10	1.02	1.10	1.24	1.29	53.27
Multilateral Operations	IE	IE	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)	
1. Energy	**1.61**		**1.75**		**1.90**		**2.10**		**2.22**		**2.34**		**2.43**		**2.44**		**2.46**		**2.40**	
A. Fuel Combustion (Sectoral Approach)	1.61		1.75		1.90		2.10		2.22		2.34		2.43		2.44		2.46		2.40	
1. Energy Industries	0.45		0.42		0.41		0.47		0.51		0.54		0.59		0.60		0.63		0.59	
2. Manufacturing Industries and Construction	0.11		0.10		0.10		0.10		0.08		0.07		0.07		0.07		0.07		0.07	
3. Transport	0.88		1.05		1.22		1.35		1.46		1.56		1.59		1.61		1.59		1.58	
4. Other Sectors	0.14		0.15		0.14		0.14		0.14		0.14		0.15		0.13		0.13		0.12	
5. Other	0.03		0.03		0.03		0.03		0.03		0.03		0.03		0.03		0.03		0.04	
B. Fugitive Emissions from Fuels	0.00		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO	
1. Solid Fuels	NA,NO		NA,NO		NA,NO		NA,NO		NA,NO		NA,NO		NA,NO		NA,NO		NA,NO		NA,NO	
2. Oil and Natural Gas	0.00		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO		IE,NA,NO	
2. Industrial Processes	**22.90**		**22.91**		**23.08**		**24.71**		**24.13**		**22.86**		**22.87**		**22.67**		**22.71**		**21.57**	
A. Mineral Products	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO	
B. Chemical Industry	22.89		22.90		23.07		24.70		24.12		22.85		22.85		22.65		22.69		21.54	
C. Metal Production	NO		NO		NO		NO		NO		NO		NO		NO		NO		NO	
D. Other Production																				
E. Production of Halocarbons and SF_6																				
F. Consumption of Halocarbons and SF_6																				
G. Other	0.01		0.01		0.02		0.01		0.02		0.02		0.02		0.02		0.02		0.03	
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	**37.44**		**38.33**		**40.35**		**40.97**		**39.57**		**41.26**		**40.59**		**40.17**		**39.36**		**38.02**	
A. Enteric Fermentation	2.62		2.78		2.93		2.97		2.85		2.93		2.88		2.84		3.05		3.12	
B. Manure Management																				
C. Rice Cultivation																				
D. Agricultural Soils	34.82		35.55		37.42		38.00		36.71		38.34		37.71		37.33		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	1.66		1.69		1.65		1.61		1.61		1.49		1.46		1.44		1.48		1.42	
B. Waste-water Handling	IE		IE		IE		IE		IE		IE		IE		IE		IE		IE	
C. Waste Incineration	0.00		0.03		0.06		0.08		0.12		0.14		0.14		0.14		0.14		0.14	
D. Other	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
7. Other *(as specified in Summary 1.A)*																				
Total N_2O emissions including N_2O from LULUCF	**64.33**		**65.43**		**67.77**		**70.17**		**68.30**		**68.74**		**68.12**		**67.42**		**66.67**		**64.04**	
Total N_2O emissions excluding N_2O from LULUCF	**64.33**		**65.43**		**67.77**		**70.17**		**68.30**		**68.74**		**68.12**		**67.42**		**66.67**		**64.04**	
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	2005	2006	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**2.37**	**2.39**	**2.42**	**2.42**	**2.43**	**2.44**	**2.46**	**52.74**
A. Fuel Combustion (Sectoral Approach)	2.37	2.39	2.42	2.42	2.43	2.44	2.46	52.79
1. Energy Industries	0.63	0.66	0.70	0.70	0.73	0.78	0.77	71.14
2. Manufacturing Industries and Construction	0.07	0.07	0.07	0.07	0.07	0.07	0.08	-29.02
3. Transport	1.53	1.53	1.52	1.49	1.47	1.44	1.46	66.60
4. Other Sectors	0.10	0.11	0.10	0.13	0.13	0.13	0.13	-10.92
5. Other	0.03	0.03	0.03	0.03	0.03	0.02	0.02	-31.43
B. Fugitive Emissions from Fuels	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	-100.00
1. Solid Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
2. Oil and Natural Gas	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	-100.00
2. Industrial Processes	**22.06**	**20.03**	**19.15**	**19.42**	**21.12**	**20.55**	**20.21**	**-11.74**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	22.04	20.01	19.12	19.40	21.10	20.53	20.19	-11.79
C. Metal Production	NO	NO	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	0.02	0.02	0.02	0.02	0.02	0.02	0.02	120.82
3. Solvent and Other Product Use	0.44	0.36	0.29	0.29	0.28	0.25	0.26	-63.88
4. Agriculture	**34.97**	**33.57**	**31.77**	**30.71**	**30.69**	**30.58**	**30.37**	**-18.88**
A. Enteric Fermentation	2.95	2.88	2.90	2.37	2.62	2.79	2.75	4.87
B. Manure Management								
C. Rice Cultivation								
D. Agricultural Soils	32.03	30.69	28.88	28.34	28.07	27.78	27.62	-20.67
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0.00**
A. Forest Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
C. Grassland	NE	NE	NE	NE	NE	NE	NE	0.00
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	0.00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	0.00
F. Other Land	NE	NE	NE	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**1.53**	**1.53**	**1.51**	**1.41**	**1.42**	**1.39**	**1.35**	**-18.43**
A. Solid Waste Disposal on Land								
B. Waste-water Handling	1.38	1.39	1.37	1.28	1.29	1.26	1.23	-25.86
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	0.15	0.13	0.14	0.13	0.14	0.13	0.12	5,422.09
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**61.38**	**57.88**	**55.13**	**54.25**	**55.94**	**55.21**	**54.66**	**-15.04**
Total N_2O emissions excluding N_2O from LULUCF	**61.38**	**57.88**	**55.13**	**54.25**	**55.94**	**55.21**	**54.66**	**-15.04**
Memo Items:								
International Bunkers	**0.41**	**0.45**	**0.45**	**0.42**	**0.45**	**0.51**	**0.52**	**69.37**
Aviation	0.08	0.08	0.08	0.08	0.09	0.09	0.08	116.72
Marine	0.33	0.37	0.36	0.34	0.37	0.42	0.44	62.65
Multilateral Operations	IE	IE	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 SF6

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[3] - (Gg 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	NO	0.00	NO
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	0.00	0.01	0.02	0.04	0.05
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	0.02	0.01	0.04	0.04	0.11	0.17	0.12	0.14
HFC-152a	NO	NO	0.01	0.03	0.02	0.02	0.03	NO	NO	NO
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	0.00	0.01	0.00	0.03	0.01	0.04	0.04
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed HFCs[4] - (Gg 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[3] - (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**	**1,472.23**
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
$c\text{-}C_4F_8$	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[4] - (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[3] - (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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	Change from base to latest reported year	
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%	
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**3,823.57**	**1,469.35**	**1,541.42**	**1,378.68**	**1,510.51**	**1,352.70**	**1,559.41**	**-64.81**	
HFC-23	0.21	0.04	0.06	0.04	0.03	0.02	0.02	-93.67	
HFC-32	0.00	0.01	0.00	0.01	0.01	0.00	0.00	100.00	
HFC-41	NO	NO	NO	NO	NO	NO	NO	0.00	
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	0.00	
HFC-125	0.06	0.08	0.06	0.07	0.09	0.09	0.10	100.00	
HFC-134	NO	NO	NO	NO	NO	NO	NO	0.00	
HFC-134a	0.12	0.16	0.20	0.24	0.30	0.33	0.37	100.00	
HFC-152a	0.02	0.01	0.00	0.00	0.01	0.00	0.00	100.00	
HFC-143	NO	NO	NO	NO	NO	NO	NO	0.00	
HFC-143a	0.08	0.05	0.05	0.06	0.07	0.08	0.09	100.00	
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	0.00	
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	0.00	
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	0.00	
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	769.40	408.12	216.39	215.91	236.43	173.03	161.24	100.00	
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**1,581.54**	**1,489.43**	**2,187.03**	**620.53**	**285.64**	**266.20**	**256.54**	**-88.67**	
CF_4	0.16	0.15	0.24	0.05	0.01	0.01	0.01	-97.12	
C_2F_6	0.04	0.04	0.06	0.01	0.00	0.00	0.00	-97.72	
C_3F_8	NO	NO	NO	NO	NO	NO	NO	0.00	
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	0.00	
$c\text{-}C_4F_8$	NO	NO	NO	NO	NO	NO	NO	0.00	
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	0.00	
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	0.00	
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	193.35	162.71	119.70	180.26	179.04	178.19	194.46	964.93	
Emissions of SF_6[3] - (Gg CO_2 equivalent)	**319.83**	**325.47**	**286.11**	**247.60**	**251.28**	**249.83**	**215.08**	**-1.03**	
SF_6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-1.03	

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)
CO_2 emissions including net CO_2 from LULUCF	162,023.13	166,935.89	164,881.01	169,241.05	169,178.76	173,104.71	180,216.71	173,836.74	175,851.44	170,371.43
CO_2 emissions excluding net CO_2 from LULUCF	159,355.83	164,358.27	162,418.71	166,808.85	166,750.72	170,639.56	177,723.55	171,162.40	173,277.08	167,795.55
CH_4 emissions including CH_4 from LULUCF	25,437.71	25,687.38	25,174.62	24,910.71	24,086.75	23,773.69	23,007.98	21,988.30	21,142.76	20,109.36
CH_4 emissions excluding CH_4 from LULUCF	25,437.71	25,687.38	25,174.62	24,910.71	24,086.75	23,773.69	23,007.98	21,988.30	21,142.76	20,109.36
N_2O emissions including N_2O from LULUCF	19,943.45	20,282.93	21,009.83	21,753.17	21,174.50	21,308.47	21,116.09	20,901.00	20,666.38	19,852.55
N_2O emissions excluding N_2O from LULUCF	19,943.45	20,282.93	21,009.83	21,753.17	21,174.50	21,308.47	21,116.09	20,901.00	20,666.38	19,852.55
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	1,472.23
SF_6	217.32	133.91	143.09	149.90	191.20	301.26	312.40	344.85	328.84	317.03
Total (including LULUCF)	**214,318.12**	**218,736.55**	**217,698.73**	**223,121.34**	**223,101.26**	**226,445.49**	**234,486.31**	**227,714.95**	**229,160.02**	**216,981.78**
Total (excluding LULUCF)	**211,650.82**	**216,158.92**	**215,236.44**	**220,689.14**	**220,673.22**	**223,980.33**	**231,993.16**	**225,040.61**	**226,585.67**	**214,405.90**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	154,005.05	159,028.11	157,681.87	162,391.67	161,622.35	165,522.15	173,314.10	165,637.92	167,884.00	162,228.65
2. Industrial Processes	22,191.44	21,214.88	21,508.23	22,359.81	24,345.41	23,559.97	24,760.29	26,100.10	26,469.58	21,249.59
3. Solvent and Other Product Use	541.18	464.65	442.64	424.10	418.80	439.85	387.10	345.15	350.45	350.48
4. Agriculture	22,097.77	22,497.50	22,888.42	23,128.93	22,346.63	23,138.69	22,576.06	22,335.08	21,671.73	21,183.59
5. Land Use, Land-Use Change and Forestry[5]	2,667.30	2,577.62	2,462.30	2,432.20	2,428.03	2,465.16	2,493.16	2,674.34	2,574.35	2,575.88
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)[5]	**214,318.12**	**218,736.55**	**217,698.73**	**223,121.34**	**223,101.26**	**226,445.49**	**234,486.31**	**227,714.95**	**229,160.02**	**216,981.78**

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	172,317.10	177,861.41	178,392.74	182,306.02	183,688.93	178,506.81	174,793.61	7.88
CO_2 emissions excluding net CO_2 from LULUCF	169,648.52	175,223.40	175,763.06	179,687.50	181,090.79	175,925.89	172,219.25	8.07
CH_4 emissions including CH_4 from LULUCF	19,229.81	18,840.37	17,983.46	17,545.82	17,252.00	16,844.92	16,282.81	-35.99
CH_4 emissions excluding CH_4 from LULUCF	19,229.81	18,840.37	17,983.46	17,545.82	17,252.00	16,844.92	16,282.81	-35.99
N_2O emissions including N_2O from LULUCF	19,027.17	17,943.73	17,090.60	16,819.01	17,341.05	17,114.70	16,943.51	-15.04
N_2O emissions excluding N_2O from LULUCF	19,027.17	17,943.73	17,090.60	16,819.01	17,341.05	17,114.70	16,943.51	-15.04
HFCs	3,823.57	1,469.35	1,541.42	1,378.68	1,510.51	1,352.70	1,559.41	-64.81
PFCs	1,581.54	1,489.43	2,187.03	620.53	285.64	266.20	256.54	-88.67
SF_6	319.83	325.47	286.11	247.60	251.28	249.83	215.08	-1.03
Total (including LULUCF)	**216,299.03**	**217,929.76**	**217,481.36**	**218,917.66**	**220,329.40**	**214,335.16**	**210,050.97**	**-1.99**
Total (excluding LULUCF)	**213,630.44**	**215,291.75**	**214,851.67**	**216,299.14**	**217,731.26**	**211,754.23**	**207,476.60**	**-1.97**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	164,282.07	170,399.38	170,992.12	174,800.06	176,088.33	170,953.63	167,085.34	8.49
2. Industrial Processes	20,247.53	16,654.42	17,027.35	15,468.46	15,883.70	15,543.55	15,659.65	-29.43
3. Solvent and Other Product Use	306.89	268.54	248.57	233.82	220.91	213.41	216.09	-60.07
4. Agriculture	19,923.12	19,589.29	18,560.84	18,290.87	18,325.92	18,281.05	18,183.47	-17.71
5. Land Use, Land-Use Change and Forestry[5]	2,668.58	2,638.02	2,629.68	2,618.52	2,598.14	2,580.93	2,574.36	-3.48
6. Waste	8,870.84	8,380.12	8,022.78	7,505.93	7,212.39	6,762.59	6,332.04	-50.59
7. Other	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)[5]	**216,299.03**	**217,929.76**	**217,481.36**	**218,917.66**	**220,329.40**	**214,335.16**	**210,050.97**	**-1.99**

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	2005	2006
National Total																	
NO_x	544.7	514.9	499.6	478.7	457.8	448.9	426.9	394.5	390.4	397.0	386.4	375.9	369.3	365.7	345.8	329.9	316.5
CO	1066.8	956.8	920.9	870.9	843.6	803.7	771.9	724.9	700.9	610.9	647.2	625.4	602.6	582.5	582.5	551.5	543.5
NMVOC	455.6	414.9	390.3	362.6	339.4	316.2	271.3	247.0	248.6	234.1	217.6	198.2	188.4	174.9	167.9	168.1	163.1
SO_2	190.0	177.1	165.4	153.2	140.6	127.8	115.7	101.9	93.5	87.7	71.5	73.4	66.6	62.7	63.3	65.5	64.4
1. Energy																	
NO_x	528.7	500.4	486.6	467.0	447.6	440.1	419.4	388.2	385.3	395.3	381.9	371.6	365.7	365.2	343.4	329.3	315.9
CO	935.7	838.5	815.4	778.3	763.9	736.7	690.3	627.9	588.3	574.6	541.3	522.8	532.7	538.9	520.9	501.1	500.8
NMVOC	242.1	213.2	200.4	184.5	173.0	161.7	150.9	133.8	123.1	113.9	108.7	99.8	92.7	87.4	81.4	80.3	78.9
SO_2	178.8	167.5	157.4	146.7	135.7	124.5	112.6	99.1	91.1	85.8	69.7	71.1	64.1	61.9	62.3	64.4	63.5
2. Industial processes																	
NO_x	12.0	10.9	9.8	8.6	7.5	6.4	5.9	5.5	5.0	0.8	4.5	3.9	3.1	0.5	1.1	0.6	0.6
CO	129.2	116.7	104.1	91.6	79.1	66.5	81.3	96.9	112.5	36.1	105.9	102.5	69.6	43.5	61.2	50.3	42.7
NMVOC	82.8	76.8	70.9	64.9	58.9	53.0	43.3	42.1	46.2	39.1	39.7	32.9	31.9	28.0	26.7	25.0	24.1
SO_2	7.1	6.3	5.5	4.7	3.8	3.0	2.8	2.7	2.5	1.9	1.9	2.2	2.5	0.8	1.0	1.1	1.0
3. Solvents and Other product use																	
NO_x	NO	NO	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	NO	NO
NMVOC	128.9	123.1	117.2	111.4	105.5	99.7	75.3	69.4	77.7	79.8	68.0	64.3	62.7	58.5	58.8	61.9	59.2
SO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Agriculture																	
NO_x	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	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	0.2	0.2
SO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste																	
NO_x	3.9	3.6	3.3	3.0	2.7	2.4	1.6	0.8	0.1	0.9	0.0	0.4	0.5	0.0	1.2	0.0	0.0
CO	1.9	1.6	1.3	1.0	0.7	0.4	0.3	0.1	0.0	0.3	0.0	0.1	0.3	0.0	0.4	0.0	0.0
NMVOC	1.6	1.6	1.7	1.7	1.8	1.8	1.7	1.6	1.5	1.1	1.0	1.0	1.0	0.9	0.9	0.8	0.8
SO_2	4.2	3.4	2.6	1.8	1.0	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Annex 9 Chemical compounds, global warming potentials, units and conversion factors

A9.1 Chemical compounds

CF_4	Perfluoromethane (tetrafluoromethane)
C_2F_6	Perfluoroethane (hexafluoroethane)
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HNO_3	Nitric Acid
NH_3	Ammonia
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: 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)

tonmetric 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 m²)
kha kilo hectare (= 1 000 hectare = 10^7 m² = 10 km²)

mln million (= 10^6)
mld milliard (= 10^9)

A9.4 Other conversion factors for emissions

From element basis to full molecular mass:		From full molecular mass to element basis	
C ® CO_2 :	x 44/12 = 3.67	CO_2 ®C :	x 12/44 = 0.27
C ® CH_4 :	x 16/12 = 1.33	CH_4 ®C :	x 12/16 = 0.75
C ® CO :	x 28/12 = 2.33	CO ® C :	x 12/28 = 0.43
N ® N_2O :	x 44/28 = 1.57	N_2O ®N :	x 28/44 = 0.64
N ® NO :	x 30/14 = 2.14	NO ®N :	x 14/30 = 0.47
N ® NO_2 :	x 46/14 = 3.29	NO_2 ®N :	x 14/46 = 0.30
N ® NH_3 :	x 17/14 = 1.21	NH_3 ®N :	x 14/17 = 0.82
N ® HNO_3 :	x 63/14 = 4.50	HNO_3 ®N :	x 14/63 = 0.22
S ® SO_2 :	x 64/32 = 2.00	SO_2 ® S :	x 32/64 = 0.50

Annex 10 List of abbreviations

AD	Activity Data
BAK	Monitoring report of gas consumption of small users
BEES	Order governing combustion plant emissions requirements (1992) (in Dutch: 'Besluit Emissie-Eisen Stookinstallaties')
BEK	Monitoring report of electricity consumption of small users
BF	Blast Furnace (gas)
BOD	Biological Oxygen Demand
C	Confidential (notation key in CRF)
CO	Coke Oven (gas)
CS	Country-Specific (notation key in CRF)
cap	capita (person)
CBS	Statistics Netherlands
CDM	Clean Development Mechanism (one of three mechanisms of the Kyoto Protocol)
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 (countries from 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-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 SF6
FO-I	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 Agency (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 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