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Greenhouse Gas Emissions in the Netherlands 1990-2001. National Inventory Report 2003

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National Inventory Report prepared for submission in accordance with the UN Framework Convention on Climate Change (UNFCCC) and the European Union's Greenhouse Gas Monitoring Mechanism [including electronic Excel spreadsheet files containing the Common Reporting Format (CRF) data for 1990 to 2001]

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Many colleagues from a number of organisations (CBS, EC-LNV, LEI, RIVM, TNO and, recently, AOO) have been involved in the annual update of the Netherlands *Pollutant Emission Register* (PER), also called the *Emission Registration* (ER) system, which contains emissions data on hundreds of pollutants (see *Section 1.6*). This annual project is led by the VROM Inspectorate (VI) and the *Co-ordinating Committee on Target Group Monitoring* (CCDM). The emission calculations, including those for greenhouse gas emissions, are performed by members of so-called ER Task Forces (see *Section 1.3*). This is a major task, since the Netherlands' inventory contains many detailed emission sources.

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

The description of sources, analysis of trends and uncertainty estimates in emissions (see Chapters 3 to 9) of the various sources has been made in cooperation with the following RIVM experts: Mr. Dik Beker (waste), Mr. Robert van den Brink (transport), Mrs. Johanna Montfoort (fugitive emissions, energy), Mr. Durk Nijdam (small combustion, solvent and product use), Mr. Kees Peek (industry, waste incineration, waste water) and Mrs. Marian van Schijndel and Mr. Klaas van der Hoek (agriculture). In addition, Mr. Ed Zonneveld 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 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. In addition, we thank Mrs. Ruth de Wijs-Christensen for checking and improving the English of the general chapters of the report.

Contents

Samenvatting (Dutch)

National Inventory Report (NIR)

Dit rapport over de Nederlandse inventarisatie van broeikasgasemissies is opgesteld om te voldoen aan de nationale rapportageverplichtingen in 2003 van het Klimaatverdrag van de Verenigde Naties (UNFCCC) en van het Bewakingsmechanisme Broeikasgassen van de Europese Unie. Dit rapport bevat trendanalyses voor de emissies van broeikasgassen in de periode 1990-2001; een eerste analyse van zgn. 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; en een overzicht van het kwaliteitssysteem en de validatie van de emissiecijfers voor de Nederlandse Emissieregistratie. Een aparte annex bij dit rapport omvat elektronische data over emissies, activiteitendata en afgeleide emissiefactoren in het zgn. *Common Reporting Format* (CRF), waar door het VN-Klimaat-secretariaat om wordt verzocht. In de appendices bij dit rapport zijn de CRF-trendtabellen en de IPCC-tabellen '7A' opgenomen voor 1990-2001 (alle cijfers voor 2001 zijn voorlopig), alsmede tabellen over herberekeningen en compleetheid van emissiebronnen. 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 *Milieubalans 2002*.

Emissietrends broeikasgassen

De totale netto CO_2-eq.-emissies waren in 2001 4% hoger dan in 1990 (1995 voor de F-gassen HFK's, PFK's en SF_6). In periode 1990-2001 zijn de emissies van CO_2 met 13% toegenomen, terwijl de CH_4 en N_2O-emissies met resp. 25 en 3% afnamen. Van de zogenaamde F-gassen, waarvoor 1995 het referentiejaar is, nam de totale emissie met 60% af. De HFK- en PFK-emissies namen met resp. 75% en 20% af in 2001 ten opzichte van 1995, terwijl de emissies van SF_6 met 7% toenamen. Hieronder wordt per IPCC-categorie de verklaring voor de trend 1990-2001 gegeven:

- De emissies van *energiegebruik* en *-productie* (categorie 1) is met ca. 13% toegenomen ten opzichte van 1990, met name door de toename van CO_2-emissies van de centrales en de transportsector (resp. 26 en 22% toename). De verdubbeling van de elektriciteitimport in 1999 van 10 naar 20% voor het huishoudelijke elektriciteitsverbruik veroorzaakte een tijdelijke afname van de CO_2-emissies in deze sector en het landelijk totaal. De stijging van de CO_2-emissies die in de periode vóór 1999 te zien was zet zich in 2000 en 2001 weer door.
- De *industriële procesemissies* (d.w.z. niet-verbrandingsemissies) (categorie 2) zijn 30% gedaald ten opzichte van 1990, met name door de sterke afname van de HFK-emissies en een afname van de N_2O-emissies van de salpeterzuurproductie.
- Emissies van *oplosmiddelen en andere producten* (categorie 3) dragen maar weinig bij tot het nationale totaal, de emissietrend vertoont een daling door een afname van de emissie van N_2O van spuitbussen.
- De *landbouwemissies* (categorie 4) zijn sinds 1990 met 10% afgenomen. Dit komt door de sterke afname van het aantal dieren (20%), waardoor CH_4-emissies afkomstig van fermentatie en mest met 16% zijn gedaald.
- De CO_2-vastlegging in *bossen* (categorie 5) bedraagt circa 1% van het landelijke totaal. De jaarlijkse fluctuaties (-1,2 tot –1,9 Mton) worden veroorzaakt door wijzigingen in de dataset die gebruikt wordt voor het berekenen van deze categorie.
- De emissies van de *afvalsector* (categorie 6) zijn sinds 1990 circa 30% afgenomen, met name door een afname van CH_4-emissies van stortplaatsen. De aan fossiele brandstoffen gerelateerde emissie van afvalverbrandingsinstallaties zijn opgenomen in categorie 1A1.
- De sector 'overig' (categorie 7) bestaat grotendeels uit de emissie van N_2O door vervuild oppervlaktewater; deze bijdrage is constant gehouden over de jaren.
- Internationale transportemissies van lucht- en scheepvaart worden ook gerapporteerd, volgens de IPCC-richtlijn, maar als een aparte categorie die niet tot het nationale totaal gerekend wordt. Ne-

derland rapporteert alleen de CO_2-emissies, deze zijn sinds 1990 met 45% of 18 Mton toegenomen door een toename van de emissies van scheepvaartbunkers (+12 Mton) en vliegverkeer (+5 Mton).
De grootste wijzigingen in totale broeikasgasemissies (CO_2-eq.) *in 2001 ten opzichte van 2000* worden veroorzaakt door de toename van 6 Mton CO_2 (3 Mton door de relatief koudere winter van 2001) en de afname van meer dan 1 Mton HFK-emissies.

Wijzigingen ten opzichte van de rapportage van 2002

Dit jaar is gekozen voor een andere indeling van het rapport, alvast vooruitlopend op de richtlijnen hiervoor van het IPCC die volgend jaar ingaan. Hiermee willen we de nog zwakkere onderdelen in de rapportage zichtbaar maken, zodat daar bij de volgende rapportage meer aandacht aan kan worden geschonken.

De emissiecijfers in deze rapportage komen grotendeels overeen met de emissiecijfers gepubliceerd in de *Emissiemonitor 2002* en de *Milieubalans 2002* voor 1990, 1995 en 1999-2001, met uitzondering van een aanpassing van de CO_2-emissies door een correctie in de verdeling fossiele/organische koolstof bij de afvalverbrandingsinstallaties (IPCC categorie 1A1). Verder waren CO_2-emissies van openhaarden en van een gedeelte van het verbruik van biogas ten onrechte gelabeld als fossiele emissiebronnen. De belangrijkste wijzigingen ten opzichte van de vorige rapportage zijn het gevolg van methodiekverandering, verbetering in allocatie en herstel van fouten:

- *Methodiekwijzigingen:* herberekening van N_2O-emissies van salpeterzuurproductie voor de jaren 1991-1994 en 1996-1998, in lijn met de methode voor de andere jaren; herberekening van de emissies van CH_4 en N_2O van RWZI's; herziening van de HFK- en SF_6-emissies voor de jaren 1994-2001;
- *Allocatie van bronnen:* aanpassingen in de afvalsector door meer duidelijkheid over de subsectoren; verbeterde brandstofuitsplitsing in de database; consistentie in de allocatie van industriële procesemissies;
- *Foutencorrectie:* aanpassing van verkeerde toewijzing van niet-fossiele brandstoffen in de categorieën 1A4, 1A1 en 6D; dubbeltelling bij rookgasontzwaveling (categorie 2G); N_2O-emissie van landbouwgronden; CO_2-verbrandingsemissies in categorie 1A2f voor de jaren 1990, 1995, 1999 en 2000); CO_2-emissies van de energiesector (1A1) voor 1999; gegevens over non-energetisch gebruik als chemische grondstof (zgn. 'feedstocks') (1Ad) voor 1994 en 1999-2001.

Als gevolg van deze herberekeningen zijn in het basisjaar de totale CO_2-equivalente emissies met 0,3 Tg CO_2-eq. of 0,2% afgenomen. In totaal zijn de emissies in het basisjaar van CO_2 en SF_6 resp. 0,4 en 0,1 Mton CO_2-equivalent lager geworden; de HFK-emissies zijn in 1995 (het basisjaar voor de F-gassen) toegenomen met 0,04 Mton CO_2-eq.

Onzekerheden

De onzekerheid in de totale *jaarlijkse* emissies wordt geschat op ±5%; de onzekerheid in de *trend* over de periode 1990/95-2001 wordt op ±3%-punten geschat bij een toename van 4%, gebaseerd op de zgn. 'Tier 1' methodiek van de IPCC voor trendonzekerheden (met 95% betrouwbaarheidsinterval). Voor de afzonderlijke stoffen wordt de onzekerheid in de jaarlijkse emissies als volgt geschat: voor CO_2 ±3%, CH_4 ±25%, N_2O ±50%; HFK's, PFK's en SF_6: ±50%. De trendonzekerheid wordt voor CO_2, CH_4, N_2O en voor alle F-gassen als groep geschat op resp. ±3%, ±7%, ±11% and ±10%-punten.

Daarbij moet worden opgemerkt dat de onzekerheid in de emissiecijfers voor 2001 en in de emissietrend waarschijnlijk groter is dan hierboven genoemd is, als gevolg van een tijdelijk verslechtering van de kwaliteit van de emissiecijfers voor de laatste jaren ten opzichte van de data voor eerdere jaren. Dit wordt veroorzaakt door (a) een andere rapportagewijze door individuele bedrijven (thans rechtstreeks via de milieujaarverslagen) en (b) vertraging in de beschikbaarheid van (voorlopige) statistieken voor het voorgaande kalenderjaar, met name voor energiegebruik.

Respons naar aanleiding van reviews

De Nederlandse emissieregistratie voor broeikasgassen heeft de volgende reviews gehad door het VN-Klimaat-secretariaat: een 'desk review' en een 'centralised review' van de NIR 2000 en een '*Synthesis and Assessment report'* over de NIR 2001 en NIR 2002. De belangrijkste opmerkingen betroffen: inconsistentie in tijdreeksen; missende toelichtingen bij CRF-tabellen; incompleetheid van de datasets; literatuurverwijzingen; en vergelijking van activiteiten-data met internationale statistieken. In deze rapportage en/of CRF-tabellen zijn de toelichtingen aangevuld. Activiteiten- en emissiedata zijn aangevuld waar ze nog ontbraken en de zgn. *Implied Emission Factors* voor CO_2 van verbrandingsemissies zijn sterk verbeterd door alle data met inconsistente brandstof/emissie-combinaties te verplaatsen naar de categorie 'overige brandstoffen'.

Verbeteringen in de toekomst

Om te voldoen aan de richtlijnen van het IPCC met betrekking tot de emissieregistratie van broeikasgassen is in 2000 een programma gestart om de bestaande monitoringprocedures aan te passen aan de internationale eisen. Dit programma valt onder verantwoordelijkheid van het Ministerie van VROM en wordt gecoördineerd door Novem. Er is een interdepartementale werkgroep geformeerd – de *Werkgroep Emissiemonitoring Broeikasgassen*, WEB – die belast is met advisering over de verschillende uit te voeren acties. De acties in de afgelopen jaren waren onder andere een Tier-2 onzekerheidsanalyse, evaluatie van de emissiefactoren voor brandstoffen, een Tier-2 feedstock-analyse, identificatie van ontbrekende bronnen van niet-CO_2-broeikasgassen en onderzoek naar de vastlegging van CO_2. De resultaten hiervan zullen in volgende rapportages verwerkt worden. Nog lopende acties zijn het ontwikkelen van nieuwe protocollen (het beschrijven van de methodes voor het vaststellen van de emissies) en diverse *Quality Assurance* en *Quality Control* (QA/QC)-activiteiten.

Executive Summary

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

This report documents the 2003 Netherlands' annual submission of its greenhouse gas emission inventory in accordance with the guidelines provided by the *United Nations Framework Convention on Climate Change* (UNFCCC) and the European Union's *Greenhouse Gas Monitoring Mechanism*. These guidelines, which also refer to *Revised 1997 IPCC Guidelines* and IPCC *Good Practice Guidance* 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* by 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 report therefore provides explanations of the trends in greenhouse gas emissions for the 1990-2001 period and summary descriptions of methods and data sources of (a) Tier 1 assessments of the uncertainty in annual emissions and in emission trends; (b) a preliminary assessment of key sources following the Tier 1 and Tier 2 approaches of the *IPCC Good Practice Guidance*; and (c) Quality Assurance and Quality Control activities. This report gives no specific information on the effectiveness of government policies for reducing greenhouse gas emissions, this information can be found in RIVM's *Environmental Balance 2002*. Please note that emissions presented in this dataset for 2001 have been compiled using preliminary statistics and are calculated differently than the emissions of other years (see *Annexes 2.1* and *3*).

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 website www.greenhousegases.nl, which provides links to the RIVM's website (www.rivm.nl), where these files reside.

Climate Convention and Kyoto Protocol

The ***Kyoto Protocol*** shares the Convention's objective, principles and institutions, but significantly strengthens the Convention by committing Annex I Parties to individual, legally-binding targets to limit or reduce their greenhouse gas emissions. The EU-15 has a target of -8% in the 1990-2008/2012 period. The EU has redistributed its targets among the 15 Member States. The (burden-sharing) target of Netherlands is -6%. Please note that the definition of what should be reported under the source/sink category '*Land-use change and forestry*' (LUCF) to the ***United Nations Framework Convention on Climate Change*** is considerably different from the definition of emissions/sinks to be included in the national total under the *Kyoto Protocol*.

Reporting requirements: UNFCCC and IPCC

Annex I Parties to the UNFCCC must submit annually an *inventory* of their greenhouse gas emissions, including data for their base year (1990, except for some EITs) and data up to the last but one year prior to submission. Inventories due 15 April 2003, for example, should contain emission data up to the year 2001. The *UNFCCC Guidelines* prescribe the source categories, calculation methodologies, and the contents and the format for the inventory report. For the definition of the source categories and calculation methodologies, the *UNFCCC Guidelines* generally refer to the *IPCC Guidelines for Greenhouse Gas Inventories* and the *IPCC Good Practice Guidance* reports. The IPCC often uses the concept of a *'Tiered Approach'*, by which a stepwise approach is meant: *Tier 1* is simplest, requires least data and effort; *Tier 2* is more advanced and/or data intensive; *Tier 3* is still more advanced; etc.

Generally, more detailed/advanced emission calculation methods are recommended, data or capacity permitting and more detailed/advanced uncertainty assessments or more advanced key source assessments. The rationale behind this generic approach of methods, uncertainty assessments and key source assessment is to give recommendations to countries which have more detailed datasets and more capacity to calculation emissions, as well as to countries with less data and manpower available. However, it also serves as a means for balancing efforts in industrialised countries, by not going into details where irrelevant, thereby saving capacity for other more important but relatively weak parts of the inventory. To aid priority setting, the *Good Practice Guidance* recommends using higher Tier methods in particular for so-called key sources. Uncertainty estimates can serve to refine both the key source identification and prioritise inventory improvement activities.

The Netherlands generally applies country-specific, higher Tier methods for calculation greenhouse gas emissions (see *Section 1.5*).

Key sources

For preliminary identification of so-called 'key sources' according to the *IPCC Good Practice approach* we allocated the national emissions according to the IPCC's potential key source list wherever possible. The Netherlands has a high share of feedstock use of fuels, which is a non-combustion category of CO_2, therefore, this source category has been added to the list. 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 of which the total adds up to 95% of the national total are 18 sources for annual level assessment and 20 sources for the trend assessment out of a total of 56 sources. Both lists can be combined to get an overview of sources, which 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 refined result is a list of about 29 source categories out of a total of 56 that could be identified as 'key sources' (see *Table 1.4*).

For these sources in principle a higher Tier emission calculation method should be used. For key sources a brief comparison is made of the Netherlands' methodologies with the IPCC Tiers in the methodological sections of the sectoral Chapters 2 to 9 (also see *Table 1.4*). From this analysis it seems clear that for CH_4 from national gas distribution and CH_4 from enteric fermentation of cattle, for instance, the methods used will probably need to be improved in future. However, a comprehensive analysis still has to be made.

Description of the institutional arrangement for inventory preparation

The preparation of the greenhouse gas emission data in the Netherlands is based on the national *Pollutant Emission Register* (PER). This general process has existed for many years and is organised as a project with an annual cycle. To meet the UNFCCC and IPCC requirements additional actions are (still) necessary. Around the year 2000 a programme was started to adapt the monitoring of greenhouse gases in the Netherlands and transform this into a National System, as stated in Article 5 of the *Kyoto Protocol*. The *Climate Change and Industry Division* of the Ministry of VROM (VROM/DGM/KVI) is responsible for organising the reporting process. *Figure ES.1* presents this process, the relation with the PER and the responsibilities. The *Co-ordination Committee for Target Sector Monitoring* (CCDM) under auspices of the VROM Inspectorate is responsible for the data collection in the PER process, resulting in an intermediate database, hosted by TNO.

The NIR report, also containing a selection of CRF tables, is primarily drafted by RIVM, with contributions by CBS, TNO and Novem. This year, for the first time, organisations and individuals could make comments to the draft NIR. This process was organised by Novem and RIVM, using the site www.greenhousegases.nl. Data collected in the National Inventory Report are based on the PER.

A Greenhouse Gas Inventory Improvement Programme was started in 2000. This programme is guided by the *Working Group Emission Monitoring of Greenhouse Gases* (WEB), which directs future actions aimed at improving the monitoring of greenhouse gas emissions, relevant to reporting to the UNFCCC in all aspects. In *Section 1.6.2* we summarise the main actions presented in more detail in *Section 10.4*. Some actions already resulted in improved data; others are related to future improvements. One of the actions is aimed at improving the process of data collection and calculations by the use of protocols, which should be included in the PER system from 2003 onwards.

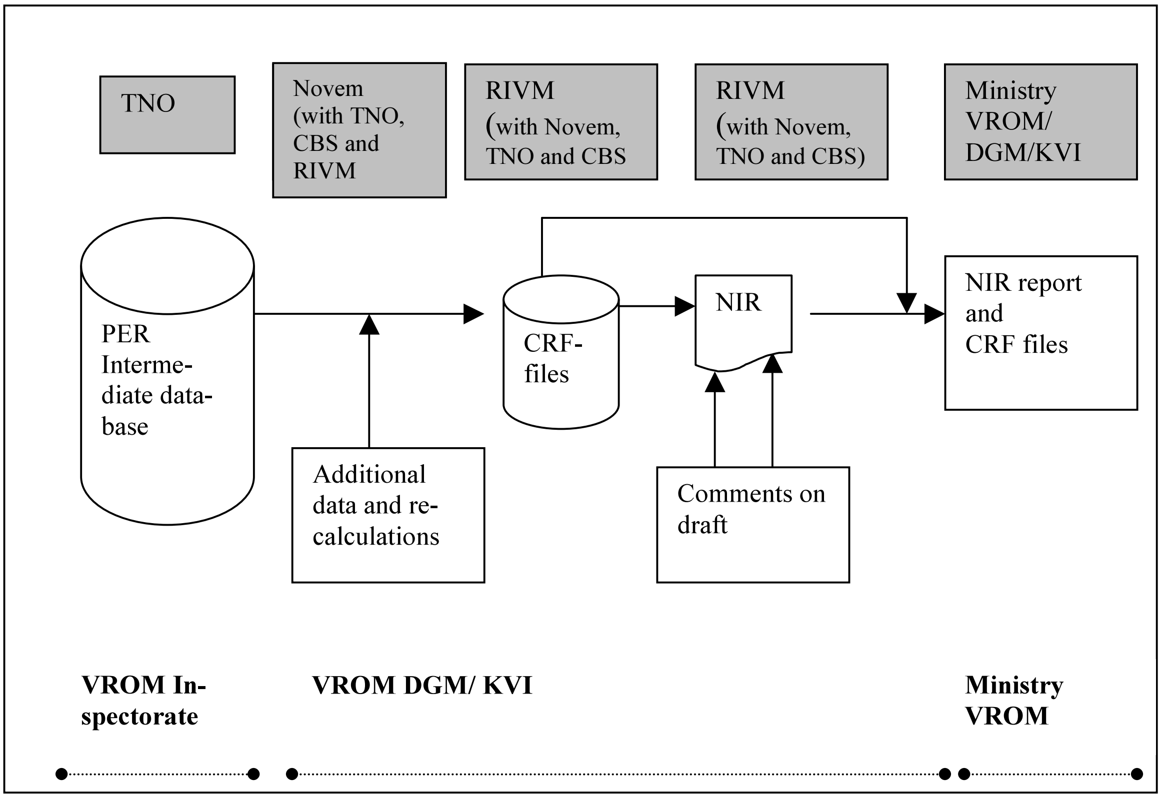

Figure ES.1. NIR and CRF preparation process, relation with the Pollutant Emission Register (PER) and responsibilities.

Organisation of the report

This year, we have changed the structure of the report into the format that will become compulsory as of next year. This was done to identify in advance the elements of the report that need extra attention in the next submission. However, due to time constraints in the preparation of the report, the reader will notice marked differences in the level of detail in the descriptive sections of Chapters 3 to 9, which describe the emissions per source sector and provide explanations of observed trends in sectoral emissions. The report starts with an introductory Chapter 1, containing background information on the Netherlands' process of inventory preparation and reporting; key sources and their uncertainties; a description of methods, data sources and emission factors, and a description of the quality assurance system, along with verification activities applied to the data. Chapter 2 provides a summary of trends for aggregated greenhouse gas emissions by gas and by main source. The final Chapter 10 present information on recalculations, improvements and response to issues raised in external reviews. In addition, the report contains 9 Annexes that provide more detailed information on key sources, methodologies, other relevant reports and detailed emission tables selected from the CRF files.

ES.2. Summary of national emission and removal related trends

In *Table ES.1* the trends in national total (net) CO_2-equivalent emissions are summarised for 1990-2001. Total CO_2-equivalent emissions of the six greenhouse gases together increased by about 4% in 2001 relative to the base year of 1990 (1995 for fluorinated gases). In *Table ES.2* the same trends per gas have been summarised but now with CO_2 emissions corrected for outside temperature in order to exclude the climatic influence that partially masks the anthropogenic trend in the CO_2 emissions. Using temperature-corrected CO_2 emissions in 1990 and 2001, the structural *anthropogenic* trend of total greenhouse gas emissions in the past 11 years is estimated to be a 2%-point lower than the actual trend of 4% increase. CO_2 emissions increased by about 13% from 1990 to 2001, mainly due to the increase in the emissions in the energy (26%) and transport sectors (22%). The doubling of imported electricity in 1999 from 10% to 20% of the domestic electricity consumption only temporarily decreased CO_2 emissions from the energy sector and total national CO_2 emissions. In 2000 and 2001 the annual increase of the pre-1999 years has resumed. CO_2 emissions peaked in 1996 due to a very cold winter.

Table ES.1. Total greenhouse gas emissions in CO_2-eq. and indexed 1990-2001(no temperature correction)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 [1]
Nat. Emissions (Tg CO_2-eq)												
CO_2 with LUCF	157.8	166.0	164.2	166.1	166.8	171.2	178.9	167.5	172.4	169.5	172.4	178.4
CO_2 excluding LUCF	***159.3***	167.5	165.7	167.9	168.8	172.4	180.3	171.7	173.8	170.7	173.8	179.9
CH_4	***27.1***	27.5	26.3	25.7	25.3	24.6	24.6	23.1	22.4	21.8	20.6	20.4
N_2O	***16.5***	16.8	17.9	18.7	18.3	18.2	18.0	17.9	17.6	17.4	16.7	16.1
HFCs	4.4	3.5	4.4	5.0	6.5	***6.0***	7.7	8.3	9.4	4.9	3.9	1.6
PFCs	2.4	2.4	2.1	2.1	1.9	***1.9***	2.0	2.2	1.7	1.4	1.5	1.5
SF_6	0.2	0.1	0.1	0.1	0.1	***0.3***	0.3	0.3	0.3	0.3	0.3	0.3
Total [group of six] [211.1 [5) 2)]]	**210.0**	**217.8**	**216.7**	**219.6**	**220.9**	**223.3**	**232.9**	**223.4**	**225.2**	**216.4**	**216.8**	**219.7**
Index (1990=100)												
Index CO_2 [2]	100	105.2	104.1	105.4	106.0	108.2	113.2	107.8	109.1	107.2	109.1	112.9
Index CH_4	100	101.3	97.0	94.9	93.1	90.5	90.8	85.1	82.4	80.3	76.1	75.3
Index N_2O	100	101.6	108.5	112.8	110.7	109.8	108.5	107.5	106.6	105.0	100.7	97.1
Total [group of three]	100	104.4	103.5	104.6	104.6	106.0	109.8	104.7	105.3	103.4	104.0	106.6
Index HFCs	100	77.9	100.3	112.8	146.4	135.8	173.2	187.4	211.2	110.5	87.4	35.7
Index PFCs	100	100.2	86.3	87.1	77.7	76.8	84.0	88.6	71.0	59.4	62.8	59.9
Index SF_6 (potential)	100	53.7	56.9	58.8	79.2	147.3	152.4	166.6	157.6	141.8	143.7	158.4
Index [group of six] [2]	**100**	**103.7**	**103.2**	**104.6**	**105.2**	**106.3**	**110.9**	**106.4**	**107.2**	**103.1**	**103.2**	**104.6**
Index (1995 = 100)												
Index HFCs	73.6	57.4	73.9	83.0	107.8	100	127.5	138.0	155.5	81.4	64.4	26.3
Index PFCs	130.3	130.5	112.4	113.5	101.3	100	109.4	115.4	92.5	77.4	81.8	78.0
Index SF_6 (potential)	67.9	36.5	38.6	39.9	53.7	100	103.5	113.1	107.0	96.3	97.6	107.5
Index [group of new gases]	**86.4**	**73.4**	**81.5**	**88.6**	**104.5**	**100.0**	**122.6**	**132.0**	**139.5**	**81.0**	**69.5**	**40.9**
Index (1990; new gases 1995) [3]												
Index [group of 6 composite] [2]	**99.5**	**103.2**	**102.6**	**104.0**	**104.6**	**105.8**	**110.3**	**105.8**	**106.7**	**102.5**	**102.7**	**104.1**
International Bunker CO_2 [4]	39.8	41.3	42.4	44.3	42.9	44.3	45.4	48.5	49.5	51.2	53.5	57.5
Index bunkers CO_2 (1990 = 100)	100.0	103.8	106.6	111.4	107.8	111.4	114.3	122.0	124.6	128.8	134.5	144.7

[1] Data for 2001 are preliminary. In particular in this submission this *'t-1'* dataset is of a relatively low quality (see *Section 1.2).*

[2] National emissions, excluding LUCF (category 5A).

[3] Base year = 100.

[4] Emissions from international marine and aviation bunkers are not included in the national totals.

[5] Base year emissions (1990 for CO_2, CH_4 and N_2O and 1995 for the F-gases, shaded/bold-italic figures): 211.1 Tg CO_2-eq.

Table ES.2. Total greenhouse gas emissions with temperature correction, in CO_2-eq. and indexed, 1990-2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Emissions (Tg CO_2-eq)												
CO_2 with LUCF (T-corrected)	164.1	166.4	168.6	167.2	170.6	173.8	174.6	169.8	175.9	174.5	177.7	180.8
CO_2 excluding LUCF (T-corrected)	165.5	167.9	170.1	169.0	172.5	175.0	176.0	174.1	177.3	175.7	179.1	182.2
Total [group of six] [1)]	216.2	218.2	221.0	220.7	224.6	225.9	228.6	225.7	228.7	221.5	222.1	222.0
Index (1990 = 100)												
Index CO_2 excluding LUCF (T-corrected)	100.0	101.5	102.8	102.1	104.2	105.7	106.4	105.2	107.1	106.2	108.2	110.1
Total [group of three] 1)	**100.0**	**101.4**	**102.5**	**102.0**	**103.3**	**104.1**	**104.5**	**102.8**	**103.9**	**102.7**	**103.5**	**104.6**
Index ('90; F-gases '95)												
Index [group of six composite] [1)]	**99.5**	**100.4**	**101.7**	**101.5**	**103.3**	**103.9**	**105.2**	**103.9**	**105.2**	**101.9**	**102.2**	**102.2**

[1)] Excluding LUCF.

CH_4 emissions decreased by 25% in 2001 compared to the 1990 level, mainly due the decrease in the waste sector (-30%), the agricultural sector (-20%) and fugitive emissions from oil and gas (-25%). N_2O emissions decreased by about 3% in 2001 compared to 1990, mainly due to the decrease in the emissions from industrial processes (-13%), which compensated increases of emissions from agriculture of about 5% and from fossil fuel combustion of 45% (mainly from transport).

Of the fluorinated greenhouse gases, for which 1995 is the reference year, emissions of HFCs and PFCs decreased in 2001 by about 75% and 20%, respectively, while SF_6 emissions increased by 7%. Total emissions of all F-gases decreased by about 60% compared to the 1995 level. In 2001 the largest changes showed an increase of 6 Mton of CO_2 – of which 3 Mton was due to the colder winter compared to 2000 – and decrease of over 1 Mton in HFC emissions. Along with the increased import of electricity since 1999, this is the primary reason why total greenhouse gas emissions have stabilised since 1997.

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

Table ES.3 provides an overview of the CO_2-eq. emission trends per IPCC source category. It clearly shows the energy sector (category 1) to be by far the largest contributor to national total greenhouse gas emissions with a share that increased from 75% in 1990 to about 81% in 2001. In contrast, emissions of the other main categories decreased, the largest being those of industrial processes (from 8 to 5% share), waste (from 6 to 4% share) and agriculture (from 8 to 7% in 2001). The sectors showing the largest growth in CO_2-eq. emissions since 1990 are the energy sector and the transport sector, showing increases of 26% and 22%, respectively. Clear exceptions are the waste sector and agriculture, which showed a decrease in CO_2-eq. emissions of about 30% and 10%, respectively. Emissions from the residential and service sectors increased by 5%, but weather effects substantially influence these: when the temperature correction was included, these emissions decreased by about 3%.

Energy Sector (CRF sector 1)

The emissions from the energy sector (category 2) are dominated by CO_2 from fossil fuel combustion, with fugitive emissions from gas and oil (methane and CO_2) contributing a few per cent and CH_4 and N_2O from fuel combustion adding one per cent. Responsible for the increasing trend in this sector are the energy industries and the transport sector, of which CO_2 emissions increased by 26 and 22% since 1990. In contrast, the energy-related CO_2 emissions from manufacturing industries appear to have decreased a few per cent in 2000 and 2001 and the actual CO_2 emissions from the other sector (residential, services and agriculture) increased by about 5%. The relatively strong increases in emissions from the energy sector and the transport sector result in increases of their CO_2 share in the national CO_2-eq. total by 5% and 2%-points, respectively, to 29% and 16% in the 2001. The 29% increase of the energy sector emissions is partly mitigated by about 10%-points due to the strong increase in net import of electricity since 1999, which is equivalent to about 4 Mton of CO_2 coming from domestic fossil-fuel generated electricity. We note that fugitive methane emissions from oil and natural gas decreased by 25% since 1990.

Table ES.3. Summary of emission trend per source category and per gas (in Tg CO_2-eq.)

Source category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1A. Energy: fuel combustion	**157.8**	**166.8**	**165.4**	**167.8**	**168.5**	**170.8**	**178.4**	**166.3**	**171.9**	**168.3**	**172.2**	**178.3**
CO_2: 1. Energy industries	51.3	52.2	54.1	53.8	56.0	56.5	58.3	57.2	60.2	56.7	61.2	64.8
CO_2: 2. Manufacturing industries	41.9	42.7	42.5	39.9	41.0	42.6	43.0	38.9	42.4	42.3	39.7	40.2
CO_2: 3. Transport	29.1	29.2	30.4	30.9	31.2	32.2	32.6	33.1	33.8	34.8	35.2	35.6
CO_2: 4. Other sectors	34.2	40.4	37.3	40.1	38.5	37.9	42.7	35.9	34.0	33.1	34.5	36.1
CO_2: 5. Other	0.0	1.1	-0.4	1.7	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
CH_4	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.6	0.6	0.7	0.7	0.7
N_2O	0.6	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.8	0.8
1B2. Energy: fugitives from oil & gas	**4.1**	**4.4**	**3.8**	**3.7**	**3.9**	**4.4**	**5.0**	**4.3**	**4.6**	**4.5**	**4.3**	**4.5**
CO_2	0.3	0.5	0.4	0.4	0.2	0.8	1.0	1.0	1.6	1.5	1.6	1.7
CH_4	3.8	4.0	3.4	3.3	3.5	3.6	4.0	3.3	3.1	3.0	2.8	2.8
N_2O	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Industrial processes [1)]	**16.3**	**15.2**	**15.7**	**16.8**	**17.9**	**17.1**	**18.9**	**19.1**	**19.8**	**15.0**	**13.9**	**11.0**
CO_2	1.6	1.5	1.3	1.2	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.1
CH_4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
N_2O	7.6	7.7	7.7	8.3	7.9	7.5	7.5	7.5	7.5	7.2	7.1	6.6
HFCs	4.4	3.5	4.4	5.0	6.4	6.0	7.6	7.7	9.0	4.7	3.7	1.5
PFCs	2.4	2.4	2.1	2.1	1.9	1.9	2.0	2.2	1.7	1.4	1.5	1.5
SF_6	0.2	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Solvent and other product use [1)]	**0.2**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**
CO_2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH_4	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)
N_2O	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
4. Agriculture	**17.5**	**17.9**	**18.7**	**18.6**	**18.2**	**18.3**	**17.9**	**17.4**	**17.0**	**16.7**	**15.8**	**15.8**
CH_4: Enteric fermentation	8.4	8.6	8.4	8.2	8.0	7.9	7.7	7.4	7.2	7.0	6.7	6.8
CH_4: Manure management	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9
N_2O: Manure management	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
N_2O: Agricultural soils	6.7	6.8	7.8	7.9	7.8	8.1	8.0	7.8	7.6	7.6	7.0	7.0
5A. Changes in forest/biomass stocks	**-1.4**	**-1.5**	**-1.5**	**-1.8**	**-1.9**	**-1.2**	**-1.4**	**-1.2**	**-1.4**	**-1.2**	**-1.4**	**-1.4**
CO_2	-1.4	-1.5	-1.5	-1.8	-1.9	-1.2	-1.4	-1.2	-1.4	-1.2	-1.4	-1.4
6. Waste	**12.9**	**11.9**	**11.5**	**11.3**	**10.9**	**11.2**	**11.4**	**11.2**	**10.0**	**10.2**	**9.0**	**8.7**
CO_2	0.9	0.0	0.0	0.0	0.0	0.9	1.1	1.2	0.5	1.0	0.4	0.4
CH_4	11.9	11.8	11.4	11.1	10.7	10.1	10.2	9.7	9.4	9.0	8.5	8.2
N_2O	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2
7. Other	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
CH_4: Solvents and other product use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O: Polluted surface water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
NATIONAL TOTAL EMISSIONS [2)]	**210.0**	**217.8**	**216.6**	**219.5**	**220.8**	**223.3**	**232.7**	**219.5**	**224.7**	**216.2**	**216.6**	**219.6**
Memo item, not included in national total:												
International bunkers	**39.8**	**41.3**	**42.4**	**44.3**	**42.9**	**44.3**	**45.4**	**48.5**	**49.5**	**51.2**	**53.5**	**57.5**
CO_2 Marine	35.3	36.3	36.5	37.8	36.1	36.6	37.2	39.5	39.8	41.1	43.4	47.7
CO_2 Aviation	4.5	5.0	5.9	6.5	6.7	7.7	8.2	9.0	9.7	10.1	10.1	9.9

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

[2)] The national total does not include the CO_2 sink reported under category 5A. This CO_2 sink is not complete and refers to the definition under the *UN Framework Convention on Climate* Change (UNFCCC), which is different from the amount to be calculated under the *Kyoto Protocol* (see *Section 1.1.2).*

Industrial processes (CRF sector 2)

The greenhouse gas emissions from industrial processes (category 2) have decreased by over 30% since 1990. As can be seen in *Table ES.3,* N_2O emissions, mainly from nitric acid manufacture, is the main contributor to this source category. However, the strong decreasing trend in HFC emissions (of 2/3 reduction since 1990 and 3/4 reduction since 1995), notably of HFC-23 from HCFC-22 manufacture, is primarily responsible for the decreasing trend in this source category. The F-gas emissions had a share of almost 50% in total source category emissions in 1995; their share is now about 30%, of which HFCs and PFCs form by far the largest part. PFC emissions in the Netherlands stem mainly from aluminium production. CO_2 emissions from industrial processes contribute 10% to the group total and stem only for 1/3 of 1/4 from cement clinker production. A large fraction of cement production in the Netherlands uses imported cement clinker. Emissions of SF_6 contribute about 3% to the group total.

Solvents and other product use (CRF sector 3)

The emissions from 'Solvent and other product use' (category 3) should be discussed in conjunction with (very small) methane emissions reported under category 7, since the IPCC tables do not allow for methane emissions under category 3. This category contributes very little to the national total: only 0.1%, primarily stem from N_2O from dispersive uses. We note the CO_2 emissions related to the use of products from non-energy use of fuels (e.g. lubricants, waxes, etc.) are not reported in this category but are included in the fuel combustion emissions reported under the manufacturing industry (1A2).

Agriculture (CRF sector 4)

The emissions of the agricultural sector have decreased by 10% since 1990, mainly through a decrease in CH_4 emissions from enteric fermentation (4.A) of 20% by reduced livestock numbers. In its wake, CH_4 from manure management (4.B) has also decreased similarly over time. At present, enteric fermentation contributes about 45% to this category's emissions as does N_2O emissions from agricultural soils (4.D); N_2O from manure management only contributes 1% to the group total. N_2O from agricultural soils increased until 1995 due to changing practices in animal manure spreading on the fields (incorporation into the soil with the aim of reducing ammonia emissions). The decrease since 1998 is mainly due to a reduction of the use of synthetic fertilisers. At present, due to historic reasons, the Netherlands reports no CO_2 emissions from agricultural soils. Indirect N_2O emissions from leaching and run-off of nitrogen from agricultural soils are reported under IPCC category 7, because the Netherlands' method provides only aggregated figures that include industrial sources as well.

Changes in biomass stocks (LUCF) (CRF sector 5)

Of the Land Use Change and Forestry (LUCF) sector, the Netherlands presently only reports the net changes of CO_2 due to changes in forests and other biomass stocks (IPCC category 5A). These result in a sink of about 1% on the national net total emissions. The variation over time is between -1.2 and -1.9 Mton CO_2.

Waste (CRF sector 6)

The emissions from the waste sector have decreased by about 30% since 1990, mainly through decreasing CH_4 emissions – predominantly from landfills – which is the dominating gas (CO_2 and N_2O emissions contributing the remaining 6%). The fossil-fuel related emissions from waste incineration are included in the fuel combustion emissions from the energy sector (1A1), since most large-scale incinerators also produce electricity or heat for energetic purposes. The CO_2 emissions from this sector, presently contributing 4% to the waste category total, have also changed over time (decreased by 0.5 Mton in 1990-2001), but the interannual variation suggests that these figures may not be very reliable.

Other (CRF sector 7)

The Netherlands uses IPCC category 7 to reports its – very minor – CH_4 emissions from solvents and other product use, because the present reporting framework does not allow for CH_4 emissions under IPCC category 3. Total indirect N_2O emissions from leaching and run-off of nitrogen from agricultural soils and industrial sources are reported here, because the Netherlands' method provides only aggregated figures that include industrial sources. The indirect N_2O emissions are labelled as '*Polluted surface water*' and are constant over time.

International transport

Emissions from international transport are not part of the national total but are reported separately. At present, the Netherlands only reports CO_2 emissions, not the – relatively minor – emissions of CH_4 and N_2O from these sources. Total CO_2 emissions from this source category have increased by 45% or 18 Mton since 1990, to which, in particular, marine bunker emissions contributed (+35% or 12 Mton) due to the marine bunkers large share in this category, but percentage-wise the emissions from international aviation increased much more (+120% or about 5 Mton). Total international transport emissions have increased as fraction of the national total greenhouse gas emissions from 19% in 1990 to 26% in 2001.

ES.4. Other information

Differences with the domestic national emission inventory

The *Climate Convention* uses a specific definition of the emissions that should be included in the national total. The *UNFCCC* and the *Kyoto Protocol* do not include CO_2 emissions from combustion of biomass fuels (such as fuelwood, wood, wood waste, agricultural waste and biogas) in the totals from fuel combustion, since these are by default assumed to be produced in a sustainable way. To the extent that they are not produced sustainably, i.e. according to the *UNFCCC Guidelines,* this should be taken into account when reporting on *Land Use Change and Forestry* (LUCF), not under CO_2 from fuel combustion. Furthermore, the IPCC source categories make a clear distinction between fuel combustion and non-combustion emissions from an economic sector (see *Section 1.1.6*), where the Netherlands' emissions of so-called Target Sectors are mostly analysed by their total emissions.

Another specific issue is the distinction that the IPCC makes between CO_2 from non-energy use/feedstock use of fuels and CO_2 emissions from other non-combustion processes. This requirement poses limitations to the extent that the Netherlands in its reporting can decompose these different sources in cases where individual companies report their emissions at a too aggregated level. Another difference is found in the definition of national versus international transport. Whereas the national method uses vehicle statistics to estimate road transport emissions, the UNFCCC requires the use of fuel delivery data as the basis for calculating the emissions from this source category. As illustrated in *Chapter 3*, this results for the Netherlands in annual differences between 5 and 10%.

Differences with other national publications

The emission data presented in this report are identical to those officially published for 1990, 1995 and 1999-2001 in the *Emission Monitor 2002* published by the VROM Inspectorate and used in RIVM's *Environmental Balance 2002.* An exception is a revision of CO_2 from waste incineration for the years 1990 and 1995-2001, which led to a decrease in CO_2 emissions of about a half Mton (see *Section 10.1.3* for details).

General uncertainty evaluation

Based on a simple Tier 1 calculation of annual uncertainties, the actual *annual uncertainty* of total annual emissions per compound and of the total is currently estimated by RIVM at:

CO_2	±3%	HFCs	±50%
CH_4	±25%	PFCs	±50%
N_2O	±50%	SF_6	±50%

The resulting uncertainty in national total annual CO_2-eq. emissions is estimated to be about 5%. If we rank the sources according to their contribution to the uncertainty in total national emissions the top-10 of sources contributing most to total *annual uncertainty* in 2001 is:

IPCC Source category	Uncertainty (as % of total national emissions in 2001)
Direct N_2O emissions from agricultural soils	1.5
N_2O emissions from nitric acid production	1.5
Indirect N_2O emissions from nitrogen used in agriculture	1.4
CH_4 emissions from solid waste disposal sites	1.2
N_2O emissions from polluted surface water	1.1
CO_2 emissions from stationary combustion: energy industries	1.1
CO_2 emissions from feedstock oil	1.0
CH_4 emissions from enteric fermentation in cattle livestock	0.6
CO_2 emissions from mobile combustion: other	0.6
CO_2 emissions from stationary combustion : other sectors	0.5

The result is a trend uncertainty in the total CO_2-eq. emissions for 1990-2001 (1995 for F-gases) of ±3% points. This means that the increase in total CO_2-eq. emissions between 1990 and 2001, which is calculated to be 4%, will be between +1 and +7%. 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%, ±7%, ±11% and ±10% points, respectively. More details on the level and trend uncertainty assessment can be found in *Annex 1* on key sources. The top-10 of sources contributing most to *trend uncertainty* in the national total is:

IPCC Source category	Uncertainty (as % into trend in total national emissions)
CO_2 emissions from stationary combustion: energy industries	1.3
CH_4 emissions from solid waste disposal sites	1.0
CO_2 emissions from mobile combustion: other (rail, pipeline)	0.8
CO_2 emissions from stationary combustion: other sectors	0.7
HFC-23 emissions from HCFC-22 manufacture	0.7
CO_2 emissions from inland shipping	0.7
CO_2 emissions from feedstock oil	0.6
CO_2 emissions from stationary combustion: manufacturing industries	0.5
Indirect N_2O emissions from nitrogen used in agriculture	0.5
N_2O emissions from nitric acid production	0.5

If we compare this list with the 10 largest contributors to annual uncertainty, we can conclude that except for CO_2 from inland shipping, CO_2 from stationary combustion from manufacturing industries and construction, N_2O from polluted surface water, CH_4 from enteric fermentation of cattle and HFC from HCFC-22 manufacture, all others (7) are included both lists.

Completeness

At present, the Netherlands greenhouse gas emission inventory includes *all* sources identified by the *Revised IPCC Guidelines* (IPCC, 1997) *except* for the following:

- Indirect N_2O emissions from *atmospheric deposition* (category 4D) are not estimated/reported due to historic reasons;
- CO_2 emissions from *agricultural soils* (category 4D) are not estimated/reported due to historic reasons;
- In addition, it has been observed that *CH_4 and N_2O from horse manure* (category 4B) is missing; this is because no manure production estimates from horses have been made to date and no emission factors for this source category have been defined;
- CH_4 emissions from soils deceased in the last 40 years due to drainage and lowering of water tables; these emissions have been included in the natural total; thus there are no net (i.e. positive) anthropogenic emissions, on the contrary, total methane from soils acts in fact a methane sink;

- CH_4, N_2O and other non-CO_2 emissions from *international bunkers (international transport)* have not yet been estimated/ reported;
- Emissions/sinks for *LUCF subcategories 5A to 5E*, except for the CO_2 sink in category 5A2. New datasets are being compiled but are still under discussion, so no data for these subcategories have been included in this submission.

The incorporation of these sources into the national greenhouse gas inventory is part of the inventory improvement programme. For some of these sources, for example indirect emissions of N_2O, bringing the methodology in compliance to *IPCC Good Practice Guidance* may result in adjustments of several Tg (i.e. Mton) of CO_2-eq.

Recalculations and improvements

The consequences of recalculations on the different greenhouse gas emissions compared to the previous NIR are presented in the *Table ES.4*. Because most changes are only minor and, since recalculations were mostly only performed to 1990 and 1995, emission figures have, in general, remained unchanged for the years 1991-1994 compared to the previous submission.

Table ES.4. Differences between NIR 2002 and NIR 2003 for 1990-2000 due to recalculations

Gas	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 [Tg]	NIR 2002	**158.2**	166.0	164.2	166.1	166.8	171.4	178.3	167.8	173.7	170.8	172.1
Incl. LUCF	NIR 2003	**157.8**	166.0	164.2	166.1	166.8	171.2	178.9	167.5	172.4	169.5	172.4
	Difference	***-0.2%***	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*-0.1%*	*0.3%*	*-0.2%*	*-0.7%*	*-0.8%*	*0.2%*
CO_2 [Tg]	NIR 2002	**159.6**	167.5	165.7	167.9	168.8	172.7	179.7	169.0	175.1	172.1	173.5
Excl. LUCF	NIR 2003	**159.3**	167.5	165.7	167.9	168.8	172.4	180.3	168.7	173.8	170.7	173.8
	Difference	***-0.2%***	***0.0%***	***0.0%***	***0.0%***	***0.0%***	***-0.1%***	***0.3%***	***-0.2%***	***-0.7%***	***-0.8%***	***0.2%***
CH_4 [Gg]	NIR 2002	**1293**	1309	1257	1226	1203	1170	1173	1101	1065	1038	983
	NIR 2003	**1292**	1309	1253	1226	1203	1170	1174	1100	1065	1037	983
	Difference	***0.0%***	*0.0%*	*-0.3%*	*0.0%*	*0.0%*	*0.0%*	*0.2%*	*-0.2%*	*0.0%*	*0.0%*	*0.0%*
N_2O [Gg]	NIR 2002	**53.3**	61.9	63.4	63.5	65.2	58.6	65.3	68.1	57.5	56.0	54.8
	NIR 2003	**53.4**	54.2	57.9	60.2	59.1	58.6	57.9	57.4	56.9	56.0	53.7
	Difference	***0.1%***	*-12.4%*	*-8.7%*	*-5.2%*	*-9.4%*	*0.0%*	*-11.4%*	*-15.7%*	*-1.1%*	*0.0%*	*-1.9%*
PFCs [Mg]	NIR 2002	353	354	304	307	273	**269**	295	312	246	203	214
	NIR 2003	353	354	304	307	273	**269**	295	312	246	203	214
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***0.0%***	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
HFCs [Mg]	NIR 2002	379	412	388	433	604	**653**	931	1424	1489	1133	1071
	NIR 2003	379	295	406	474	680	**700**	1113	1496	1585	1196	1053
	Difference	*0.0%*	*-28.4%*	*4.6%*	*9.4%*	*12.7%*	***7.2%***	*19.5%*	*5.0%*	*6.4%*	*5.6%*	*-1.7%*
SF_6 [Mg]	NIR 2002	7.8	4.2	4.5	4.6	6.2	**15.1**	15.3	16.1	15.4	14.1	13.7
	NIR 2003	7.8	4.2	4.5	4.6	6.2	**11.5**	11.9	13.0	12.3	11.1	11.2
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***-23.7%***	*-21.9%*	*-19.2%*	*-20.2%*	*-21.2%*	*-17.8%*
Total	NIR 2002	208.9	220.0	217.0	218.9	220.7	222.4	232.8	222.8	225.2	216.6	215.5
[Tg CO_2-eq.]	NIR 2003	208.6	216.3	215.2	217.8	218.9	222.1	231.5	219.1	223.8	215.2	215.4
Incl. LUCF	*Difference*	*-0.2%*	*-1.7%*	*-0.9%*	*-0.5%*	*-0.8%*	*-0.1%*	*-0.55%*	*-1.64%*	*-0.62%*	*-0.6%*	*0.0%*
Total.	NIR 2002	210.3	221.5	218.5	220.7	222.6	223.6	234.2	224.0	226.5	217.8	216.9
[Tg CO_2-eq]	NIR 2003	210.0	217.8	216.7	219.6	220.9	223.3	232.9	220.3	225.2	216.4	216.8
Excl. LUCF	*Difference*	*-0.2%*	*-1.7%*	*-0.9%*	*-0.5%*	*-0.8%*	*-0.1%*	*-0.6%*	*-1.6%*	*-0.6%*	*-0.6%*	*0.0%*

Note: base year values are indicated in bold.

For recalculation a distinction is made between:

- *Methodological changes:* new data based on revised or new estimation methods; improved emission factors are also included under methodological changes;
- *Allocation:* changes in allocation of emissions to the different sectors (only affect the totals per sector);
- *Error corrections:* repair of incorrect data transfer from the PER to the CRF.

In 2002, methodological changes were made for the years 1990, 1995, 1999, 2000 and (new) 2001. This means that for 1991-1994 and 1996-1998 no recalculations were made, except in the cases explicitly mentioned below. The following methodological changes were made:

- recalculation of N_2O emissions from nitric acid production (1991-1994; 1996-1998) based on the method for 1990, 1995 and 1999-2001;
- recalculation of CH_4 and N_2O emissions from wastewater handling (1990-2001);
- revision of HFC emissions for the years 1994-2001 based on improved analysis of data;
- revision of SF_6 emissions for the years 1994-2001 based on improved analysis of data.

In this submission the ***source allocation*** was improved in the following cases:

- *Waste*: The Dutch PER uses ambiguous source descriptions for the waste sector and these have changed over time. In the NIR 2003 an allocation was made based on the source descriptions for 2000.
- *Other fuels in fuel combustion*: In the NIR 2002 the combustion emissions with no or incomplete activity data were allocated to the category *'Other fuels'*. In the previous NIR not all LPG was allocated under liquid fuels. In this submission the consistency of the fuel split was improved.
- *Industrial processes:* The emissions from industrial processes for 1996 and 1997 were for NIR 2003 provided with the newest source codes (as used for the years 1990, 1995, 1998-2001). Therefore the allocation of the emissions to sector 2 for these years is now in fully consistent with the other years.

The most obvious ***error corrections*** were:

- Removal of double counting for CO_2 in category 2G *'Industrial processes'* (desulphurisation of flue gas) (1990);
- CO_2 emissions from Fuel combustion in (1A2f) (1990, 1995,1998 and 1999 to 2000);
- CO_2 emissions in Energy industries (1A1) (1999);
- Corrected data in the CRF Feedstock Table 1Ad for 1994, and 1999 to 2001, related to different definitions of non-energetic use of coal and cokes in the iron and steel sector;
- All data sets for 1990, 1995 to 2001 were checked for possible incorrect attribution of CO_2 from combustion of biomass fuels to emissions included in the national total;
- N_2O from agricultural soils (1990 and 2000).

Recalculation of base year

The total CO_2-eq. emissions in the base year 1990 decreased by 0.3 Tg CO_2-eq or 0.2% compared to last submission. This decrease can be explained by the following most relevant changes (all in CO_2 equivalent):

- For CO_2: -0.6 Tg in the category *Energy* (1A) mainly due to error correction in 1A4 and reallocation to *Waste* (6); +0.4 Tg in *Waste* (6D) on the basis of improved allocation of fuel related emissions; and -0.1 Tg in *Industrial processes* (2G) due to removal of double counting;
- For other gases the changes are very small*:* -0.004 Tg for CH_4 in *Energy* (1A) and *Waste* (6) and +0.03 Tg for N_2O in *Agricultural Soils* (4D) due to error corrections;

The changes for F-gases in 1995 (the base year for the F-gas emissions) due to recalculations are very minor (rounded 0.0 Tg CO_2-eq.): +0.04 Tg for HFCs and -0.086 Tg for SF_6 emissions. Improved data and changes in source allocation can explain the remainder of the differences in emissions.

Recalculation of year 2000

The data for 2000 are now 'final'; in the previous submission they were partly based on preliminary statistics. The increase in the total CO_2-eq. emissions for 2000 was 0.1 Tg CO_2-eq or 0.04 % compared to NIR 2002. For the finalisation of the 2000 figures a different estimation method is used than the last year, when the emissions 2000 had to be estimated partly by extrapolation of incomplete data, which obviously leads to changes in emission data. The main changes are (all in CO_2 equivalent):

- For CO_2: +0.5 Tg in *Energy* (1A) due to the use of final energy statistics; -0.1 Tg in *Industry* (2) due to reallocation to *Energy* (1A); and -0.1 Tg in *Waste* (6) due to reallocation to *Energy* (1A);
- For CH_4: +0.02 Tg in *Energy* (1) mainly due finalisation of 1B2; -0.03 Tg in *Industry* (2); +0.06 Tg in *Agriculture* (4A Enteric fermentation) based on final agricultural statistics; -0.04 Tg in *Waste* (6), mainly based on final figures for *Wastewater handling* (6B) and *Waste disposal* (6A);
- For N_2O: - 0.3 Tg mainly due the finalisation of the *Agricultural soil emissions* (4D);
- For HFCs and SF_6: -0.04 Tg and -0.06 Tg, respectively, due to recalculations

Implications for emission trends, including time-series consistency

The trend in emissions for the years 1990 to 2001 is shown in *Table ES.5.* From this table it can be concluded that due to recalculations the trend in the total national emissions increased by 0.1% compared to the NIR 2002. The largest relative changes in emission trends are observed for N_2O, HFCs and SF_6.

Table ES.5. Differences between NIR 2002 and NIR 2003 for the emission trends 1990-2000

Compound [unit]	**Trend (absolute change)**			**Trend (%)**		
	NIR 2002	NIR 2003	*Difference*	NIR 2002	NIR 2003	*Difference*
CO_2 [Gg] [1)]	13,897	14,570	*673*	8.7%	9.1%	*0.4%*
CH_4 [Gg]	-310	-309	*1*	-24.0%	-23.9%	*0.0%*
N_2O [Gg]	1.5	0.4	*-1.1*	2.8%	0.7%	*-2.1%*
HFCs [Mg]	692	674	*-18*	182.7%	177.9%	*-4.8%*
PFCs [Mg]	-139	-139	*0*	-39.3%	-39.3%	*0.0%*
SF_6 [Mg]	5.9	3.4	*-2.4*	74.9%	43.7%	*-31.2%*
CO_2-eq. [Gg] [1)]	6,568	6,812	*244*	3.1%	3.2%	*0.1%*

[1)] Excluding LUCF.

Emission trends for indirect greenhouse gases and SO_2

Trends in total emissions of CO, NO_x, NMVOC and SO_2 are presented in *Table ES.6*. The CO and NMVOC emissions were reduced in 2001 by about 40-45% compared to 1990, for SO_2 even 55%, and for NO_x the 2001 emissions are about 30% lower than the 1990 level. NO_x emissions were recalculated on basis of new information on emission factors for small combustion plants (<20 MW) for the years, 1990, 1995, 2000 and 2001 (not yet recalculated for 1999), resulting in about 10 Gg less emissions in 2000. The uncertainty in the activity data is small compared to the accuracy of the emission factors. Therefore, the uncertainty in the overall total of sources included in the inventory is estimated to be in the order of 25% for CO, 10% for NO_x and SO_2, and about 25% for NMVOC.

Table ES.6 Trend in emissions of ozone and aerosol precursors 1990-2001 (in Gg)

Compound	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Total NO_X	563.0	537.9	525.9	505.1	482.4	482.7	470.3	441.0	427.0	428.1	411.6	409.8
Total CO	1120.5	1022.5	966.3	948.6	905.1	854.8	866.6	785.7	740.5	704.2	681.2	661.6
Total NMVOC	492.4	460.6	436.2	403.2	387.7	363.3	306.3	271.1	301.6	291.1	278.3	271.2
Total SO_2	202.4	163.5	157.2	150.4	136.5	141.5	133.7	115.9	108.0	103.3	91.6	89.0

Response to the issues raised in UNFCCC reviews

The Netherlands greenhouse gas inventories are subject to the following reviews by the UNFCCC Secretariat: (a) Desk Review and Centralised Review of the NIR 2000 and (b) Country section of Synthesis & Assessment report on the NIR 2001 and the NIR 2002. In general the findings of the different UNFCCC reviews are well observed and described. The Netherlands response to the general remarks is as recorded below. The Netherlands responded and made improvements in this NIR on the following aspects: inconsistency in time series, missing notation keys and other documentation in CRF tables, incompleteness of CRF and NIR, additional info in NIR, and comparison of activity data with international statistics. Partly in response to the reviews and partly as a result of the national improvement programme changes were made in the CRF tables (see *Section 10.4.6* for details):

- Replacing 0 by notation keys such as '*Not Estimated*' etc., where appropriate, and adding to the completeness table and other documentation boxes the source allocation used in cases of sources '*Included Elsewhere*';
- Many activity data gaps have been filled;
- Correction of typing/unit errors as observed;
- So-called implied emission factors for CO_2 from fuel combustion have been improved substantially.

Planned improvements

The *UNFCCC Guidelines for reporting* the emissions and the *Guidelines for National Systems* for annual emission monitoring under the Kyoto Protocol have added additional requirements to the present *Pollutant Emission Register* (PER) of the Netherlands. In 2000 a programme was started to adapt the monitoring procedures of greenhouse gases in the Netherlands to meet these requirements. Similar requirements were imposed by the European Union, which is also a Party to the Convention and the Protocol, which require that the EU Member States' National Systems to be operational by 1 January 2005.

The national system improvement programme is being implemented under the responsibility of the Netherlands Ministry of Spatial Planning, Housing and the Environment (VROM), who delegated the practical co-ordination to Novem. Ultimately, all improvements and arrangements will become an integral part of the larger system of annual emission monitoring (PER). In recent years a series of source-specific activities to improve the greenhouse gas inventory have been concluded. Some examples are a re-evaluation of CO_2 emission factors for fuels, a Tier 2 feedstock analysis, identification of non-CO_2 sources that are not yet included in the inventory, and a sinks assessment. Other more general activities aim at improving the national system:

- *Development of protocols and process descriptions:* as part of the National System, in these protocols all relevant methodologies, procedures, tasks, responsibilities and such will be described in a transparent way.
- *Elaboration and implementation of a QA/QC system as part of the National System:* in 2001 a three phase project was started to develop (or rather adapt) the QA/QC system for the Netherlands GHG monitoring and NIR/CRF process.
- *Improvement proposals resulting from compiling the NIR/CRF 2003 submission:* during the compilation and checks of the data for the CRF files it was concluded that the data for the waste sector were not satisfactory. Actions should be taken to standardise source descriptions, and new estimations of the related emissions may be necessary.

Furthermore, it was concluded that the CO_2 emissions from waste incineration and CO_2 emissions for 1997 and 1999 from combustion in the chemical industry and 1or 1997 in the food industry are not well fitting in the expected trend. This not yet fully explained emission trend for 1997 also contributes to the large difference of 4% between the *Reference Approach* and the *National Approach* for CO_2 in that year. These issues will be brought to the attention of the *Co-ordinating Committee on Target Group Monitoring* (CCDM).

1. INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

This report documents the 2003 Netherlands' annual submission of its greenhouse gas emission inventory in accordance with the guidelines provided by the *United Nations Framework Convention on Climate Change* (UNFCCC) and the European Union's *Greenhouse Gas Monitoring Mechanism*. These guidelines, which also refer to *Revised 1997 IPCC Guidelines* and IPCC *Good Practice Guidance* reports (IPCC, 1997, 2000), 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* by the UNFCCC. Therefore, the inventories should be *transparent, consistent, comparable, complete* and *accurate* as elaborated in the *UNFCCC Guidelines* for reporting (UNFCCC, 1999) and be prepared using *good practice* as described in IPCC (2000).

This report therefore provides explanations of the trends in greenhouse gas emissions for the 1990-2001 period and summary descriptions of methods and data sources of (a) Tier 1 assessments of the uncertainty in annual emissions and in emission trends; (b) a preliminary assessment of key sources following the Tier 1 and Tier 2 approaches of the *IPCC Good Practice Guidance* (IPCC, 2000); and (c) Quality Assurance and Quality Control activities.

Please note that the emissions presented in this dataset for 2001 have been compiled using preliminary statistics and are calculated differently than the emissions in other years (see *Annexes 2.1* and *3*). In particular, estimates for fuel combustion are, just as done previously, based on energy statistics for the first three quarters of 2001 only, since data for the fourth quarter were not available on time. However, for public power generation, refineries and steel production, further adjustments were made on the basis of annual environmental reports from individual companies (Koch *et al.*, 2002).

For detailed assessments to what extent changes in emissions, as explained in this report, are due to implementation of policy measures, we refer to the annual *Environmental Balance* published by RIVM (RIVM, 2002, in Dutch), the *Third Netherlands' National Communication on Climate Change Policies* (VROM, 2001) and a special assessment by Jeeninga *et al.* (2002), available in Dutch only.

Twelve so-called *Common Reporting Format* (CRF) spreadsheet files, containing data on emissions, activity data and implied emission factors, accompany this report as electronic annexes. These files, with file names '*Netherlands - submission 2003 v 2.0 - NNNN.xls'* with NNNN = 1990 .. 2001, have been compressed into three zip files: crf-nld-2003-v2-90-93.zip; crf-nld-2003-v2-94-97.zip; crf-nld-2003-v2-98-01.zip. The complete set of CRF files as well as the NIR in pdf format can be found at website www.greenhousegases.nl, which provides links to the RIVM's website (www.rivm.nl), where these files reside.

1.1.1 Greenhouse gases and climate change: Global Warming Potential

The six main greenhouse gases whose emissions should be reported under the *Climate Convention* are:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide, also called 'laughing gas' (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF_6).

Actually, HFCs and PFCs comprise two groups of gases, but the greenhouse gases above are often in short called the 'six greenhouse gases'. Although each of these greenhouse gases individually has a heating effect on the atmosphere, one kg consisting of different gases will make a different contribution to this phenomenon. SF_6, HFCs and PFCs, also referred to as 'F-gases', are the most heat-absorbent gases, CH_4 traps over 21 times more heat per molecule than CO_2, and N_2O absorbs 310 times more heat per molecule than CO_2.

Since each greenhouse gas differs in its ability to absorb heat in the atmosphere, there is a need for a common emission unit for environmental policies that are meant to control greenhouse gas emissions. This is the *Global Warming Potential* or *GWP*, expressing the emissions of a gas in CO_2-equivalent emissions. The exact definition of this concept is subject to discussion; it can, for instance, be expressed as the total warming effect during a certain period of time, e.g. 20, 100 or 500 years, and may or may not include indirect effects. The Parties (i.e. mostly countries) to the *UNFCCC* and the *Kyoto Protocol* have adopted the GWP values with a 100-year time horizon as reported by the IPCC in its *Second Assessment Report* (UNFCCC, 1999). In *Annex 8*, the relevant GWP values used in this report have been summarised.

In addition to these so-called *direct* greenhouse gases there are other gases that also contribute to heating the atmosphere. Some of these, such as CFCs and HCFCs, are already subject to reduction in other protocols, which will be phased out according to the Montreal Protocol and its subsequent amendments. Other species act *indirectly* as greenhouse gas or as cooling agents in the atmosphere, such as CO, NO_x and NMVOC. These are precursors of tropospheric ozone, a greenhouse gas, and of SO_2, which leads to aerosol formation with a cooling effect. These compounds are also often the subject of regional protocols that control the emissions over time (e.g. the *UNECE Protocols* of the *Convention of Long-Range Transboundary Air Pollution*, CLRTAP). Therefore it was decided to limit the detailed reporting for the *Climate Convention* and the *Kyoto Protocol* to the six direct greenhouse gases mentioned above and only request summary information on the national emissions of CO, NO_x, NMVOC and SO_2.

1.1.2 Climate Convention and Kyoto Protocol

In 1992 the ***United Nations Framework Convention on Climate Change*** (UNFCCC) was adopted at the United Nations Headquarters in New York and was open for signature at the Earth Summit in Rio de Janeiro from June 1992. The Convention entered into force in March 1994. The Convention sets an *ultimate objective* of stabilising atmospheric concentrations of greenhouse gases at levels that would prevent ‘dangerous’ human interference with the climate system. Such levels, which the Convention does not quantify, should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. To achieve this objective, all Parties to the Convention – those countries that have ratified, accepted, approved, or acceded to, the treaty – are subject to an important set of general commitments, which place a fundamental obligation on both industrialised and developing countries to respond to climate change.

The Convention divides countries into two main groups: those that are listed in its Annex I, known as *Annex I Parties*, and those that are not, known as *non-Annex I Parties*. Some Annex I Parties are also listed in the Convention’s Annex II, and are known as *Annex II Parties*. The Convention currently lists 41 *Annex I Parties*. These are the industrialised countries that have historically contributed the most to climate change. They include both the relatively wealthy industrialised countries that were members of the *Organisation for Economic Co-operation and Development* (OECD) in 1992, plus countries with *Economies-In-Transition* (the EITs), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

The ***Kyoto Protocol*** to the UNFCCC was adopted at the third session of the Conference of the Parties (COP) to the UNFCCC in Kyoto, Japan in December 1997. By March 1999 the Protocol had received 84 signatures. Those Parties that have not yet signed the Kyoto Protocol may accede to it at any time. The Protocol is subject to ratification, acceptance, approval or accession by Parties to the Convention. It shall enter into force on the 90^{th} day after the date on which not less than 55 Parties to the Convention, incorporating Annex I Parties, which accounted in total for at least 55 % of the total carbon dioxide emissions for 1990 from that group, have deposited their instruments of ratification, acceptance, approval or accession.

The *Kyoto Protocol* shares the Convention’s objective, principles and institutions, but significantly strengthens the Convention by committing Annex I Parties to individual, legally-binding targets to limit or reduce their greenhouse gas emissions. Only Parties to the Convention that have also become Parties to the Protocol, however (that is, by ratifying, accepting, approving, or acceding to it), will be bound by the Protocol’s commitments, once it comes into force. The individual targets for Annex I Parties are listed in the *Kyoto Protocol*’s Annex B. These add up to a total cut of at least 5% from 1990 levels in the so-called ***commitment period*** 2008-2012. The maximum amount of emissions (measured as the equivalent in carbon dioxide) that a Party may emit over the commitment period in order to comply with its emission target is known as a Party's ***assigned amount.*** Most countries, including the EU-15, have a target of -8% in the 1990-2008/2012 period. The EU has redistributed its targets among the 15 Member States. The (burden-sharing) target of Netherlands is -6%. Other targets are: USA -7% (has indicated its intention not to ratify the Kyoto Protocol); Canada, Hungary, Japan, Poland -6%; Croatia -5%; New Zealand, Russian Federation, Ukraine 0%; Norway +1%; Australia +8%; and Iceland +10%. The targets cover emissions of the six main greenhouse gases mentioned above (from: UNFCCC, 2003).

The key differences between the Kyoto Protocol and the Climate Convention can be summarised as follows:

- an assigned amount for 2008-2002 vs. non-quantitative emission requirements;
- another way of accounting for CO_2 sinks in the land use, land-use change and forestry (LULUCF) sector (including CO_2 in the agricultural sector);
- options to include emission reductions abroad in the assigned amounts through the so-called Kyoto Mechanisms of emissions trading (referred to as ET, JI and CDM);
- requirements for institutional and procedural arrangements for inventory compilation (so-called *National System Guidelines*).

Please note that the definition of what should be reported under the source/sink category '*Land-use change and forestry*' (LUCF) to the ***United Nations Framework Convention on Climate Change*** – as in this report – is considerably different from the definition of emissions/sinks to be included in the national total under the *Kyoto Protocol*.

According to the Kyoto *Protocol Parties* may offset their emissions by increasing the amount of greenhouse gases removed from the atmosphere by so-called carbon 'sinks' in the LULUCF sector. However, only certain activities in this sector are eligible: *afforestation*, *reforestation* and *deforestation* (defined as eligible by the Kyoto Protocol) and *forest management*, *cropland management*, *grazing land management* and *revegetation* (added to the list of eligible activities by the Marrakesh Accords). Greenhouse gases removed from the atmosphere through eligible sink activities generate credits known as ***removal units.*** Any greenhouse gas *emissions* from eligible activities, in turn, must be offset by greater emission cuts or removals elsewhere.

1.1.3 Reporting requirements: UNFCCC and IPCC

Annex I Parties to the UNFCCC must submit annually an *inventory* of their greenhouse gas emissions, including data for their base year (1990, except for some EITs) and data up to the last but one year prior to submission. Inventories due 15 April 2003, for example, should contain emission data up to the year 2001. National communications are subject to an individual *in-depth review* by teams of experts, including in-country visits. Since 2000, annual inventories have also been subject to a *technical review*.

In addition, Annex I Parties must regularly submit reports, known as *National Communications,* detailing their climate change policies and measures. Most Annex I Parties have now submitted three national communications. The third national communications were due on 30 November 2001.

UNFCCC

The *UNFCCC Guidelines* prescribe the source categories, calculation methodologies, and the contents and the format for the inventory report. For the definition of the source categories and calculation methodologies, the *UNFCCC Guidelines* generally refer to the *IPCC Guidelines for Greenhouse Gas Inventories* and the *IPCC Good Practice Guidance* reports. These reports are also available on the web (see *Annex 8*). The UNFCCC reporting requirements for Annex I countries are formed by the submission of an NIR that documents, explains and justifies the reported emission inventory dataset, and a set of so-called *Common Reporting Format* (CRF) files, which contain fairly detailed emissions, activity data, so-called implied or aggregated emission factors and additional information. Countries may choose to print their *National Inventory Report* (NIR) or publish it in its entirety, electronically only, by placing it on a designated public website.

IPCC

The IPCC often uses the concept of a *'Tiered Approach'*, in other words, a stepwise approach:

- *Tier 1* is simplest and requires the least data and effort;
- *Tier 2* is more advanced and/or data-intensive;
- *Tier 3* is still more advanced etc.

Generally, more detailed/advanced emission calculation methods are recommended, data or capacity permitting and more detailed/advanced uncertainty assessments or more advanced key source assessments. The rationale behind this generic approach of methods, uncertainty assessments and key source assessment is to give recommendations to countries which have more detailed datasets and more capacity to calculation emissions, as well as to countries with less data and manpower available. However, it also serves as a means for balancing efforts in industrialised countries, by not going into details where irrelevant, thereby saving capacity for other more important but relatively weak parts of the inventory.

To aid priority setting, the *Good Practice Guidance* recommends using higher Tier methods in particular for so-called key sources. Uncertainty estimates can serve to refine both the key source identification and prioritise inventory improvement activities. This report also provides guidance in inventory compilation, reporting, documenting, quality assurance and quality control (QA/QC) comparable with the formal ISO 9001-2000 quality assurance system.

The Netherlands generally applies country-specific, higher Tier methods for calculation greenhouse gas emissions (see *Section 1.5*).

1.1.4 Role of the European Union

Since the European Union (EU) is also a Party to the UNFCCC and the Kyoto Protocol and has to submit similar datasets and reports for the collective 15 EU Member States as national Parties have, the EU imposes some additional guidelines to EU Member States through the *EU Greenhouse Gas Monitoring Mechanism* to guarantee that the EU meets its reporting commitments:

- submission of the same national dataset (CRF files and NIR) that will be submitted to the Climate Secretariat to the EU, but a few months earlier than the UNFCCC deadline of 15 April to provide preparation time for the EU inventory and the EU NIR;
- reporting of international transport emissions with a distinction of intra- and extra-EU transport;
- requirements for a National System at Member State level to be in place by 1995.

In addition, the EU has developed an internal Burden Sharing system to reallocate the assigned amounts to its Member States in such a way that the EU target of -8% for 2008-2012 will be met. Also, the EU has decided on a emission trade system within EU countries.

Within the EU burden-sharing agreement, the Netherlands has a 6% decrease target. Although CO_2 emissions for domestic policy purposes are often corrected for temperature to filter out the effect of accidental mild or cold winters, the calculation of the *assigned amount* of the Kyoto Protocol only considers the actual emissions in the base year and the commitment period. The Kyoto Protocol also requires Annex I countries to have a so-called National System in place for the annual compilation and reporting of the emissions. *National System Guidelines* have been defined in which institutional and procedural arrangements are described. In addition, the EU has developed its own guidelines for the Member States to ensure that the National System at EU level complies with the requirements of the Kyoto Protocol.

1.1.5 Differences with the domestic national emission inventory

The *Climate Convention* uses a specific definition of the emissions that should be included in the national total. In general, this differs from domestic national inventories by the way transport emissions are handled and by limiting CO_2 emissions to non-organic anthropogenic sources, i.e. excluding CO_2 from biomass combustion from the national total.

The *UNFCCC* and the *Kyoto Protocol* do not include CO_2 emissions from combustion of biomass fuels (such as fuelwood, wood, wood waste, agricultural waste and biogas) in the totals from fuel combustion, since these are by default assumed to be produced in a sustainable way. However, to the extent that they are not produced sustainably, i.e. according to the *UNFCCC Guidelines,* this should be taken into account when reporting on *Land Use Change and Forestry* (LUCF), not under CO_2 from fuel combustion.

Furthermore, the IPCC source categories make a clear distinction between fuel combustion and non-combustion emissions from an economic sector (see *Section 1.1.6*), where the Netherlands' emissions of so-called ‘Target Sectors’ are mostly analysed by their total emissions. Another specific issue is the distinction that the IPCC makes between CO_2 from non-energy use/feedstock use of fuels and CO_2 emissions from other non-combustion processes. This requirement poses limitations to the extent that the Netherlands in its reporting can decompose these different sources in cases where individual companies report their emissions at a too aggregated level. The country-specific allocation of emissions from non-energy use of fuels (such as chemical feedstocks), co-generation, coke ovens, transport and military activities are explained in detail in *Sections 3.1* and *3.2*.

Another difference is found in the definition of national versus international transport. Whereas the national method uses vehicle statistics to estimate road transport emissions, the UNFCCC requires the use of fuel delivery data as the basis for calculating the emissions from this source category. As illustrated in *Chapter 3*, this results for the Netherlands in annual differences between 5 and 10%.

Differences with other national publications

The emission data presented in this report are identical to those officially published for 1990, 1995 and 1999-2001 in the *Emission Monitor 2002* published by the VROM Inspectorate (Koch *et al*., 2002) and in RIVM’s *Environmental Balance 2002* (RIVM, 2002a). An exception is a revision of CO_2 from waste incineration (reported under source category 1A1 *‘Energy sector’*) for the years 1990 and 1995-2001. The last mentioned action led to a decrease in CO_2 emissions compared to those reported by Koch *et al.* (2002) of about a half Mton (see *Section 10.1.3* for details).

This is due to a revision of the fractions of fossil and organic carbon used to extract the fossil part from the datasets provided by the individual companies. Furthermore, an error correction was made in labelling CO_2 from residential fuelwood and biogas combustion (reported under source category 1A4) as a fossil source instead of as CO_2 from biomass. In addition, the allocation of fossil CO_2 emissions has been improved, causing a small shift from 1A1 to 6D, compared to the corresponding table in the *Emission Monitor 2002.*

1.1.6 Correspondence between Netherlands’ Target Sectors and IPCC source categories

UNFCCC guidelines for reporting greenhouse gas emissions (UNFCCC, 1997) require the use of source categories as defined in the *Revised 1996 IPCC Guidelines for national Greenhouse gas Inventories* (IPCC, 1997). The IPCC guidelines make a subdivision into 7 main source categories, separating combustion (or fuel-related) and non-combustion (or ‘process’) emissions:

1. Energy
2. Industrial processes
3. Solvents and other product use
4. Agriculture
5. Land-Use Change and Forestry (LUCF)
6. Waste
7. Miscellaneous

The first category comprises both fossil fuel and biofuel use, and is subdivided into *1A Fuel combustion* and *1B Fugitive emissions from fuels.* For users in the Netherlands, where emission sources are usually subdivided into so-called Target Sectors, *Table 1.1* presents the correspondence between the Netherlands’ Target Sector emissions to the nomenclature of UNFCCC/IPCC source categories used in this report.

Due to data processing limitations some subcategories have been defined somewhat differently than the source category definition in the *Revised IPCC Guidelines* (IPCC, 1997). The source allocation for 1991-1994 may also be different than for other years due to subsequent revisions of national source codes and of the correspondence table with IPCC sectors, which have not yet been implemented for these years. This may show up as discontinuities at subcategory levels for years 1990/1991 and 1995/1996, in particular in source categories 1A1 and 1A2 (combustion), 2 (industrial non-combustion processes) and 6D (other waste).

Table 1.1. Correspondence between the Netherlands' Target Sector emissions to IPCC source categories

Target Sector	Code	IPCC: Combustion emissions	Code	IPCC: Process emissions
Agriculture	1A4c	Fuel combustion; Other sectors; c.	4	Agriculture [1)]
Industry	1A2	Fuel combustion; Manufacturing industries and construction [2)]	2	Industrial processes [2)]
Refineries [6)]	1A1b	Fuel combustion; Energy industries; sub b (Petroleum refining)	1B2	Fugitive emissions from oil and natural gas
Energy sector				
- power generation	1A1a	Fuel combustion; Energy industries; a (electricity and heat production)	1B	Fugitive emissions [3)]
- fossil fuel production/ transmission		-	1B2	Fugitive emissions from oil and natural gas
Waste handling				
- landfills		-	6A	Waste; Solid waste disposal
- waste incineration ('AVI')	1A1a	Fuel combustion; Energy industries; a (electricity and heat production) [4)]		
- WWTP ('RWZI')	1A4a	Other sectors; Other	6B	Waste; Wastewater handling
- Other	6D	Waste; Other	6D	Waste; Other
Transport and Traffic	1A3	Fuel combustion; Transport		-
Consumers	1A4b	Fuel combustion; Other sectors; b (residential)	3	Solvents and other product use [5)]
Trade, Services, Government ('HDO')	1A4a	Fuel combustion; Other sectors; a (commercial/institutional)	3	Solvents and other product use [5)]
Construction	1A2	Fuel combustion; Manufacturing industries and construction	2	Industrial processes
Drinking-water treatment	1A4a	Fuel combustion; Other sectors; a (commercial/institutional)	7	Miscellaneous (CH_4)

[1)] N_2O from polluted surface water: *7 Miscellaneous*
[2)] CO_2 from non-energy use of fuels e.g. chemical feedstock reported under *1A2 Fuel combustion*
[3)] CO_2 from flue gas desulphurisation: *2 Industrial processes*; sub G
[4)] It has been assumed that all waste incineration facilities also produce electricity or heat used for energy purposes; therefore these are reported under category 1A1a
[5)] CH_4 and NMVOC: *7 Miscellaneous* (since IPCC tables of source category 3 allow reporting these gases).
HFCs, PFCs and SF_6: *2 Industrial Processes*.
[6)] For domestic reporting in recent years the Target Sector 'Refineries' has been included in the Target Sector 'Industry'.

1.1.7 CRF files: printed version of summary tables and completeness

Annexes 5 and *7* of this report present a printed version (summary) of the following CRF files:

- Completeness Table 9 for 1990 (in *Annex 5*);
- IPCC Summary Tables 7A for 1990-2000 (CRF Summaries 1);
- Recalculation Tables and Explanation Table 8.a and 8.b for 1990 and 1995-2000;
- Trend Tables 10 for each gas individually and for all gases and source in CO_2-eq.;
- Trend Tables 10 for precursor gases and SO_2.

Section 10.4 provides details on the extent that the CRF data files for 1990-2001 have been completed. For this NIR report, a special effort was made to:

- fill activity data gaps 1991-1994 for categories not hampered by non-ER-I data (categories 1A4, total nitrogen in animal waste management systems in 4B);
- add additional information (e.g. fraction of domestic and international transport in 1A3, length of pipelines in 1B2, waste composition in 6A, methane recovery data in 6B);
- improve the implied emission factors in 1A1 and 1A2 subcategories by removing inconsistent fuel consumption/emissions data from ER-I sources from specific fuel types to 'unspecified fuels'
- re-evaluate the CO_2 emissions from biomass, in particular, from the ER-I datasets, to improve the dataset.

In general, completeness of the CRF tables is hampered by the present level of detail of ER-I data storage, in particular for IPCC categories 1A1, 1A2 and 2 (see *Table 10.5*). These are the sectors that are largely reported by individual firms of which the level of detail, completeness and quality vary considerably (see *Section 1.6* on Quality Assurance).

For PFCs and SF_6 not all *potential* emissions (= total consumption data) are reported at present due to the limited number of companies for which currently consumption figures are available and used for estimating actual emissions (so-called Confidential Business Information). Some of these entries are therefore labelled 'C', but note that as a result of the CRF structure, most of the summed figures for potential emissions show '0.0' or '!VALUE'. However, the *actual* emissions have been reported from all known sources.

1.1.8 Territorial aspects; import/exports

The territory of the Netherlands from which emissions are reported is the legal territory; this includes a 12-mile zone from the coastline and 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 at the Netherlands' part of the continental shelf are included. Emissions from all electricity generation in the Netherlands are accounted for, including the fraction of the domestically produced electricity that is exported. Until 1999, the Netherlands imported about 10% of its electricity; in 1999, however, the net import increased by 55% due to the liberalisation of the European electricity markets.

1.1.9 Presentation of figures: rounding off and summation

Please note that the same number of decimal digits is used within all tables (or per compound column). Therefore, the number of (decimal) digits shown does not correspond with the number of significant digits of the numbers presented. Please note too that the numbers in the tables may not exactly add up to the (sub)totals because of independent rounding off. We refer to *Section 1.7* for information about the uncertainty in sectoral and national total emissions.

1.1.10 Organisation of the report

This year we have changed the structure of the report into the format that will become compulsory as of next year (UNFCCC, 2002). This was done to identify in advance the elements of the report that need extra attention in the next submission. However, due to time constraints in the preparation of the report, the reader will notice marked differences in the level of detail in the descriptive sections of *Chapters 3 to 9*.

Following the new format in this chapter, we will further present the institutional arrangements for the inventory compilation process, a brief description of methodologies, data sources used, identified key sources, the QA/QC plan and a general evaluation of the uncertainty and the completeness of the inventory. *Chapter 2* will discuss the trends in total emissions at an aggregated level in CO_2-equivalents, by gas and by source. Subsequently, *Chapters 3 to 9* discuss the emission sources/sinks per main IPCC sector, with a description of sources/sinks, methodological issues and uncertainty, and time-series consistency (explanation of emission trends). Anticipating the new reporting requirements, we have, in principle, now included all additional information tables from the present CRF files in the report itself in these chapters. The main report concludes with *Chapter 10* on recalculations performed since the last NIR submission and planned improvements.

Finally, the annexes to the report include the following compulsory topics: information on key sources, detailed description of methodologies, and comparison between the so-called *IPCC Reference Approach* for CO_2 (estimating emissions from fuel use by using apparent consumption by fuel type as activity data and correction for carbon storage in feedstock products). Furthermore, we here include the (national) *Sectoral Approach*, completeness and any other information to be considered as part of the NIR. For ease of referencing we have also inserted annexes with copies of key CRF tables: IPCC summary tables '7A' for specific years, recalculation tables and trend tables. Other annexes provide units, other factors, internet links to reporting guidelines and a list of abbreviations.

1.2 Description of the institutional arrangement for inventory preparation

The preparation of the greenhouse gas emission data in the Netherlands is based on the national *Pollutant Emission Register* (PER). This general process has existed for many years and is organised as a project with an annual cycle. To meet the UNFCCC and IPCC requirements additional actions are (still) necessary. Around the year 2000 a programme was started to adapt the monitoring of greenhouse gases in the Netherlands and transform this into a National System, as stated in Article 5 of the *Kyoto Protocol*. In the following section we will present information for both (interrelated) processes in separate sections. One will deal with the PER and one with the NIR and the CRF files.

1.2.1 The Pollutant Emission Register (PER)

The Netherlands has had a *Pollutant Emission Register* (PER) for many years, in Dutch also referred to as *Emission Registration* (ER), where data on emissions to air, water and soil are collected. This inventory has been established in co-operation:

- Inspectorate of Housing, Spatial Planning and the Environment of the Netherlands Ministry of Spatial Planning, Housing and the Environment (VROM Inspectorate, VI)[1]
- Statistics Netherlands (CBS)
- National Institute of Public Health and Environment (RIVM)
- Ministry of Agriculture, Nature Conservation and Fishery (LNV) through representation by the National Reference Centre for Agriculture (EC-LNV, formerly IKC-L)
- Ministry of Transport, Public Works and Water Management (V&W) through representation by the National Institute of Water Management and Waste Treatment (RWS/RIZA), and
- Netherlands Organisation for Applied Scientific Research (TNO)

The PER (see *Figure 1.1*) comprises the registration, analysis, localisation and presentation of emission data of both industrial and non-industrial sources in the Netherlands. Emission data is gathered from the source categories industry, public utilities, traffic, households, agriculture and natural sources. So-called *Task Forces* collect the data required and perform the emission calculations Agreement on definitions, methods and emission factors, is discussed and reported by experts in these Task Forces. The *Co-ordination Committee for Monitoring of Target Sectors* (CCDM) approves these reports.

The emissions of the large industrial point sources are registered individually, on the basis of detailed information of each individual plant. The emissions of the *Small and Medium-sized Enterprises* (SME) as well as non-industrial diffuse sources, are calculated collectively with statistical activity data and emission factors. The data collection process for emissions of large industrial point sources has been changed substantially since 1995 (see *Box.1.1* and *Figure 1.2*).

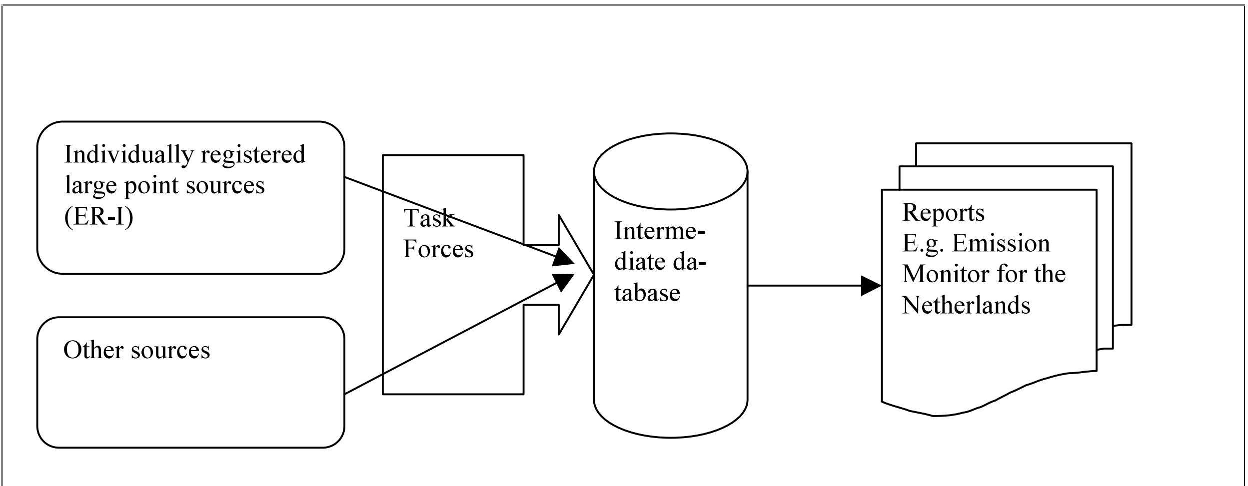

Figure 1.1. Main elements in the Pollutant Emission Register (PER)

[1] From January 2002, the Ministry introduced a single integral inspectorate for Housing, Spatial Planning and the Environment in which the former 'Inspectorate HIMH' has been integrated.

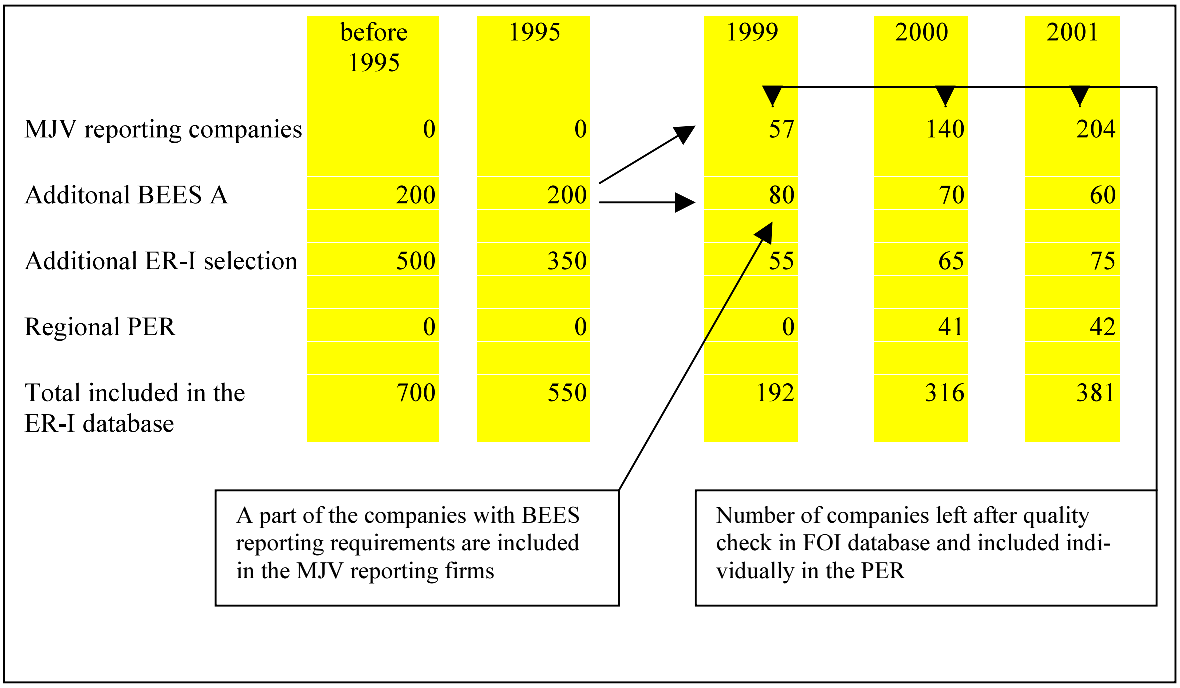

Figure 1.2. Changes in time in data sources used for the individually registered point sources in the PER (for abbreviations see Box 1.1)

Box 1.1. Major changes in data collection and submission of emissions and activity data by large companies

The method for the collection of emissions from large industrial point sources has been changed since 1995 (see *Figure 1.2*). Before 1995, the 'ER-I' data collection for air emissions of about 700 large companies was initiated by the Ministry of VROM, with TNO assisting (on request), the companies in estimating their annual emissions. The activity data and emissions of these large industrial point sources were collected, checked and processed by TNO. These 700 point sources included about 200 large combustion plants which submitted information on fuel consumption and NO_x and SO_2 emissions under the 'BEES A' regulation. In 1995 the number of point sources was reduced to 550.

Since 1996, this data collection has been gradually replaced by data reported by industry in their annual environmental reports (*MJVs*). The *Pollutant Emission Register* (PER) has used these reports since 1996 for more and more companies. For the 1998 PER, 265 companies reported their emissions in the format of the annual environmental reports. These were processed by TNO and included in the ER-I database.

Annual environmental reports were collected for the 1999 emissions and those for subsequent years. After approval by the provinces, these were processed and included in a database by the *Facilitating Organisation for Industry* (FOI). For the 1999 PER onwards, a group of 220 companies were obliged to report their emissions in the format of the *annual environmental reports* (MJVs). Another 45 companies reported their emissions in a voluntary MJV. Subsequently, this administrative FOI database was checked for consistency and transformed by TNO to be included in the PER. Due to poor quality, only 57 of the companies were processed by TNO and included in the ER-I database for the year 1999. The emissions of the remaining companies were not registered individually but were used as part of the supplementary estimate, resulting in a smaller detailed dataset for individually registered companies. The PER dataset was extended as previously with reported information on fuel consumption and emissions from all companies required to do so under the *'BEES A' regulation* (large combustion plants). In addition, TNO collected data from 55 industries according to the 'old' method. In line with the year 1998, the voluntarily submitted MJVs were also included in the ER-I. In total, the individual data set holds emissions for 192 companies.

The PER 2000 dataset includes the individual registered emissions based on the MJVs reported by 140 companies. Emission data from a regional PER (from the province Noord-Brabant) are also included. Together with the data collected for the 70 BEES A companies and additional 65 industries for which TNO collected data using the 'old' method, the individual data set holds emissions for 316 companies.

The PER 2001 includes an increased number of the individually registered emissions based on the MJVs: 204. Additional emission data from the regional PER (42), BEES A (60) and additional selected companies (60) are also included again in the database. So the individual data set holds emissions for 381 companies. This data set was used to compile the CRF data for 2000 (final data) and was also used to make the preliminary estimate for the CRF data for 2001.

This resulted in a reduced number of individual sources in the PER database: about 700 in 1990 and 550 in 1995. For the year 1999 the ER-I database contains the smallest number of companies: 192. Since then this numbers has increased to 316 in 2000 and 381 in 2001. As explained in *Box 1.1*, in the transition period of companies to another reporting system and another reporting format, the quality of the emission data relevant for the NIR/CRF has also temporarily deteriorated. In section 1.6 we summarise actions that started to improve data quality again.

1.2.2 The National Inventory Report and CRF files

The Minister of Housing, Spatial Planning and the Environmental is responsible for the annual reporting to the UNFCCC Secretariat as well as to the European Commission. The *Climate Change and Industry Division* of the Ministry of VROM (VROM/DGM/KVI) is responsible for organising the reporting process. *Figure 1.3* presents this process, the relation with the PER and the responsibilities. The *Co-ordination Committee for Target Sector Monitoring* (CCDM) under auspices of the VROM Inspectorate is responsible for the data collection in the PER process, resulting in an intermediate database, hosted by TNO.

On behalf of the *Climate Change and Industry Division*, Novem is involved in the extraction of the data from the PER, the collection of additional data and the presentation of data in the CRF. The NIR report, also containing a selection of CRF tables, is primarily drafted by RIVM, with contributions by CBS, TNO and Novem. This year, for the first time, organisations and individuals could make comments to the draft NIR. This process was organised by Novem and RIVM, using the site www.greenhousegases.nl, developed to improve the transparency of the National System (see *Section 1.6.2*).

More than 150 selected persons within the Netherlands were informed by mail and per e-mail that the draft NIR was available for public review. In addition, about 100 experts from UNFCCC, IPCC and EU working groups received an e-mail that they could comment to the draft. More than 20 persons provided comments; some in detail, some on special subjects and some provided more general comments. Although comments were received on almost all chapters, the majority was related to energy. Only a few comments were received from people living outside the Netherlands.

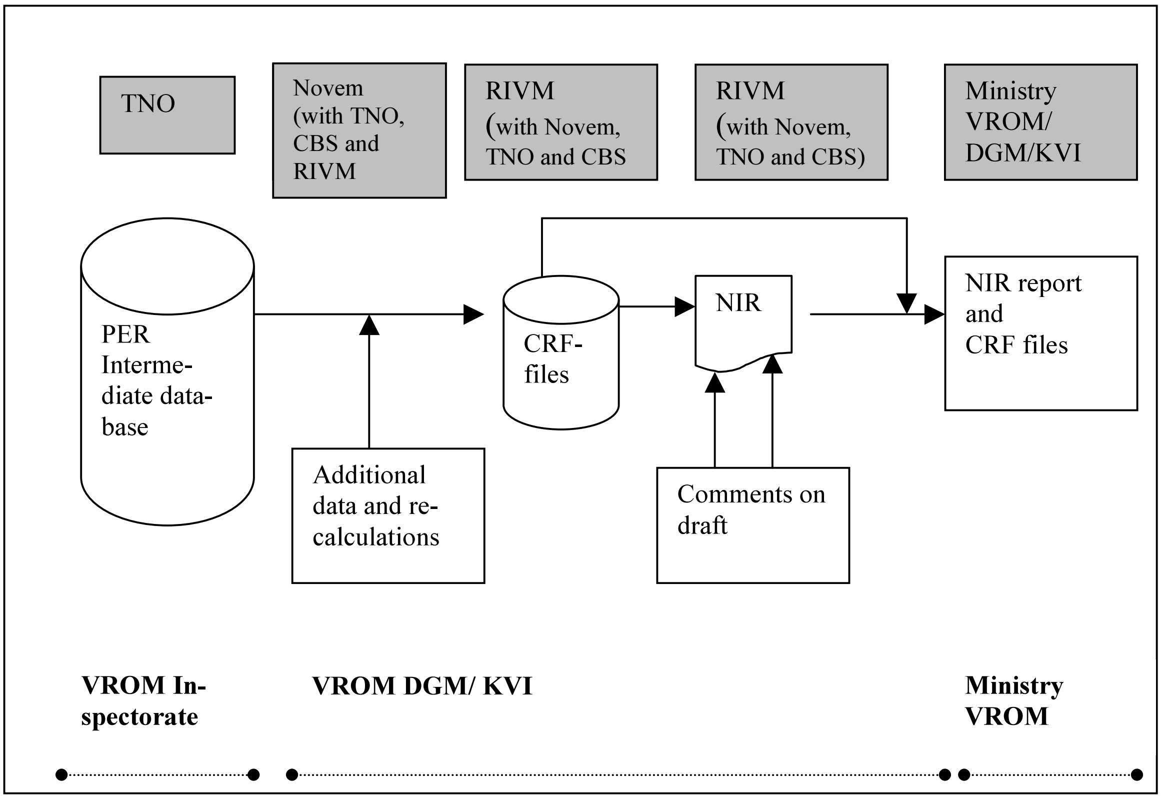

Figure 1.3. NIR and CRF preparation process; relation with Pollutant Emission Register (PER) and responsibilities

1.3 Brief description of the process of inventory preparation

Data collected in the National Inventory Report are based on the PER. In this annual Emission Inventory System, in year *t* final emissions have been calculated for year *t-2* and preliminary estimates were made for emissions of the last year but one (*t-1*). In the case of methodological changes, emissions are also recalculated for *t-3* as well as for 1990 and 1995. This means that in 2002 emissions were (re)calculated for 1990, 1995, 1999, 2000, and 2001.

The data from the PER have to be 'translated' to the Common Report Format (CRF). Additional information and calculations are also necessary to fill the CRF files. Several institutes are involved in this process. Especially experts participating in the Task Force ENINA provide additional information to do recalculations or to improve the data consistency in the CRF files.

A Greenhouse Gas Inventory Improvement Programme was started in 2000. This programme is guided by the *Working Group Emission Monitoring of Greenhouse Gases* (WEB), which directs future actions aimed at improving the monitoring of greenhouse gas emissions, relevant to reporting to the UNFCC in all aspects. In *Section 1.6.2* we summarise the main actions presented in more detail in *Section 10.4*. Some actions already resulted in improved data; others are related to future improvements. One of the actions is aimed at improving the process of data collection and calculations by the use of protocols, which should be included in the PER system from 2003 onwards.

In the reviews of the National Inventory Report, including CRF files, suggestions were made to improve the quality. *Section 10.4* describes the Netherlands' response to the issues raised in those reviews.

1.4 Brief general description of methodologies and data sources used

The general methodology for calculating emissions to air and water in the Netherlands' *Pollutant Emission Register* (PER) – or *Emission Registration* ('ER' in Dutch) – is described in Van der Most *et al.* (1998) [in Dutch]. The methodology for calculating emissions of greenhouse gases is described in more detail in Spakman *et al.* (1997) [in Dutch], of which an electronic update has been published in Dutch in 2003 and in English (Spakman *et al.,* (2003). For methane and nitrous oxide these methods were based on background documents [in English] prepared by Van Amstel *et al*. (1993) and Kroeze (1994). Other documents in English providing descriptions of emission calculation methodology are the proceedings of workshops on greenhouse gas emissions and sinks in the Netherlands held in 1999 (Van Amstel *et al*., 2000a,b) [in English]. These and other key reports documenting the methodologies and data sources used in the Netherlands are listed in *Annex 6* and are electronically available in pdf format on the website, www.greenhousegases.nl.

Please note that the methodology used for the *'t-1'* inventory for the last-but-one-year is often somewhat different from the methodological descriptions in these reports. For the latest year the methodology is often partly based on extrapolation, since not all annual statistics and year-specific emission factors may be available in time (see *Annexes 2 and 3*).

Several specific features of the Netherlands country-specific methodology are summarised below, while *Table 1.2* shows the CRF Summary 3 table for the methods and emission factors used. Major methodological changes compared to the previous report show:

- Recalculation of N_2O emissions from nitric acid production (1991-1994; 1996-1998) based on the method for 1990, 1995 and 1999-2001 (years that were recalculated prior to the previous submission);
- Recalculation of CH_4 and N_2O emissions from wastewater handling (1990-2001);
- Revision of HFC emissions for the years 1994-2001 based on improved analysis of data;
- Revision of SF_6 emissions for the years 1994-2001 based on improved analysis of data.
- Recalculation of the NO_x emissions from inland navigation based on improved emission factors (total time series);
- Recalculation of NO_x emissions from 'small combustion sources' (less than 20 MW) for the years 1990, 1995, 2000 and 2001 based on new emission factors.

Table 1.2. CRF Summary table 3 with methods and emission factors applied

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2		CH4		N2O	
	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)
1. Energy						
A. Fuel Combustion						
1. Energy Industries	CS/T2	PS, CS	CS/T2	PS, CS	CS/T1	PS, D
2. Manufacturing Industries and Construction	CS/T2	PS, CS	CS/T2	PS, CS	CS/T1	PS, D
3. Transport	CS/T2(Box 2)	CS	CS/T3(road);T1(non-r)	CS (road	CS/T3(road);T1(rest)	CS(road)/D(rest)
4. Other Sectors	CS/T2	CS	CS/T2	CS	CS/T1	D
5. Other	CS/T2	CS	CS	CS	NE	
B. Fugitive Emissions from Fuels						
1. Solid Fuels	IE		IE		IE	
2. Oil and Natural Gas	CS/T3;>97:T1	CS	CS/T1	CS	CS/T1	CS
2. Industrial Processes						
A. Mineral Products	CS/T2(clinker)	PS, CS	CS	PS, CS	NO	
B. Chemical Industry	CS/IE	PS, CS	CS	PS, CS	CS/T2	PS
C. Metal Production	CS/IE	PS, CS	NE		NO	
D. Other Production	NO					
E. Production of Halocarbons and SF6						
F. Consumption of Halocarbons and SF6						
G. Other	CS	PS, CS	CS	PS, CS	NO	
3. Solvent and Other Product Use	**CS**	**CS**			**CS**	**CS**
4. Agriculture						
A. Enteric Fermentation			cattle 90: T2; rest: T1	cattle: CS; rest: D		
B. Manure Management			CS/T2	CS (=D,corrected)	CS	CS
C. Rice Cultivation			NO			
D. Agricultural Soils	NE		IE	CS	CS/T1b(D&I)	CS
E. Prescribed Burning of Savannas			NO		NO	
F. Field Burning of Agricultural Residues			NO		NO	
G. Other	NO		NO		NO	
5. Land-Use Change and Forestry						
A. Changes in Forest and Other Woody Biomass Stocks	T1	CS				
B. Forest and Grassland Conversion	NE		NE		NE	
C. Abandonment of Managed Lands	NE					
D. CO2 Emissions and Removals from Soil	NE					
E. Other	NO		NO		NO	
6. Waste						
A. Solid Waste Disposal on Land	NE		M, CS/T2	CS		
B. Wastewater Handling			CS/T2	CS	CS/T2	CS
C. Waste Incineration	NO (IE)		NO (IE)		NO (IE)	
D. Other	CS	CS	CS	CS	CS	CS
7. Other (please specify)						
Solvents/polluted surface water	NA		CS	CS	CS/T1b	CS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs		PFCs		SF6	
	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)	Method applied (1)	Emission factor (2)
2. Industrial Processes						
A. Mineral Products						
B. Chemical Industry	CS/T2	PS	NO		NO	
C. Metal Production			CS/T2&T3b	PS	NO	
D. Other Production						
E. Production of Halocarbons and SF6	CS/T2	PS	NO		NO	
F. Consumption of Halocarbons and SF6	M,CS/T2	CS	T2&T3b	D	T2&T3b	PS/CS/D
G. Other	NO		NO		NO	

Explanation of notation keys used:

- to specify the method applied:
  - **D** (IPCC default); **RA** (Reference Approach)
  - **T1** (IPCC Tier 1)
  - **T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively)
  - **T2** (IPCC Tier 2)
  - **T3** (IPCC Tier 3)
  - **C** (CORINAIR); **CS** (Country Specific); **M** (Model)
- to specify the emission factor used:
  - **D** (IPCC default)
  - **C** (CORINAIR)
  - **CS** (Country Specific)
  - **PS** (Plant Specific)
  - **M** (Model).
- other keys: **NO** = Not Occurring; **NE** = Not Estimated; **IE** = Included Elsewhere.

1.4.1 Carbon dioxide emissions

Carbon dioxide emissions arise mainly from the combustion of fuel and are calculated on the basis of detailed energy statistics and carbon content of the energy carriers. However, about 75% of emissions from public electricity production, refineries, large industries and waste incineration are directly reported by individual companies. This part of the PER is called 'ER-I'. For these sectors, the remainder of the emissions is calculated on the basis of calculated remaining fuel consumption (difference in national energy statistics for the sector and energy consumption reported by these large companies) and standard emission factors.

For the calculation of the *carbon storage* in the *IPCC Reference Approach* for CO_2, carbon storage fractions in products like plastics and bitumen were taken from an analysis of petrochemical products, half products and feedstock use (of energy carriers) by Gielen (1996). This reference calculation is also used to calculate the remainder of feedstock emissions, where total CO_2 from feedstocks reported by the chemical industry is less than the reference value calculated with the Tier 1 method in the *CO_2 Reference Approach*. In addition, fossil-based CO_2 emissions from *waste incineration* (e.g. plastics) are calculated from the total amount of waste incinerated, split into 8 waste types, each with a specific carbon content and fraction of fossil C in total C, based on an analysis by De Jager and Blok (1993). In recent years this amounted to about 2 Mton. The fuel use related to *statistical differences* is included as a source of CO_2 for 1991-1994, since it was assumed that the associated fuel use is real and not accounted for in individual end-use sectors. More information on the methodology for estimating CO_2 emissions from fossil fuel combustion is provided in *Annex 2.1*.

Finally, a *temperature correction* of fuel use for space heating is applied for (domestic) environmental policy purposes, but only to CO_2 emissions from natural gas consumption. The restriction to natural gas is made because this is by far the dominant fuel type for space heating. A description of this method is provided in *Annex 2.2* and the result of the calculation is presented in *Section 3.1.1*.

1.4.2 CO_2 from sinks

At present, the Netherlands only estimates CO_2 removals for *LUCF category 5A*. For the period 1990-2000 period the data on carbon stock and carbon changes were based on:

- forest area (in ha) ;
- average annual growth by category (in m^3/ha per year);
- harvest by category (in m^3/ha per year).

No correction is made for the amount of fuelwood harvested, since this amount is implicitly included in these three variables. For forest stock the FAO definition is used, but for the wood volume a threshold level of 5 cm diameter is used for UNFCCC reporting. All conversion factors have been checked for replacing IPCC default values by country-specific values. It was decided to use IPCC default values for all variables, except for the conversion ratio from volume (in m^3) to dry matter (tonne dm), for which the Netherlands uses more detailed figures: 0.5 and 0.6 t dm/m^3 for coniferous and broadleaf forest, respectively. See *Annex 3.2* for a detailed description.

1.4.3 Methane

Methane from fuel combustion is estimated using the energy statistics and emission factors from the annual *Emission Monitor,* with figures provided by the *Pollutant Emission Register* (PER). Road traffic emissions of CH_4 are calculated and reported according to the *Revised IPCC Guidelines* (i.e. initially based on vehicle-km, then calibrated to fuel supply statistics). For more details, we refer to the description provided for CO_2. Fugitive methane emissions from oil and gas are estimated for onshore and offshore sites separately.

Methane from agriculture is estimated on the basis of emission factors developed in the methane background document by Van Amstel *et al.* (1993), and agricultural statistics for animal numbers and manure production from *Statistics Netherlands* (CBS). For dairy and non-dairy cattle the emission factors for enteric fermentation are based on an IPCC Tier 2 analysis made for Netherlands' cattle in 1990. These emission factors are used, for subsequent years, however, specific factors are applied to 4 and 3 subcategories within dairy and non-dairy cattle, respectively. The calculation of animal manure production and waste management systems is described in Van der Hoek (2002).

Methane emissions from landfills are calculated using a first-order decomposition model (first-order decay function) with annual input of the total amounts deposited and characteristics of the land-filled waste and the amount of landfill gas extracted. The integration time for the emission calculation is, for all years, the period from 1945 to the year for which the calculation is made. A small source in the waste sector is wastewater treatment, with very small emissions due the high fraction recovered.

A very small source identified in the Netherlands is degassing of drinking water, reported in Sector 9. The reduced methane emissions from agricultural soils are regarded as 'natural' (non-anthropogenic) and are estimated on the basis of the methane background document (Van Amstel *et al.*, 1993). Since the IPCC methodology only considers CO_2 sinks, these reduced CH_4 emissions have been included in the 'natural emissions' total, although they act as a methane sink. Therefore they are not reported as anthropogenic emissions under IPCC category 7. Other 'natural emissions' are methane emissions from wetlands and water.

1.4.4 Nitrous oxide

N_2O emissions from fuel combustion is estimated using the energy statistics and emission factors from the annual *Emission Monitor,* with figures provided by the Emission Registration system (PER). Road traffic emissions of N_2O are calculated and reported according to the *Revised IPCC Guidelines* (i.e. initially based on vehicle-km, then calibrated to fuel supply statistics); for more details we refer to the description provided for CO_2. For more details on the emission factors from road transport we refer to *Section 3.4*.

N_2O emissions from the production of chemicals include N_2O from nitric acid, caprolactam production and solvents, as reported by the manufacturing industry and included in the Netherlands' Emission Registration system (PER) (Spakman *et al.,* 2003). It also includes N_2O emissions from product use comprise N_2O used as anaesthesia and as propelling agent in aerosol cans.

The nitrous oxide emissions from agriculture are based on the methods described in the nitrous oxide background document by Kroeze (1994). The calculation of animal manure production and waste management systems is described in Van der Hoek (2002). Indirect N_2O emissions from atmospheric deposition have not yet been estimated. Other indirect N_2O emissions are either included under '*Background agricultural soils'* (4D) or as *'Polluted surface water'* (7). These 'background' emissions include N_2O emissions from cultivation of histosols and emissions from manure and fertiliser applications in the past. This is to reflect that agricultural soil emissions will not stop when agricultural activities are stopped. Emissions from crop residues left in the field are also included.

The latter category 7 '*Polluted surface water'* is a fixed value that comprises leaching and run-off from all anthropogenic activities, including human sewage. Since this figure includes more than only agriculture-related emissions, we do not report these under 4.D but as a separate category '7'. N_2O emissions from human sewage are reported partly under '*Wastewater handling'* (6B) and partly under *category 7* as '*Polluted surface water'*. For more details on the exact definition of these indirect N_2O source terms we refer to Spakman *et al.* (2003) or to Kroeze (1994).

1.4.5 HFCs, PFCs and SF_6

By-product HFC and PFC emissions from HCFC-22 production and primary aluminium production, respectively, are based on measured data reported by halocarbon and aluminium producing companies. In addition, the halocarbon producers report handling emissions of HFCs.

Emissions from HFC and PFC consumption are calculated using Tier 2 and country-specific methodologies, as summarised in *Section 4.6*. Emissions of SF_6 are based on estimates of SF_6 consumption for the existing stock of Gas Insulated Switchgear (GIS) equipment, addition of new GIS equipment and manufacturing of GIS equipment for semiconductor manufacture and for the production of SF_6 containing soundproof double-glazed windows. The latter source has been included for 1995 onwards. In Spakman *et al.* (2003) the methodologies are described in more detail.

1.4.6 Data sources

The following primary data sources supply the annual activity data used in the emission calculations:

- fossil fuel data: (a) annual inventory reports by individual firms (including biofuel data); (b) national energy statistics from CBS (National Energy Statistics; Energy Monitor); (c) agricultural gas consumption (LEI);
- residential biofuel data: (a) annual survey of residential woodstove and fireplace penetration by the Association for Comfortable Living (in Dutch: *Vereniging Comfortabel Wonen*); (b) a survey in 1996 on wood consumption by residential woodstove and fireplace owners by the Stove and Stack Association (in Dutch: *Vereniging van Haard en Rookkanaal, VHR*).
- transport statistics: monthly statistics for traffic and transportation from CBS;
- industrial production statistics: (a) annual inventory reports by individual firms; (b) national statistics from CBS;
- consumption of HFCs: annual reports by the KPMG accountant firm (only HFC data are used due to inconsistency for PFCs and SF_6 with emissions reported otherwise);
- consumption/emissions of PFCs and SF_6: reported by individual firms;
- anaesthetic gas: data provided by Hoekloos, the major supplier of the gas;
- N_2O containing spray cans: Dutch association of aerosol producers (in Dutch: *Nederlandse Aerosol Vereniging*, NAV);
- animal numbers: agricultural database from CBS/LEI-DLO, with data from the agricultural annual census ;
- manure production and handling: national statistics from CBS/LEI-DLO;
- fertiliser statistics: agricultural statistics from LEI-DLO;
- forest and wood statistics: (a) forest area 1980 and 2000: CBS (1985) and Dirksen *et al.* (2001), respectively, supplemented with agricultural statistics on orchards and nurseries from LEI/CBS (2000); CBS (1985, 1989), Daamen (1998) and Edelenbosch (1996) for the years in between; (b) stem volume, annual growth and fellings: Schoonderwoerd (2000), Stolp (1995) and Daamen (1998);
- waste production and handling: Working Group on Waste Registration (WAR), CBS, RIVM;
- methane recovery from landfills: VVAV (until 1998); RIVM estimates from 1999.

Many recent statistics are available on the internet at the statistical website '*Statline*' of CBS (www.cbs.nl) and at the *Environmental Data* website of CBS/RIVM (www.rivm.nl). However, please note that domestically sometimes different units and definitions are used than used in this report. In particular for CO_2 data are provided with or without temperature correction, with or without organic CO_2 included, with or without LUCF sinks.

1.5 Brief description of key source categories

For preliminary identification of so-called 'key sources' according to the *IPCC Good Practice approach* (IPCC, 2000), we allocated the national emissions according to the IPCC's potential key source list wherever possible. The Netherlands has a high share of feedstock use of fuels, which is a non-combustion category of CO_2, therefore, this source category has been added to the list. A number of others could not be clearly identified in the present dataset. Compared with the previous submission it was now possible to identify the possible key source CO_2 emissions from iron and steel production. 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 of which the total adds up to 95% of the national total are 18 sources for annual level assessment and 20 sources for the trend assessment out of a total of 56 sources. Both lists can be combined to get an overview of sources, which 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 done using the uncertainty estimates discussed above. The results of the Tier 1 and Tier 2 levels and trend assessment are summarised in *Table 1.3*. As could be expected, the Tier 2 level and trend assessment increase the importance of small sources that are relatively very uncertain. Some of these sources are below the 95% cut-off line in the Tier 1 assessment are shifted above this line in the Tier 2 assessment.

Table 1.3. Preliminary key source identification using the IPCC Tier 1 and 2 approach

IPCC	Gas	Source category (key source = bold)	Key (L/T/Tier)	Tier 1	Tier 2	Method/Tier	Emission factor
		ENERGY SECTOR					
1A1	**CO2**	**Emissions from stationary combustion : Energy Industries**	**Key (L,T)**	**L, T**	**L, T**	**CS, T2**	**PS, CS**
1A2	**CO2**	**Emissions from stationary combustion : Manufacturing Industries and Constr.**	**Key (L,T)**	**L, T**	**L, T**	**CS, T2**	**PS, CS**
1A2	**CO2**	**Emissions from iron and steel industry**	**Key (L1,T1)**	**L, T**		**CS, T2**	**PS, CS**
1A2	**CO2**	**Feedstock gas**	**Key (L,T1)**	**L, T**	**L**	**CS, T1**	**PS, CS**
1A2	**CO2**	**Feedstock oil**	**Key (L,T1)**	**L, T**	**L**	**CS, T1**	**PS, CS**
1A2	CO2	Feedstock coal	Non-key			CS, T1	PS, CS
1A3	**CO2**	**Mobile combustion: road vehicles**	**Key (L,T)**	**L, T**	**L, T**	**CS, T2 (Box 2)**	**CS**
1A3	**CO2**	**Mobile combustion: water-borne navigation**	**Key (L2)**		**L**	**CS, T2**	**CS**
1A3	**CO2**	**Mobile comustion: aircraft**	**Key (T1)**	**T**		**CS, T2**	**CS**
1A3	**CO2**	**Mobile combustion: other**	**Key (L)**	**L**	**L**	**CS, T2**	**CS**
1A3	CH4	Mobile combustion: road vehicles	Non-key			CS, T3 (road)	CS
1A3	CH4	Mobile combustion: other	Non-key			CS, T1	CS
1A3	**N2O**	**Mobile combustion: road vehicles**	**Key (L2)**		**L**	**CS, T3 (road)**	**CS**
1A3	N2O	Mobile combustion: other	Non-key			CS, T1	D
1A4	**CO2**	**Emissions from stationary combustion : Other Sectors**	**Key (L1,T2)**	**L**	**T**	**CS, T2**	**PS, CS**
1A	**CH4**	**Emissions from stationary combustion: non-CO2**	**Key (L2)**		**L**	**CS, T2**	**PS, CS**
1A	N2O	Emissions from stationary combustion: non-CO2	Non-key			CS, T1	PS, D
1B1	CH4	Coal mining	Not Occuring	NO			
1B1	all	Coke production	Included in 1A2	IE			
1B2	**CO2**	**Misc. CO2 (2/3 in category 1B2)**	**Key (L,T)**	**L, T**	**L, T**	**CS, T3; >97: T1**	**CS**
1B2	**CH4**	**Fugitive emissions from oil and gas: gas production**	**Key (L,T1)**	**L, T**	**L**	**CS, T1**	**CS**
1B2	**CH4**	**Fugitive emissions from oil and gas: gas distribution**	**Key (L,T1)**	**L, T**	**L**	**CS, T1**	**CS**
1B2	CH4	Fugitive emissions from oil and gas operations: other	Non-key			CS, T2	CS
		INDUSTRIAL PROCESSES					
2A	CO2	Emissions from cement production	Non-key			CS	PS, CS
2	CO2	Other industrial: CO2	Non-key			CS	PS, CS
2A	CO2	Emissions from lime consumption	Included in 2G	IE			
2B	CO2	Chemical industry: feedstock use / NEU	Included in 1A2	IE			
2C	CO2	Metal production: steel production	Included in 1A2	IE			
2	CH4	Other industrial: CH4	Non-key			CS	PS, CS
2B	**N2O**	**Emissions from nitric acid production**	**Key (L,T1)**	**L, T**	**L**	**CS, T2**	**PS**
2G	N2O	Other industrial: N2O	Included in 2B	IE			
2C	**F-gas**	**PFC emissions from aluminium production**	**Key (L,T1)**	**L, T**	**L**	**CS, T2&T3b**	**PS**
2E	**F-gas**	**HFC-23 emissions from HCFC-22 manufacture**	**Key (T)**	**T**	**T**	**CS, T2**	**PS**
2E	F-gas	HFC by-product emissions from HFC manufacture	Non-key			CS, T2	PS
2F	**F-gas**	**Emissions from substitutes for ODS substitutes: HFC**	**Key (T1,L2)**	**T**	**L**	**M, CS, T2**	**CS**
2F	F-gas	PFC emissions from PFC use	Non-key			T2&T3b	D
2F	**F-gas**	**SF6 emissions from SF6 use**	**Key (L2)**		**L**	**T2&T3b**	**PS, CS, D**
		SOLVENTS AND OTHER PRODUCT USE					
3	CO2	Misc. CO2 (minor part in category 3)	Non-key			CS	CS
3	CH4	Solvents and other product use	Included in 7	IE			
3	**N2O**	**Misc. N2O**	**Key (T2)**	**L**	**T**	**CS, -**	**CS**
		AGRICULTURAL SECTOR					
4A	**CH4**	**CH4 emissions from enteric fermentation: cattle**	**Key (L,T1)**	**L, T**	**L**	**90:T2; T1**	**CS**
4A	CH4	CH4 emissions from enteric fermentation: swine	Non-key			T1	D
4A	CH4	CH4 emissions from enteric fermentation: sheep	Non-key			T1	D
4A	CH4	CH4 emissions from enteric fermentation: other	Non-key			T1	D
4B	**CH4**	**Emissions from manure management : cattle**	**Key (L2)**		**L**	**CS, T2**	**CS (=D, corrected)**
4B	**CH4**	**Emissions from manure management : swine**	**Key (T1,L2)**	**T**	**L**	**CS, T2**	**CS (=D, corrected)**
4B	CH4	Emissions from manure management : poultry	Non-key			CS, T2	CS (=D, corrected)
4B	CH4	Emissions from manure management : other	Non-key			CS, T2	CS (=D, corrected)
4B	N2O	Emissions from manure management	Non-key			CS, T2	CS
4C	CH4	Rice cultivation	Not Occuring	NO			
4D	**N2O**	**Direct N2O emissions from agricultural soils**	**Key (L)**	L	L	**CS, T1b**	**CS**
4D	**N2O**	**Indirect N2O emissions from nitrogen used in agriculture**	**Key (L)**	L	L	**CS, T1b**	**CS**
4E	all	Prescribed burning of savannas	Not Occuring	NO			
4F	n-CO2	Emissions from agricultural residue burning	Not Occuring	NO			
		LUCF					
5A	all	LUCF	Partly estimated	PE		T1	CS
		WASTE SECTOR					
6A	**CH4**	**CH4 emissions from solid waste disposal sites**	**Key (L,T)**	L, T	L, T	**M, CS, T2**	**CS**
6B	**CH4**	**Emissions from wastewater handling**	**Key (T1)**	T		**CS, T2**	**CS**
6B	N2O	Emissions from wastewater handling	Non-key			CS, T2	CS
6C	all	Emissions from waste incineration	Included in 1A1	IE			
6D	CO2	Misc. CO2 (1/3 in category 6D)	Non-key			CS	CS
		OTHER					
7	CH4	Misc. CH4	Non-key			CS, -	CS
7	**N2O**	**Polluted surface water**	**Key (L)**	L	L	**CS, T1b**	**CS**

Notion keys:

L, T = Level, Trend CS = country-specific PART = Partial
T1 = IPCC Tier 1 PS = Point source IE = Included Elsewhere
T2 = IPCC Tier 2 D = IPCC Source Category Default NO = Not Occurring

Legend for notation keys used for method and emission factors: see bottom part of the table and the footnotes of *Table1.2*.

1.5.1 Key source identification and methodological choice

The result is a list of about 29 source categories out of a total of 56 that could be identified as 'key sources' according to the definition of the *IPCC Good Practice Guidance* report. Depending on what criteria is used to determine them (level, trend, or both; or qualitative criteria such as expected high growth or decrease rates) more or less source categories are selected. In any case, a few conclusions can already be drawn in connection with the methodology and emission factor type label added to *Table 1.3.* For many of the country-specific methods the associated IPCC Tier still has to be determined, but it seems clear that for CH_4 from national gas distribution and CH_4 from enteric fermentation of cattle for instance, the methods used will probably need to be improved in future. However, a comprehensive analysis still has to be made.

1.5.2 Limitations

We recall that Tier 2 key source assessments are subject to the limitations of the Tier 1 uncertainty estimates, as discussed in *Section 1.7*. Nevertheless, it provides clear indications of the increasing importance of some smaller but very uncertain sources, in particular:

- CH_4 from manure management of cattle and swine;
- Indirect N_2O emissions from nitrogen used in agriculture.

1.6 Information on the QA/QC plan

The preparation of the greenhouse gas emission data in the CRF files is highly related to the national *Pollutant Emission Register* (PER), see *Section 1.2.* To meet the UNFCCC and EU requirements additional actions are (still) necessary. In the following section we will present information for both (interrelated) processes in separate sections. One deals with the PER and the other with the NIR and the CRF files.

1.6.1 The Pollutant Emission Register (PER)

Quality Assurance for the Netherlands' PER

The *Pollutant Emission Register* (PER) process has been in existence for many years and deals with over 100 different pollutants from point sources, area sources and diffuse sources, with emissions to air, water and soil. It also includes waste handling data. This emission inventory process is organised as a project with an annual cycle. Required changes and priorities for improvement are discussed prior to the next year of data collection. Each year the Inspectorate of the Ministry of VROM commissions TNO to draft a detailed plan for the compilation of the emission inventory for the forthcoming year (e.g. WEM/CCDM, 2002). This project plan includes responsibilities of the parties involved, members of the Task Forces, the division of tasks, the selection of substances and years, the list of source categories and the time schedule. Each Task Force has task to define or update a protocol for the monitoring process of their specific Target Sector. This protocol covers the data collection, validation, data storage, data management and data dissemination, and is documented in a report and a meta-information sheet. At the end of the project, the PER Project Group (WEM) reports the necessary improvements identified for next year's emission inventory update.

In 1997 the quality assurance system ISO 9001 was introduced to ascertain the quality of the monitoring process related to the PER. All procedural activities by the Inspectorate, TNO and RIVM are subject to this quality control, as well as the maintenance of the PER database by RIVM. However, the activities of actual data collection and emission calculation by the Task Forces are not yet part of the formal ISO quality assurance programme.

Quality of Annual Environmental Reports (MJVs)

As presented in *Figure 1.2* and *Box 1.1* the *Annual Environmental Reports* (in Dutch: '*MJVs*') contain the data for the large companies that form input for the PER. The 1999 MJVs were analysed to establish the quality of the data, as it was the first time that the large companies had, by virtue of statutory obligation, prepared this report themselves. Analysis on these MJVs and a trend analysis on emission data for 1998 and 1999 for 171 companies led to doubts about the quality. For example CO_2 emissions for these 171 companies showed reductions of 33% from 1998 to 1999. Additional in-depth research on 57 MJVs was conducted. Some differences between 1998 and 1999 data could be traced back to changes in production of energy use, technical improvements, production disturbance and improved measurements. Also mistakes in units and calculations etc. were shown. Overall the improved data for these companies resulted in a new figure for CO_2 emissions; not a 33% reduction, but 7% (Heslinga, 2001a).

An investigation was also made of the quality of MJVs submitted on 2000 emissions (Heslinga, 2001b). The energy input, specified by fuel type, should be reported in the MJV. It was concluded that only 40% of this detailed information could only be used. Moreover, this information is essential for activity data as well as for the calculation of greenhouse gas emissions. In the MJVs a total of 71 Tg CO_2 emissions is reported. In the quality research it was concluded that the energy input could not be verified for 112 companies responsible for 34 Tg CO_2, in particular, for some large companies that kept their energy details confidential. This is also the situation for NO_x: 36 Gg out of a total of 65 Gg could not be verified. These comments on the 1999 and 2000 data do not necessarily mean that these data are wrong, but that reported emissions could not be cross-checked with underlying fuel consumption data at company level.

The Inspectorate of the Ministry of VROM started improvement actions. In 2001 the different reporting formats for the MJV were condensed to one format, which will be used for the MJV 2002. In this format the companies will have to report on several processes. This classification of the processes makes the differences between fuel combustion and non-combustion emissions more transparent. The Ministry of VROM will annually report the progress in this improvement plan (VROM, 2002).

Documentation of methodologies used in the PER

The methodology for calculating emissions to air and water in the Netherlands' *Pollutant Emission Register* has in the course of time been described in a number of reports, as documented below:

- general methodologies and data in Van der Most *et al.* (1999) [in Dutch];
- the methodology for calculating greenhouse gas emissions in more detail in Spakman *et al.* (2003), an update of the 1997 report [available in Dutch and English];
- specific changes in methods of datasets in the annual reports on emissions and waste, e.g. Koch *et al.* (2002) [in Dutch]. These reports also summarise the quality of national total emissions of several compounds by a qualitative classification based on expert judgement in terms of shares of quality classes A to E in conformity with EMEP/CORINAIR and EPA methods. A summary of these reports is also published in English, e.g. Koch *et al.* (2002);
- a set of source category reports documenting or summarising the methodology used by the Task Forces is posted at a new website (so-called meta-data files) [in Dutch, English translation in preparation] (TNO, 2003).

Finally, since 1994 changes in methodologies, deviating source definitions and changes in source allocations in greenhouse gas emissions, have been reported in the annual National Inventory Reports on greenhouse gas emissions in the Netherlands, prepared and co-ordinated by RIVM for submission to the UNFCCC and the *EU Greenhouse Gas Monitoring Mechanism*.

At the end of 2002 the main data and documentation was to be included in a new website http://dm.milieumonitor.net. This site is in the Dutch language, but also contains the English reports that the CCDM publishes. Also the documentation in the meta-data files (in Dutch) is now generally available on at that site. Please note that all emission data provided on this website are presented according to the national method (including emissions from biomass and natural emissions, and those without LUCF); emissions according to the UNFCCC/IPCC definitions can be found at the website www.greenhousegases.nl.

The Quality Control (QC) activities of the PER

The Quality Control (QC) activities of the Dutch Emission Inventory can be divided in the following phases:

- QC by Task Forces before data delivery to TNO (including QC on ER-I data);
- QC by TNO;
- QC by Task Forces before the trend verification workshop;
- QC by Task Force and RIVM Target Sector co-ordinators at the workshop above;
- QC on the IPCC summary tables included in the annual *Emission Monitor* report.

The data deliveries and feedback to the Task Forces is performed in accordance with the procedure ‘Data handling and presentation’ from the quality assurance system of the Netherlands Pollutant Emission Register. The Task Forces filled a standard-format database delivered by TNO with emission data for 1999, 2000 and 2001 and for the years 1995 and 1990. After a check on the emission file by the Task Force before submission, TNO performed QC activities such as checks on completeness, consistency and formats. The (corrected) data were processed to a comprehensive draft data file. The Task Forces can access the relevant emissions in the draft data file, which can be consulted on the internet by the Task Forces in order to check the TNO data handling. Observed errors and information about how the quality controls are performed by the Task Forces are reported to TNO. All corrections made in the draft data file are documented and accessible on the internet for the Task Forces.

In July 2002 a workshop was held on trend analysis of the emissions to air. The Task Forces were provided in advance with the emission data in the new draft data file for each source category (including the relevant time series). In this way the Task Forces could check for level errors and consistency in the algorithm/method used for calculations throughout the time series. The Task Forces performed checks for, amongst others, CO_2, CH_4 and N_2O emissions from all sectors for the years 1990, 1995, 1999, 2000 and 2001. The totals for the sectors were compared with last year's dataset. Where significant differences were found, the Task Forces looked at the emission data in more detail. The results of these checks were discussed at the workshop.

TNO also made time series of emissions per substance for the individual Target Sectors. The Task Force members, the chairman of the Task Force and the RIVM co-ordinator of the Target Sector examined these time series. Since the annually published national emissions report (Koch *et al.,* 2002) contains the IPCC Summary Tables 7A for the last three years, the emissions for these years have subsequently been aggregated in the format of IPCC Summary Table 7A. A distinct difference with the national sectoral reporting is that for international reporting according to the IPCC format, the sectoral emission sources of most so-called Target Sectors are split into fuel combustion and non-combustion emissions. Therefore, the emissions data were also checked at the IPCC reporting format level for outliers in two ways: (a) the levels for 1999 and 2000 were compared with the table published the previous year; (b) annual trends for 1999/2000 and 2000/2001 have been calculated as percentages.

Box 1.2. Results of the trend verification workshop

Twenty actions were formulated and discussed at the workshop. Those relevant for greenhouse gases are listed below.
Task Force on Energy, Industry and Waste Handling (ENINA): - TNO action: correction of emissions of F-gases. - CBS action: check CO_2 emissions per sector because of unexpected trends (2000, 2001).
Task Force on Residential, Commercial and Construction sectors: *- TNO, RIVM action: check N_2O from anaesthesia.*
Task Force on Traffic and Transport: - No action.
Task Force on Agriculture: - TNO action: no problems observed on greenhouse gases.
All Task Forces: - Action: methodological changes must be documented in meta-information documents and sent to TNO.

Remarkable trend changes observed were noted and discussed at the workshop, resulting in an action list (see *Box 1.2*). Items on this list have to be processed within two weeks or become a footnote this year (2003) and will be dealt with in 2004. Where the Task Force members could explain a large change in the trend, it was removed from the list. Inexplicable trend changes were studied in more detail at emission source level after the workshop. Points of special interest concerning combustion emissions were discussed with the chairman of the Task Forces. In some cases the differences could be explained or the emission figures were corrected and sent to the chairmen of the Task Forces. The proposed changes have been sent to the chairmen of the Task Forces and then approved in writing. The new emission database was then sent to TNO, which processed the second data delivery into a new comprehensive data file. The chairmen approved the new data file, after which the emission data were released by TNO to the participating agencies. Finally, the Task Forces made a list of recommended improvements for next year's (2004) inventory compilation.

1.6.2 The National Inventory Report and CRF files

Building a National System

Greenhouse gas emission data in the Netherlands are prepared as part of the *Pollutant Emission Register* (PER) (see *Section 1.2.1).* The UNFCCC, the EU and the Kyoto Protocol added additional requirements to the PER. For example, some additional greenhouse gas sources had to be included and the monitoring had to be brought in line with the UNFCCC, IPCC and EU Monitoring Mechanism requirements. To achieve this around the year 2000 a programme was started to adapt the monitoring of greenhouse gases in the Netherlands and transform this to a National System as in Article 5 of the Kyoto Protocol.

The *Quality Assurance* (QA) process and *Quality Control (QC)* activities are incorporated into the development of a National System. We will summarise the overall inventory improvement programme and three selected issues: the monitoring improvement programme, protocols and process descriptions, and a development project for a QA/QC system. In *Section 10.4* we will present these elements in more detail. We elaborate the following *Quality Control* elements in separate sections:

- the impact of the quality of the annual environmental reports on the quality of the data in the CRF files;
- the relationship between the verification process in the PER and for the CRF data at IPCC source category level;
- the documentation of the process to complete the data in the CRF files.

The responses to the issues raised in UNFCCC reviews on the NIR are described in *Section 10.4*.

Quality Assurance as part of building a National System

The UNFCCC and Kyoto Protocol added additional requirements to the regular emission inventory system (PER). To achieve this in 2000 a programme was started to adapt the monitoring of greenhouse gases in the Netherlands and transforming this to a National System as in Article 5 of the Kyoto Protocol. The programme is being implemented under responsibility of the Netherlands Ministry of Spatial Planning, Housing and the Environment (VROM), who delegated the practical co-ordination to Novem. An interdepartmental committee, the *Working Group Emission Monitoring of Greenhouse Gases* (WEB) was created to direct the actions. Many institutes are involved in these activities. The programme is set up as a temporary special assignment. All improvements and arrangements will eventually become an integral part of the wider system of regular emission monitoring (PER).

This programme consists of three main elements: a monitoring improvement programme, development of monitoring protocols and process descriptions, and a QA/QC system as part of the National System. The monitoring improvement programme deals with methods, activity data and emission factors that are assessed and, where needed, adapted. To this end, a series of studies and activities are being carried out to improve – where necessary – data quality, methodologies, documentation and data compilation procedures. The elaboration and implementation by protocols and process descriptions involves assessing and, where needed, redefining processes, methods, procedures, tasks, roles and responsibilities with regard to inventories of greenhouse gases. These different aspects are being laid down in transparent descriptions and procedures in so-called ‘protocols’ per gas and sector, and in process descriptions for other relevant tasks in the National System.

In 2001, a three-phase project was started to adapt the QA/QC system for use in the Netherlands greenhouse gas monitoring and NIR/CRF process. The first phase (finished early 2002) included an assessment of the present situation as compared to the UNFCCC/IPCCC requirements. The second phase (to be finalised in 2003) involves the elaboration and description of relevant processes and procedures, including adaptation of the present situation. This work is interrelated with the elaboration of the protocols and is co-ordinated by Novem with involvement from the Ministry of VROM and the PER. The third phase comprises the formal and legal arrangements, needed for the structural embedding of the QA/QC procedures. This will be done in 2003/2004, together with the legal embedding of the protocols in the PER.

Quality of Annual Environmental Reports (MJVs) and CRF files

For the years 1990 and 1995-2000, CRF files now also include sectoral background data (i.e. emissions per fuel type) for '*Fuel combustion'* (1A). This includes *'Energy Industries'* (1A1) and *'Manufacturing Industries'* (1A2). However, these data are only presented for the three specific fuel types if individual companies (in the MJV) had reported CO_2 and related fossil fuel consumption per fuel type with a proper match. If this specification was not reported or did not properly match, fuel consumption and CO_2 emissions were allocated in the CRF *Sectoral Background Tables* under '*Other fuels'*. This fraction of national total CO_2 emissions increases from about 11% of fossil-fuel related emissions in 1990 to 15% in 1995-1999, and to 34% in 2000; i.e. this percentage of national CO_2 emissions could not be allocated to a specific fuel type in either energy sector or manufacturing industry sector. Therefore, due to limited data quality and completeness of point source data, up to 34% of the national CO_2 emissions from fossil fuel consumption has been included under '*Other fuels'*, for which no correct and meaningful so-called '*Implied Emission Factors'* could be provided in the CRF. The following three groups of economic sectors account for almost all of the unspecified emissions in 2000, each contributing about one-third:

- refineries and iron and steel production, of which *all* CO_2 emissions in 1999 could not - or could not properly - be associated with reported fossil fuel consumption;
- public electricity production and
- the chemical industry.

Please refer to the relevant sections in *Chapters 3 and 4* for more details.

QA and verification of the CRF data at IPCC source category level

A distinct difference with the national annual emissions report (Van Harmelen *et al.,* 2002) is that for international reporting according to the IPCC format, the sectoral emission sources of most so-called Target Sectors are split into fuel combustion and non-combustion emissions. Therefore, the data were checked at the reporting format level for outliers in two ways: (a) the levels for 1998 and 1999 were compared with the table published previously; (b) annual trends for 99/98 and 2000/1999 were calculated as percentages.

The NIR co-ordinator summarised relatively large differences and contacted the relevant sectoral experts of RIVM in the Task Forces to check the correctness of the source allocation and the plausibility of the difference for all flagged items. This resulted in a confirmation or correction (of the IPCC source allocation, for example) and in explanations in terms of either a deliberate recalculation or a probable cause in case of large annual change). This has been done for the greenhouse gases CO_2, CH_4 and N_2O, as well as for the four precursor gases.

Finally, in preparing the CRF data set, similar trend and level checks of outliers were carried out at a more detailed level of the sub-sources of all sectoral background tables:

- annual changes in emissions of the six greenhouse gases;
- annual changes in activity data;
- annual changes in implied emission factors for CO_2, CH_4 and N_2O;
- level values of implied emission factors, in particular, of CO_2 from combustion.

The agency responsible for the data entry checks all flagged items for correctness of the figures and the plausibility of the difference. Again, remaining flagged items are communicated with the relevant RIVM sectoral expert in the Task Forces to explain the marked items. The explanations of both checks are used to document the differences with the previous release of the CRF in the recalculation tables and to explain unusual trends in the NIR. These activities have been documented since 2001 (see, for example, Coenen and Olivier, 2003).

Documentation of completing CRF files

The PER database does not contain all information necessary to fill the CRF files. In general, additional data are needed for the following four groups:

- *IPCC Reference Approach* for CO_2 from fuel combustion, derived from the national energy statistics; complemented with data on the carbon content of crude oil, natural gas liquids and other refinery inputs;
- recalculations (and additional data) for the years, 1991-1994, which were not considered in the inventory update project in 2002;
- full recalculations for the years, 1996-1998, which were not considered in the inventory update project in 2002; the source allocation for these years is also made consistent with the period, 1995-2000;
- documentation on recalculations as described in the *UNFCCC guidelines* and the *IPCC Good Practice* report, respectively;
  - additional activity data for the agricultural sector, the waste sector and fuel combustion;
  - data related to *Land Use Change and Forestry* (LUCF: sinks).

Changes in the data reported in the previous NIR have to be reported in the CRF Recalculation Tables 9a/b (see *Annex 7.2*). All activities and data sources to complete the 2003 CRF files have been documented in Coenen and Olivier (2003).

1.7 General uncertainty evaluation

The IPCC Tier 1 methodology for estimating uncertainty in annual emissions and trends has recently been applied to the more detailed IPCC list of possible key sources listed in IPCC (2000). This was done to get a more detailed first-order estimate of the uncertainty in the annual emissions as well as in the trend. Secondly, these uncertainties could be used for a first Tier 2 analysis to identify 'key sources' as defined in the *IPCC Good Practice Guidance* report (IPCC, 2000). However, since key source identification can be done using many more criteria, important for meeting the National System requirements, the information presented in this section should only be considered as a first step in this process.

1.7.1 Data used

To estimate total uncertainty in both *annual* emissions and in emission *trends,* we applied the *IPCC Tier 1 uncertainty approach* at the level of the IPCC list of possible key sources (see *Section 1.5*). The emissions data for 1990 and 2001 were taken from the preliminary submission to the EU and allocated to the IPCC source category list, i.e. where these emissions could be separated for these source categories. However, the IPCC list was slightly adjusted. In view of the importance for the Netherlands of CO_2 from feedstocks and the relatively high uncertainty in these emissions, we separated CO_2 from non-energy use and CO_2 from fuel combustion.

The following information sources were used for estimating the uncertainty in activity data and emission factors (Olivier and Brandes, 2003):

- estimates used for reporting uncertainty in greenhouse gases emissions in the Netherlands 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 factsheets on calculation methodology and data uncertainty (RIVM, 1999);
- any other recent information on the data quality (Boonekamp *et al.*, 2001).

These were supplemented with expert judgement of RIVM emission experts. Next, the uncertainty in the emissions in 1990 and 2001 was estimated according to the IPCC Tier 1 methodology. This was done for both the annual emissions and the emission trend for the Netherlands. All uncertainty figures are to 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.

Table 1.4. Tier 1 level uncertainty assessment of source categories of the IPCC potential key source list (without adjustment for correlations between sources) (1990 level; 1995 for F-gases) (in Tg CO_2-eq.)

IPCC	Source category	CO_2-eq. 90/95	CO_2-eq. 2001	AD unc	EF unc	EM unc
1A	Emissions from stationary combustion : Energy Industries	51,305	64,776	3%	2%	4%
1A	Emissions from stationary combustion : Other Sectors	34,179	36,126	3%	1%	3%
1A	Emissions from stationary combustion : Manufacturing Indus	27,711	25,027	3%	1%	3%
1A	Mobile combustion: road vehicles	25,374	31,984	2%	2%	3%
1A	Emissions from iron and steel industry	6,255	6,196	3%	3%	4%
1A	Feedstock gas	4,805	4,664	5%	10%	11%
1A	Feedstock oil	2,549	3,902	20%	50%	54%
1A	Mobile combustion: other	2,378	2,458	50%	2%	50%
1A	Mobile combustion: water-borne navigation	877	969	100%	2%	100%
1A	Feedstock coal	569	408	5%	10%	11%
1A	Mobile combustion: aircraft	492	197	50%	2%	50%
2	Other industrial: CO2	1,181	1,124	20%	5%	21%
2	Emissions from cement production	400	437	5%	10%	11%
7	Misc. CO2	1,189	1,579	20%	50%	54%
	Total CO2	**159,263**	**179,847**			**2%**
						-> 3%
1A	Emissions from stationary combustion: non-CO2	557	638	3%	50%	50%
1A	Mobile combustion: road vehicles	158	81	5%	60%	60%
1A	Mobile combustion: other	8	7	50%	100%	112%
1B	Fugitive emissions from oil and gas operations: gas productio	2,097	1,454	1%	25%	25%
1B	Fugitive emissions from oil and gas operations: gas distributi	1,524	1,287	5%	50%	50%
1B	Fugitive emissions from oil and gas operations: other	133	79	20%	50%	54%
2	Other industrial: CH4	69	30	10%	50%	51%
4A	CH4 emissions from enteric fermentation in domestic livestoc	7,678	6,054	5%	20%	21%
4A	CH4 emissions from enteric fermentation in domestic livestoc	438	412	5%	50%	50%
4A	CH4 emissions from enteric fermentation in domestic livestoc	286	218	5%	30%	30%
4A	CH4 emissions from enteric fermentation in domestic livestoc	37	83	5%	30%	30%
4B	Emissions from manure management : swine	1,033	848	10%	100%	100%
4B	Emissions from manure management : cattle	905	803	10%	100%	100%
4B	Emissions from manure management : poultry	216	182	10%	100%	100%
4B	Emissions from manure management : other	19	23	10%	100%	100%
6A	CH4 emissions from solid waste disposal sites	11,802	8,181	15%	30%	34%
6B	Emissions from wastewater handling	138	16	20%	25%	32%
7	Misc. CH4	43	39	20%	25%	32%
	Total CH4	**27,140**	**20,434**			**17%**
						-> 25%
1A	Mobile combustion: road vehicles	341	583	5%	50%	50%
1A	Emissions from stationary combustion: non-CO2	208	223	2%	50%	50%
1A	Mobile combustion: other	31	29	50%	100%	112%
2B	Emissions from nitric acid production	7,029	6,564	10%	50%	51%
4B	Emissions from manure management	205	189	10%	100%	100%
4D	Direct N2O emissions from agricultural soils	5,214	5,518	10%	60%	61%
4D	Indirect N2O emissions from nitrogen used in agriculture	1,460	1,460	50%	200%	206%
6B	Emissions from wastewater handling	126	194	20%	50%	54%
7	Polluted surface water	1,178	1,178	50%	200%	206%
7	Misc. N2O	753	129	50%	50%	71%
	Total N2O	**16,544**	**16,067**			**34%**
						-> 50%
2X	HFC-23 emissions from HCFC-22 manufacture	5,759	450	15%	25%	29%
2X	Emissions from substitutes for ozone depleting substances (O	248	943	10%	50%	51%
2X	HFC by-product emissions from HFC manufacture	12	192	10%	50%	51%
2X	PFC emissions from aluminium production	1,799	1,320	5%	20%	21%
2X	PFC emissions from PFC use	68	136	5%	25%	25%
2X	SF6 emissions from SF6 use	275	296	100%	25%	103%
	Total F-gases	**8,160**	**3,337**			**21%**
	-> 50% for HFCs ,PFCs and SF6					
	Total Netherlands (CO2-eq.)	**211107**	**219685**			**4%**
						-> 5%

1.7.2 Results

The results of the uncertainty calculation according to the *IPCC Tier 1 uncertainty approach* are summarised in *Table 1.4.* The Tier 1 calculation of annual uncertainty in CO_2-eq. emissions results in 2%, 17%, 34% and 22% for CO_2, CH_4, N_2O and F-gases, respectively, and in an overall uncertainty of 4%. However, these figures do not include the correlation between source categories (e.g. energy amounts for feedstocks and fuel combustion, 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 RIVM at:

CO_2	±3%	HFCs	±50%
CH_4	±25%	PFCs	±50%
N_2O	±50%	SF_6	±50%

The resulting uncertainty in national total annual CO_2-eq. emissions is estimated to be about 5%.

If we rank the sources according to their contribution to the uncertainty in total national emissions (using the column 'Combined Uncertainty as % of total national emissions in 2001' in *Table 1.7)* the top 10 sources contributing the most to total *annual uncertainty* in 2001 are:

IPCC	IPCC Source category	Uncertainty (as % of total national emissions in 2001)
4D	Direct N_2O emissions from agricultural soils	1.5
2X	N_2O emissions from nitric acid production	1.5
4D	Indirect N_2O emissions from nitrogen used in agriculture	1.4
6A	CH_4 emissions from solid waste disposal sites	1.2
7X	N_2O emissions from polluted surface water	1.1
1A	CO_2 emissions from stationary combustion: energy industries	1.1
1A	CO_2 emissions from feedstock oil	1.0
4A	CH_4 emissions from enteric fermentation in cattle livestock	0.6
1A	CO_2 emissions from mobile combustion: other	0.6
1A	CO_2 emissions from stationary combustion: other sectors	0.5

Table A1.4 of *Annex 1* summarises the estimate of the *trend uncertainty 1990-2001* calculated according to the IPCC Tier 1 approach in the *IPCC Good Practice Guidance* (IPCC, 2000). The result is a trend uncertainty in the total CO_2-eq. emissions for 1990-2001 (1995 for F-gases) of ±3% points. This means that the increase in total CO_2-eq. emissions between 1990 and 2001, which is calculated to be 4%, will be between +1 and +7%. 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%, ±7%, ±11% and ±10% points, respectively. More details on the level and trend uncertainty assessment can be found in *Annex 1* on key sources. The top-10 of sources contributing most to *trend uncertainty* in the national total is:

IPCC	IPCC Source category	Uncertainty (as % into trend in total national emissions)
1A	CO_2 emissions from stationary combustion: energy industries	1.3
6A	CH_4 emissions from solid waste disposal sites	1.0
1A	CO_2 emissions from mobile combustion: other (rail, pipeline)	0.8
1A	CO_2 emissions from stationary combustion: other sectors	0.7
2X	HFC-23 emissions from HCFC-22 manufacture	0.7
1A	CO_2 emissions from inland shipping	0.7
1A	CO_2 emissions from feedstock oil	0.6
1A	CO_2 emissions from stationary combustion: manufacturing industries	0.5
4D	Indirect N_2O emissions from nitrogen used in agriculture	0.5
2X	N_2O Emissions from nitric acid production	0.5

If we compare this list with the 10 largest contributors to annual uncertainty, we can conclude that except for CO_2 from inland shipping, CO_2 from stationary combustion from manufacturing industries and construction, N_2O from polluted surface water, CH_4 from enteric fermentation of cattle and HFC from HCFC-22 manufacture, all others (7) are included both lists.

Because of the problems identified with annual environmental reports (see *Box 1.1*) an extra uncertainty in national CO_2 emissions was estimated for 2000 at 2% (Heslinga, 2001b). This will also be the case with 2001 emissions. In addition, delays in compiling (preliminary) statistics for the last but one calendar year, notably for energy consumption, have caused extra uncertainty for some sectors due to the use of *estimated* data for the 4th quarter of 2001. For the same reason the other greenhouse gas emissions are also more uncertain in 2001, but this extra uncertainty has not been quantified.

1.7.3 Limitations

The uncertainty estimates presented in *Table 1.4* and *Table A1.4* have been calculated according to the Tier 1 uncertainty estimate of IPCC. In this method uncertainty ranges are summed for all sectors or gases using the standard calculation for error propagation: 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 division ('Gaussian'), b) 2σ smaller than 60%, c) sector to sector and substance to substance are independent (non-correlated). Indeed for a number of sources it is clear that activity data or emission factors are correlated, which increases the overall uncertainty of the sum to an unknown extent. For some sources it is also already known that the probability distribution is not normal; in particular, when uncertainties are very high (in the order of 100%) it is clear that the distribution will be skewed towards zero.

Even more important is that, although the uncertainty estimates have been based on the documented uncertainties mentioned above, uncertainty estimates are unavoidably and in the end based on expert judgement of representativeness for the circumstances of the particular source category in the Netherlands. Sometimes, however, only limited reference to actual Netherlands data was possible to support these estimates. Focusing on the order of magnitude of the individual uncertainty estimates, we believe that this dataset provides a reasonable first assessment of the uncertainty of key source categories in the Netherlands.

Furthermore, in using the uncertainty estimates presented in *Table 1.4* and *Table A1.4* we have neglected the uncertainty introduced by the emissions from the sources of the ER-I (individually reporting firms), of which the uncertainty is actually unknown. These sources in the Emission Registration account for about half of the total CO_2 emissions in the Netherlands (see *Figure A2.1*). However, as described in *Annex 2.1*, total CO_2 emissions per industrial subsector do not deviate from the reference calculation by more than 5% (in practice, the group total may show much less deviation). For 2000 and 2001, as sited above, an extra uncertainty in national CO_2 emissions was estimated at 2%. This is in addition to the extra uncertainty introduced in the last year's emission estimates, due to the use of preliminary or incomplete statistics as basis for the inventory.

In the assessments made above only random errors have been estimated, assuming that the calculation methodology used does not include systematic errors. It is well known that in practice this may well be the case. Therefore, more independent verification of the emission level and emission trends, e.g. by 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 Netherlands' *Reduction Programme on Other Greenhouse Gases* (ROB). Results of these studies can be found in, for example, Berdowski *et al.* (2001), Roemer and Tarasova (2002) and Roemer *et al.* (2003).

1.8 General assessment of the completeness

At present, the Netherlands greenhouse gas emission inventory includes *all* sources identified by the *Revised IPCC Guidelines* (IPCC, 1997) *except* for the following:

- Indirect N_2O emissions from *atmospheric deposition* (category 4D) are not estimated/reported due to historical reasons;
- CO_2 emissions from *agricultural soils* (category 4D) are not estimated/reported due to historical reasons;

- In addition, it has been observed that *CH_4 and N_2O from horse manure* (category 4B) is missing; this is because no manure production estimates from horses have been made to date and no emission factors for this source category have been defined;
- CH_4 emissions from soils deceased in the last 40 years due to drainage and lowering of water tables; these emissions have been included in the natural total; thus there are no net (i.e. positive) anthropogenic emissions, on the contrary, total methane from soils acts in fact a methane sink.
- CH_4, N_2O and other non-CO_2 emissions from *international bunkers (international transport)* have not yet been estimated/ reported.
- Emissions/sinks for LUCF subcategories 5A to 5E, except for the CO_2 sink in category 5A2. New datasets are being compiled but are still under discussion, so no data for these subcategories have been included in this submission.

The incorporation of these sources into the national greenhouse gas inventory is part of the inventory improvement programme. For some of these sources, for example indirect emissions of N_2O, bringing the methodology in compliance to *IPCC Good Practice Guidance* may result in adjustments of several Tg (i.e. Mton) of CO_2-eq. More information on the completeness is provided in *Annex 5*.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

2.1 Emission trends for aggregated greenhouse gas emissions

The trend in total CO_2-eq. emissions of greenhouse gases and comparison of the contribution of the various gases has been calculated using the IPCC *Global Warming Potentials* (GWP) according to the Second Assessment Report (UNFCCC, 1999) for a time horizon of 100 years.

In *Table 2.1* the trends in national total CO_2-equivalent emissions are summarised for 1990-2001. The trends have also been visualised in *Figures 2.1* and *2.2*, showing the relative contribution of each gas to annual total emissions. Detailed trends in CO_2-equivalents by gas and by source category are provided in *Annex 7.3*. Total CO_2-equivalent emissions of the six greenhouse gases together increased by about 4% in 2001 relative to the base year of 1990 (1995 for fluorinated gases). Without policy measures the emissions in 2000 would have been about 10% higher (RIVM, 2001a).

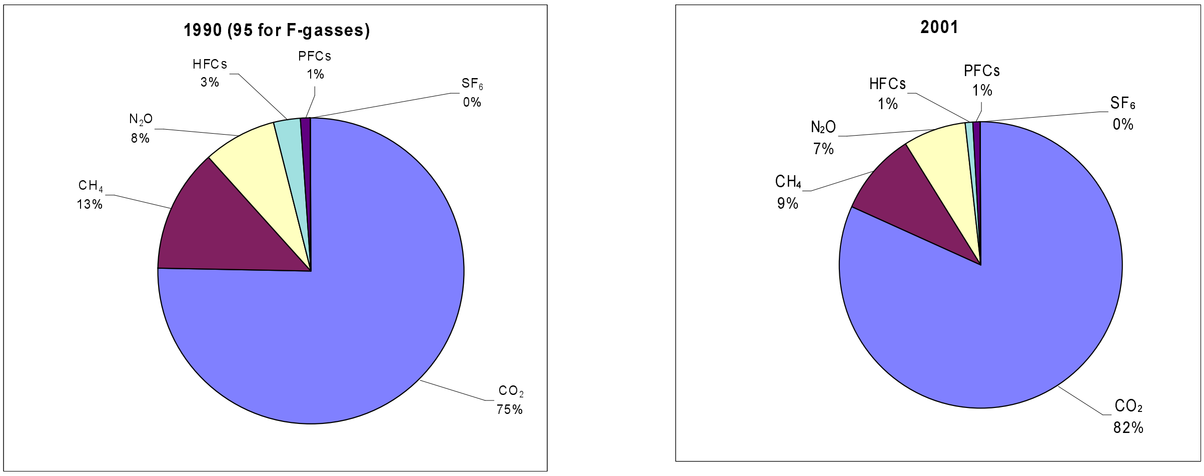

Figure 2.1. Shares of greenhouse gases in total emissions in 1990 (left) and 2001 (right)

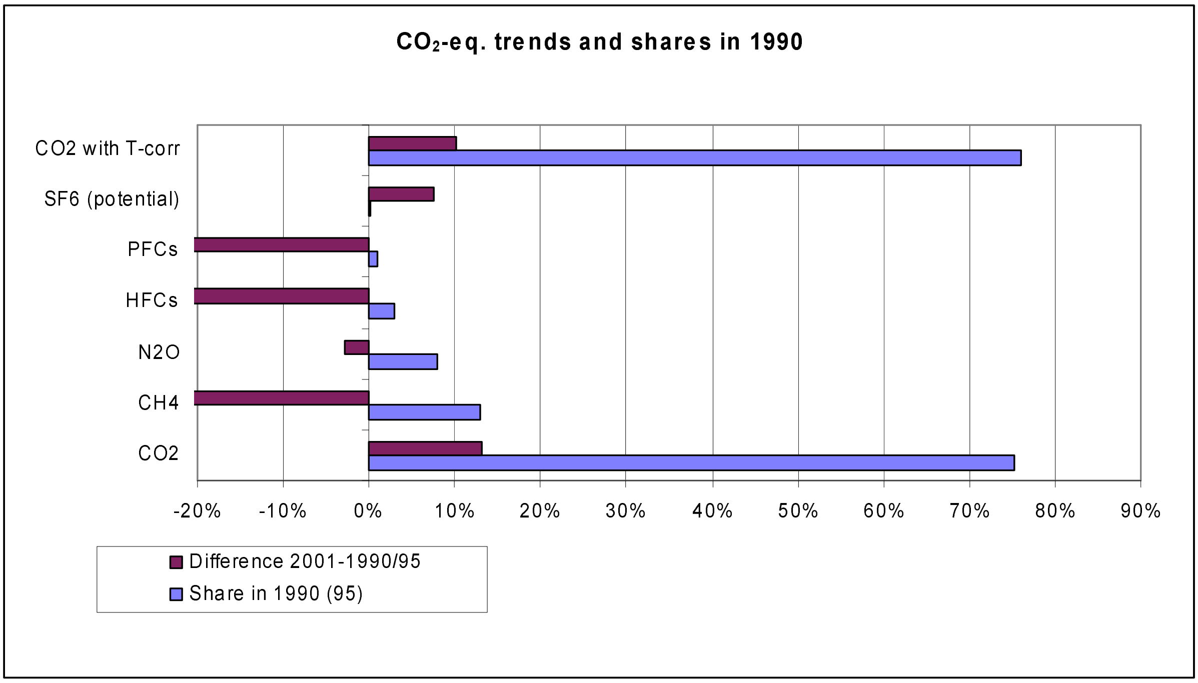

Figure 2.2. Shares and trends in greenhouse gas emissions per gas 1990-2001 (1995-2001 F-gases) and CO_2 also with temperature correction

To exclude the climatic influence that partially masks the anthropogenic trend in the CO_2 emissions, the same trends per gas have also been analysed with CO_2 emissions corrected for outside temperature[2]. Using temperature-corrected CO_2 emissions in 1990 and 2001, the structural anthropogenic trend of total greenhouse gas emissions in the past 11 years is estimated to be a 2%-point lower than the actual trend of 4% increase (*Table 2.2*).

CO_2 emissions increased by about 13% from 1990 to 2001, mainly due to the increase in the emissions in the energy (26%) and transport sectors (22%). In *Figures 2.3 and 2.4* one can observe that the doubling of imported electricity in 1999 from 10% to 20% of the domestic electricity consumption only temporarily decreased CO_2 emissions from the energy sector and total national CO_2 emissions. In 2000 and 2001 the annual increase of the pre-1999 years has resumed. CO_2 emissions peaked in 1996 due to a very cold winter, as can be observed in *Figure 2.4*, showing a substantial peak in emissions in 1996 from '*Other sectors*', particularly vulnerable to weather conditions.

Table 2.1. Total greenhouse gas emissions in CO_2-eq. and indexed 1990-2001(no temperature correction)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 [1]
Nat. Emissions (Tg CO_2-eq)												
CO_2 with LUCF	157.8	166.0	164.2	166.1	166.8	171.2	178.9	167.5	172.4	169.5	172.4	178.4
CO_2 excluding LUCF	***159.3***	167.5	165.7	167.9	168.8	172.4	180.3	171.7	173.8	170.7	173.8	179.9
CH_4	***27.1***	27.5	26.3	25.7	25.3	24.6	24.6	23.1	22.4	21.8	20.6	20.4
N_2O	***16.5***	16.8	17.9	18.7	18.3	18.2	18.0	17.9	17.6	17.4	16.7	16.1
HFCs	4.4	3.5	4.4	5.0	6.5	***6.0***	7.7	8.3	9.4	4.9	3.9	1.6
PFCs	2.4	2.4	2.1	2.1	1.9	***1.9***	2.0	2.2	1.7	1.4	1.5	1.5
SF_6	0.2	0.1	0.1	0.1	0.1	***0.3***	0.3	0.3	0.3	0.3	0.3	0.3
Total [group of six] [211.1 [5) 2)]]	**210.0**	**217.8**	**216.7**	**219.6**	**220.9**	**223.3**	**232.9**	**223.4**	**225.2**	**216.4**	**216.8**	**219.7**
Index (1990=100)												
Index CO_2 [2]	100	105.2	104.1	105.4	106.0	108.2	113.2	107.8	109.1	107.2	109.1	112.9
Index CH_4	100	101.3	97.0	94.9	93.1	90.5	90.8	85.1	82.4	80.3	76.1	75.3
Index N_2O	100	101.6	108.5	112.8	110.7	109.8	108.5	107.5	106.6	105.0	100.7	97.1
Total [group of three]	100	104.4	103.5	104.6	104.6	106.0	109.8	104.7	105.3	103.4	104.0	106.6
Index HFCs	100	77.9	100.3	112.8	146.4	135.8	173.2	187.4	211.2	110.5	87.4	35.7
Index PFCs	100	100.2	86.3	87.1	77.7	76.8	84.0	88.6	71.0	59.4	62.8	59.9
Index SF_6 (potential)	100	53.7	56.9	58.8	79.2	147.3	152.4	166.6	157.6	141.8	143.7	158.4
Index [group of six] [2]	**100**	**103.7**	**103.2**	**104.6**	**105.2**	**106.3**	**110.9**	**106.4**	**107.2**	**103.1**	**103.2**	**104.6**
Index (1995 = 100)												
Index HFCs	73.6	57.4	73.9	83.0	107.8	100	127.5	138.0	155.5	81.4	64.4	26.3
Index PFCs	130.3	130.5	112.4	113.5	101.3	100	109.4	115.4	92.5	77.4	81.8	78.0
Index SF_6 (potential)	67.9	36.5	38.6	39.9	53.7	100	103.5	113.1	107.0	96.3	97.6	107.5
Index [group of new gases]	**86.4**	**73.4**	**81.5**	**88.6**	**104.5**	**100.0**	**122.6**	**132.0**	**139.5**	**81.0**	**69.5**	**40.9**
Index ('90; new gases '95) [3]												
Index [group of 6 composite] [2]	**99.5**	**103.2**	**102.6**	**104.0**	**104.6**	**105.8**	**110.3**	**105.8**	**106.7**	**102.5**	**102.7**	**104.1**
International Bunker CO_2 [4]	39.8	41.3	42.4	44.3	42.9	44.3	45.4	48.5	49.5	51.2	53.5	57.5
Index bunkers CO_2 (1990 = 100)	100.0	103.8	106.6	111.4	107.8	111.4	114.3	122.0	124.6	128.8	134.5	144.7

1) Data for 2001 are preliminary. In particular, this *'t-1'* dataset is of a relatively low quality in this submission (see *Section 1.2).*

2) National emissions excluding LUCF (category 5A).

3) Base year = 100.

4) Emissions from international marine and aviation bunkers are not included in the national totals.

5) Base year emissions (1990 for CO_2, CH_4 and N_2O and 1995 for the F-gases, shaded/bold-italic figures): 211.1Tg CO_2-eq.

2 In *Table 2.2* the same trends per gas have been summarised but now with CO_2 emissions corrected for outside temperature in order to exclude the climatic influence that partially masks the trend in these emissions. This analysis leads to the conclusion that of the 4% increase in total actual greenhouse gas emissions since 1990 about a 2% point are caused be weather effects in the base year and the present year.

Table 2.2. Total greenhouse gases emissions with temperature correction, in CO_2-eq. and indexed 1990-2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Emissions (Tg CO_2-eq)												
CO_2 with LUCF (T-corrected)	164.1	166.4	168.6	167.2	170.6	173.8	174.6	169.8	175.9	174.5	177.7	180.8
CO_2 excluding LUCF (T-corrected)	165.5	167.9	170.1	169.0	172.5	175.0	176.0	174.1	177.3	175.7	179.1	182.2
Total [group of six] [1)]	216.2	218.2	221.0	220.7	224.6	225.9	228.6	225.7	228.7	221.5	222.1	222.0
Index (1990 = 100)												
Index CO_2 excluding LUCF (T-corrected)	100.0	101.5	102.8	102.1	104.2	105.7	106.4	105.2	107.1	106.2	108.2	110.1
Total [group of three] 1)	**100.0**	**101.4**	**102.5**	**102.0**	**103.3**	**104.1**	**104.5**	**102.8**	**103.9**	**102.7**	**103.5**	**104.6**
Index ('90; F-gases '95)												
Index [group of six composite] [1)]	**99.5**	**100.4**	**101.7**	**101.5**	**103.3**	**103.9**	**105.2**	**103.9**	**105.2**	**101.9**	**102.2**	**102.2**

[1)] Excluding LUCF.

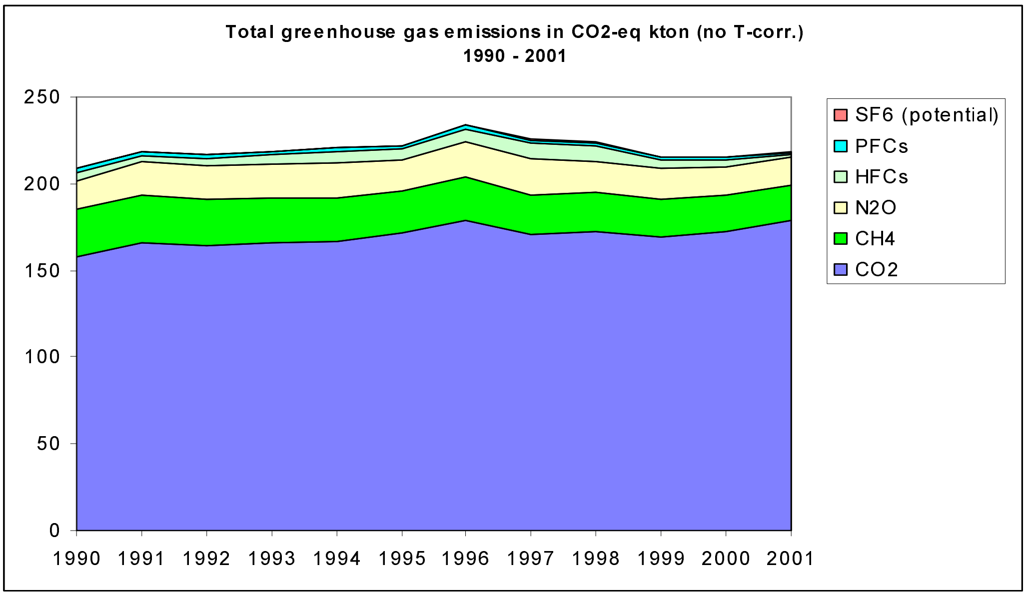

Figure 2.3. Trend in greenhouse gas emissions per gas 1990-2001 (no temperature correction)

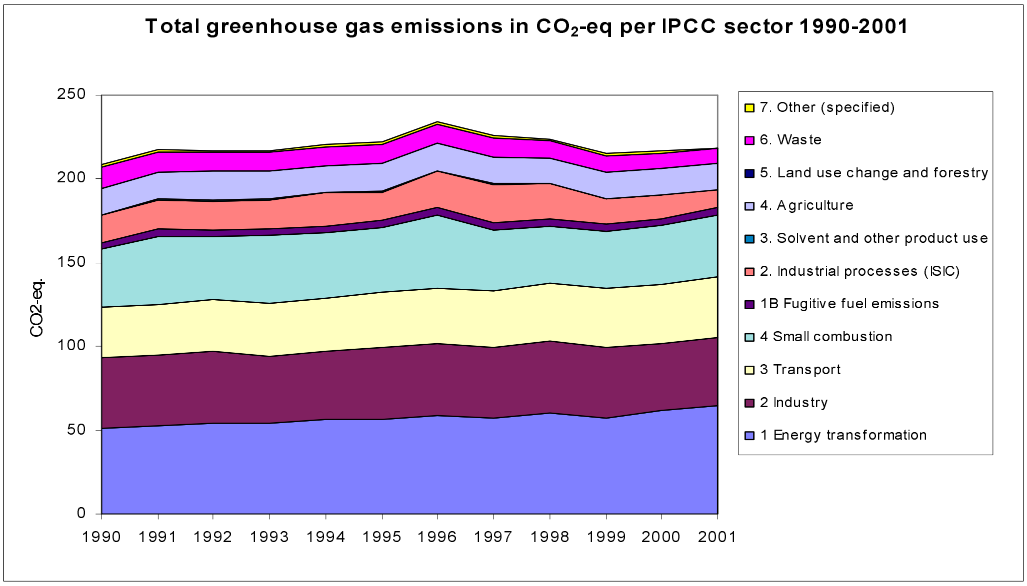

Figure 2.4. Trend in CO_2-eq. emissions per sector 1990-2001 (no temperature correction)

CH_4 emissions decreased by 25% in 2001 compared to the 1990 level, mainly due the decrease in the waste sector (-30%), the agricultural sector (-20%) and fugitive emissions from oil and gas (-25%). N_2O emissions decreased by about 3% in 2001 compared to 1990, mainly due to the decrease in the emissions from industrial processes (-13%), which compensated increases of emissions from agriculture of about 5% and from fossil fuel combustion of 45% (mainly from transport).

Of the fluorinated greenhouse gases, for which 1995 is the reference year, emissions of HFCs and PFCs decreased in 2001 by about 75% and 20%, respectively, while SF_6 emissions increased by 7%. Total emissions of all F-gases decreased by about 60% compared to the 1995 level. In 2001 the largest changes showed an increase of 6 Mton of CO_2 – of which 3 Mton was due to the colder winter compared to 2000 – and decrease of over 1 Mton in HFC emissions. Along with the increased import of electricity since 1999, this is the primary reason why total greenhouse gas emissions have stabilised since 1997 (see *Figures 2.3 and 2.4*).

The uncertainty in the *trend* of CO_2-equivalent emissions of the six greenhouse gases together is about ± 3%-point in the 4% increase, based on the *IPCC Tier 1 trend uncertainty assessment* (see *Section 1.7*). Per individual gas, the *trend* uncertainty in total emissions of CO_2, CH_4, N_2O and the total group of F-gases, as calculated with the *Tier 1 IPCC Good Practice* method described in *Section 1.7*, is estimated ±3%, ±7%, ±11% and ±10% points, respectively (*Figure 2.5*). However, it should be kept in mind that the 2001 emissions, although preliminary by definition, include additional uncertainty as explained in *Section 1.7*. The uncertainty in *annual* emissions of N_2O and CH_4 is estimated at ±50% and ±25%, respectively. For CO_2 the estimate of uncertainty in *annual* emissions is ±3%, for HFCs, PFCs and SF_6 ±50% (see *Section 1.7*).

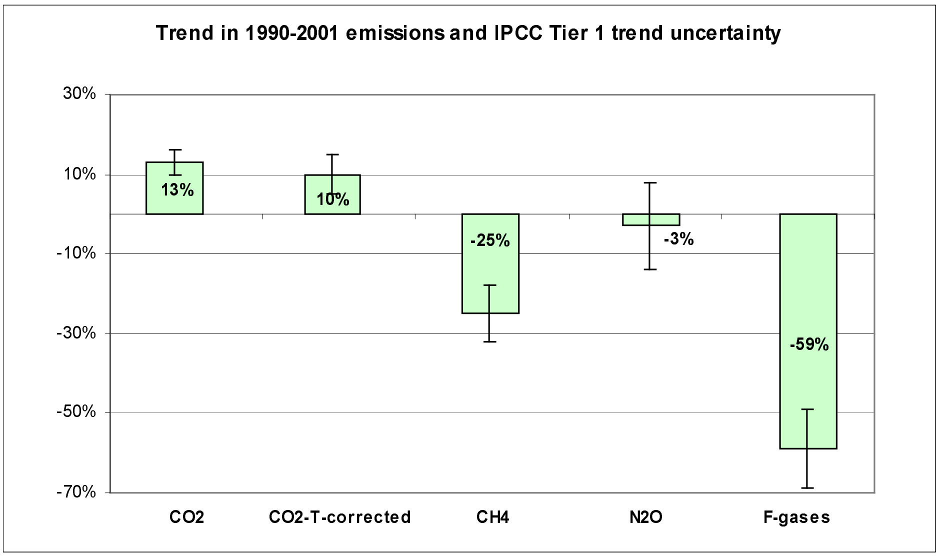

Figure 2.5. Trends in greenhouse gas emissions per gas 1990-2001 (1995-2001 for F-gases) and their uncertainty according to the IPCC Tier 1 trend uncertainty analysis, and, shows CO_2 with temperature correction)

2.2 Emission trends by gas

In *Table 2.3* and *Figure 2.6* the actual trend in actual CO_2 emissions is presented per source category. In 2001, total actual national CO_2 emissions increased since 1990 by 13%[3]. The largest increase in emissions (6.5 Tg) occurred in the transport sector. The decrease in the electricity production sector (1A1a) in 1999 is due to the marked increase of imported electricity since 1999, which almost doubled compared with 1998, and to a relatively large shift from coal to oil and natural gas in 1999. The small decrease in fossil-fuel related emissions of 4% in industry (1A2) appears to be caused by a decrease of feedstock emissions.

[3] This translates to an increase of 10% with both years temperature-corrected and an increase of 12% with only 2001 emissions temperature-corrected (i.e. compared to the base year level).

With a temperature correction, the 1990-2001 increase of CO_2 emissions is 3%-points less than without this correction. The influence of the weather on annual emissions, for example as suggested by the bump in 1996 in *Figure 2.4*, can indeed be traced back by annual variation in residential, commercial and agricultural emissions, as presented in *Figure 2.5*. Both the cold winter in 1996 and the mild winter in 1990 caused the emissions from the 'small combustion sector' to clearly deviate from the trend[4]. For more details refer to *Section 3.2.4*.

Table 2.3. CO_2 emissions and sinks per IPCC sector 1990-2001 (no temperature correction) (Tg)

IPCC Sector	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
TOTAL NET NAT. EMISSIONS Incl. LUCF	157.8	166.0	164.2	166.1	166.8	171.2	178.9	170.5	172.4	169.5	172.4	178.4
TOTAL NET NAT.. EMISSIONS Excl. LUCF	159.3	167.5	165.7	167.9	168.8	172.4	180.3	171.7	173.8	170.7	173.8	179.9
1. All Energy (combustion and fugitive)	**156.8**	**165.9**	**164.4**	**166.7**	**167.3**	**170.1**	**177.9**	**169.0**	**172.0**	**168.3**	**172.3**	**178.4**
A Fuel combustion total	156.5	165.5	164.0	166.4	167.1	169.2	176.9	168.0	170.5	166.8	170.7	176.7
1a Electricity and heat production	40.3	41.6	43.3	43.2	44.8	44.5	45.8	45.1	47.9	44.6	49.0	51.9
1bc Other transformation	11.0	10.6	10.9	10.6	11.2	12.0	12.6	12.1	12.3	12.1	12.2	12.9
2 Industry	41.9	42.7	42.5	39.9	41.0	42.6	43.0	41.9	42.4	42.3	39.7	40.2
3 Transport	29.1	29.2	30.4	30.9	31.2	32.2	32.6	33.1	33.8	34.8	35.2	35.6
4a Commercial/Institutional	5.9	10.3	9.4	10.6	10.1	8.6	9.1	7.6	7.7	6.7	7.9	8.8
4b Residential	19.8	21.6	19.5	20.6	19.6	21.2	24.8	20.8	18.8	19.3	19.6	20.4
4c Agriculture/Forestry/Fishing	8.4	8.5	8.5	8.8	8.8	8.1	8.9	7.5	7.5	7.1	7.1	7.0
5 Other	0.0	1.1	-0.4	1.7	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
B Fugitive fuel emissions	0.3	0.5	0.4	0.4	0.2	0.8	1.0	1.0	1.6	1.5	1.6	1.7
2 Crude oil and natural gas	**0.3**	**0.5**	**0.4**	**0.4**	**0.2**	**0.8**	**1.0**	**1.0**	**1.6**	**1.5**	**1.6**	**1.7**
2. Industrial processes (ISIC)	**1.6**	**1.5**	**1.3**	**1.2**	**1.4**	**1.4**	**1.4**	**1.4**	**1.3**	**1.3**	**1.2**	**1.1**
3. Solvent and other product use	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
5. Land-use change and forestry	**-1.4**	**-1.5**	**-1.5**	**-1.8**	**-1.9**	**-1.2**	**-1.4**	**-1.2**	**-1.4**	**-1.2**	**-1.4**	**-1.4**
6. Waste	**0.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.9**	**1.1**	**1.2**	**0.5**	**1.0**	**0.4**	**0.4**
7.Other	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Memo item, not included in national total:												
International bunkers	**39.8**	**41.3**	**42.4**	**44.3**	**42.9**	**44.3**	**45.4**	**48.5**	**49.5**	**51.2**	**53.5**	**57.5**
CO_2 Marine	35.3	36.3	36.5	37.8	36.1	36.6	37.2	39.5	39.8	41.1	43.4	47.7
CO_2 Aviation	4.5	5.0	5.9	6.5	6.7	7.7	8.2	9.0	9.7	10.1	10.1	9.9

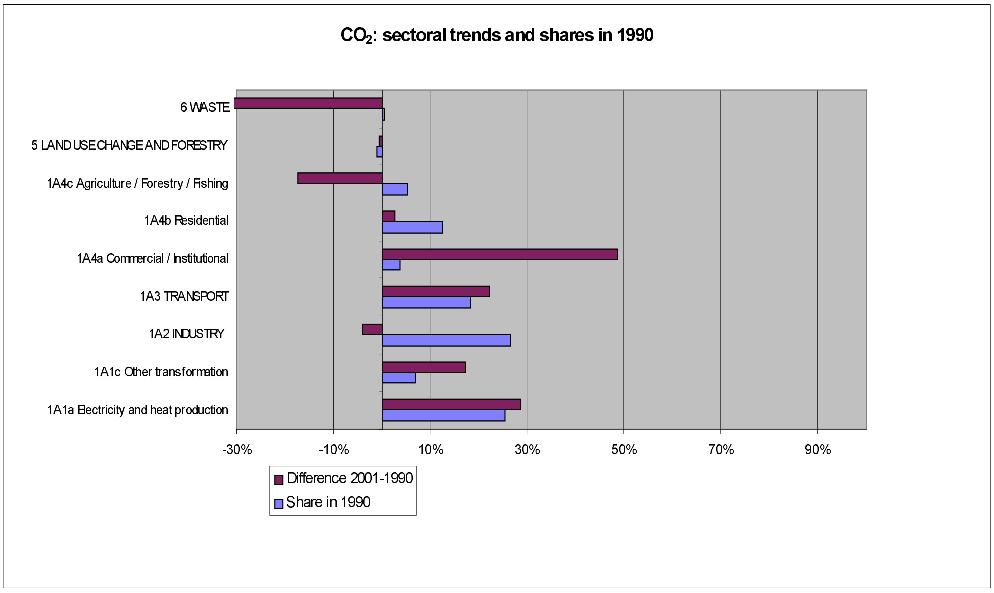

Figure 2.6. CO_2 emission shares and trends per IPCC sector, 1990-2001

[4] Actual CO_2 emissions increased by 13% in the period 1990-1996, while from 1996 till 2000 the CO_2 emissions decreased by about 6%. Temperature-corrected, these changes are 6% and 0%, respectively.

In 2000, total CO_2 emissions increased by 2% (3 Mton) compared to 1999 (according to the preliminary data for 2000 provided in the previous NIR 2002, this change was estimated at 1% or 1.3 Mton). This was mainly caused by the increased energy use in the energy, service and transport sectors, while the emissions from industry decreased by 2 Mton.

In *Table 2.4* and *Figure 2.7* the trend in methane emissions is presented per source category. In 2001, total CH_4 emissions decreased by 25% compared to the 1990 level. Sectors that contributed most to the decrease were the waste sector (-30%) and the agricultural sector (-20%), with 3.7 and 2.0 Mton CO_2-eq., respectively.

Table 2.4. CH_4 emissions per IPCC sector 1990-2001 (Gg)

IPCC Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TOTAL NET NATIONAL EMISSIONS	**1292.4**	**1308.5**	**1253.1**	**1225.9**	**1202.9**	**1170.2**	**1173.7**	**1100.1**	**1064.6**	**1037.5**	**983.2**	**973.2**
1. All Energy (combustion and fugitive)	**213.2**	**223.8**	**199.0**	**192.4**	**202.2**	**207.0**	**225.3**	**185.9**	**177.4**	**177.5**	**164.7**	**168.9**
A Fuel combustion total	34.4	35.7	35.9	34.4	33.7	36.7	37.0	29.4	30.8	33.1	33.7	34.6
1 Energy	3.3	3.2	3.8	3.4	3.7	4.9	5.7	3.0	4.4	6.0	6.0	6.3
2 Industry	2.9	3.5	4.9	3.2	2.6	5.1	1.8	1.0	1.7	3.0	3.3	3.4
3 Transport	7.9	6.9	6.7	6.4	6.1	6.0	5.5	5.2	5.0	4.8	4.4	4.2
4 a Commercial/Institutional	0.8	1.1	1.0	0.9	1.4	0.5	1.1	0.5	1.0	0.8	1.1	1.1
4 b Residential	16.8	18.3	16.8	17.7	17.0	17.4	19.8	17.2	16.2	15.9	17.1	17.1
4 c Agriculture/Forestry/Fishing	2.6	2.7	2.7	2.8	2.8	2.5	2..2	2.4	2.4	2.2	2.2	2.2
B Fugitive fuel emissions	178.8	188.1	163.1	158.0	168.5	170.3	188.3	156.5	146.6	144.3	131.0	134.3
2 Crude oil and natural gas	178.8	188.1	163.1	158.0	168.5	170.3	188.3	156.5	146.6	144.3	131.0	134.3
2. Industrial processes	**3.3**	**3.5**	**3.7**	**4.9**	**5.3**	**2.6**	**5.7**	**2.7**	**2.4**	**2.7**	**1.5**	**1.4**
3. Solvent and other product use	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
4. Agriculture	**505.3**	**517.1**	**505.8**	**497.8**	**483.1**	**477.0**	**463.6**	**445.8**	**434.7**	**425.0**	**410.5**	**410.6**
A Enteric fermentation	401.9	411.6	401.2	392.7	381.7	376.7	365.9	352.6	341.4	333.9	319.4	322.2
B Manure management	103.5	105.5	104.6	105.1	101.5	100.3	97.7	93.2	93.3	91.1	91.1	88.4
5. Land-use change and forestry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**568.6**	**562.1**	**542.6**	**528.8**	**510.0**	**481.5**	**477.1**	**463.8**	**448.2**	**430.3**	**404.6**	**390.3**
A Solid waste disposal on land	562.0	556.1	540.2	522.5	504.9	480.0	475.9	463.0	444.5	428.3	403.8	389.6
B Waste water handling	6.6	6.0	2.4	6.3	5.1	1.5	1.3	0.8	3.6	2.1	0.8	0.8
7. Other	**2.1**	**2.0**	**2.0**	**2.0**	**2.3**	**2.1**	**2.0**	**2.0**	**1.9**	**1.9**	**1.9**	**1.9**

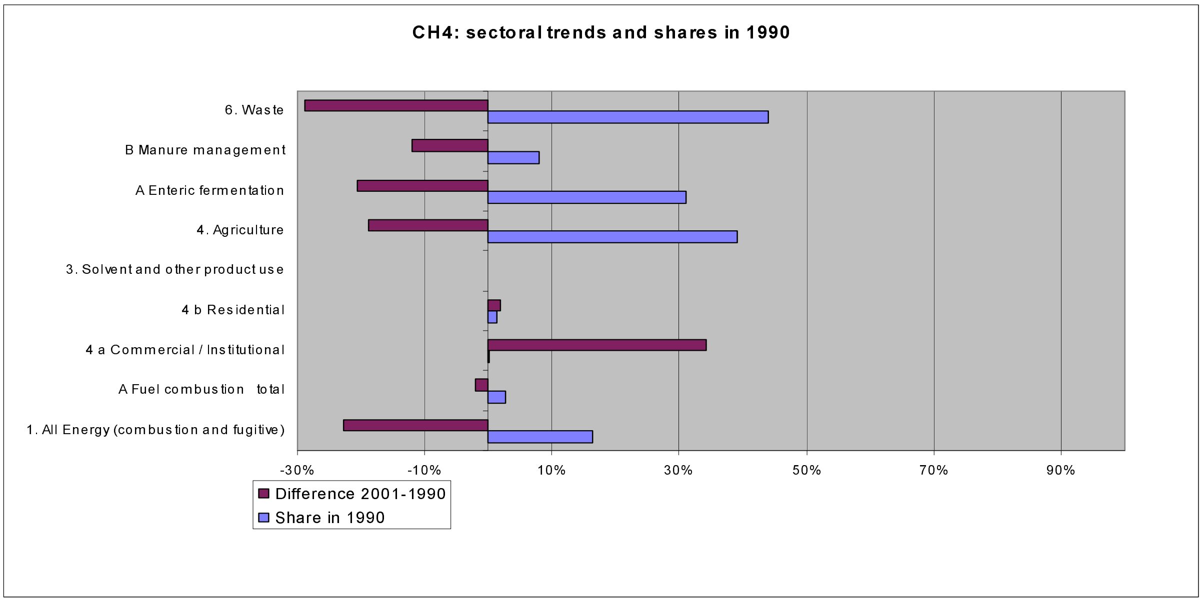

Figure 2.7. CH_4 emission shares and trends per IPCC sector, 1990-2001

In *Table 2.5* and *Figure 2.8* the trend in nitrous oxide emissions is presented per source category. In 2001, total N_2O emissions *decreased* by about 3% compared to 1990, mainly due to the decrease in the emissions from industrial processes of 1.0 Mton CO_2-eq. (-13%). This compensated increases of emissions from agriculture (5%) and from fossil fuel combustion (45%) (mainly from transport) of 0.3 and 0.2 Mton CO_2-eq., respectively (see *Table 2.7* and *Figure 2.10*). Note that in the previous submission, based on preliminary data for 2000, an *increase* of 3% over the period 1990-2000 was reported.

Table 2.5. N_2O emissions per IPCC sector, 1990-2001

IPCC sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TOTAL NET NATIONAL EMISSIONS	**53.4**	**54.2**	**57.9**	**60.2**	**59.1**	**58.6**	**57.9**	**57.4**	**56.9**	**56.0**	**53.7**	**51.8**
1. All Energy (combustion and fugitive)	**1.9**	**1.9**	**2.1**	**2.3**	**2.4**	**2.6**	**2.6**	**2.4**	**2.3**	**2.6**	**2.6**	**2.7**
A Fuel combustion total	1.9	1.9	2.1	2.3	2.4	2.2	2.6	2.4	2.3	2.6	2.6	2.7
1 Energy transformation	0.5	0.5	0.5	0.5	0.5	0.2	0.5	0.0	0.0	0.5	0.5	0.5
2 Industry	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.1	0.1
3 Transport	1.2	1.2	1.4	1.6	1.7	1.8	1.9	2.0	2.0	2.0	2.0	2.0
4 Small combustion	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5 Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B Fugitive fuel emissions	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
2. Industrial processes	**24.4**	**24.4**	**24.7**	**24.9**	**26.7**	**25.5**	**24.2**	**24.2**	**24.2**	**24.1**	**23.2**	**23.0**
3. Solvent and other product use	**0.7**	**0.7**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.7**	**0.6**	**0.5**	**0.5**	**0.4**
4. Agriculture	**22.2**	**22.2**	**22.7**	**25.9**	**26.2**	**26.1**	**26.9**	**26.4**	**26.0**	**25.2**	**25.2**	**23.2**
5. Land-use change and forestry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**0.5**	**0.5**	**0.6**	**0.5**	**0.6**	**0.6**
7. Other	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**

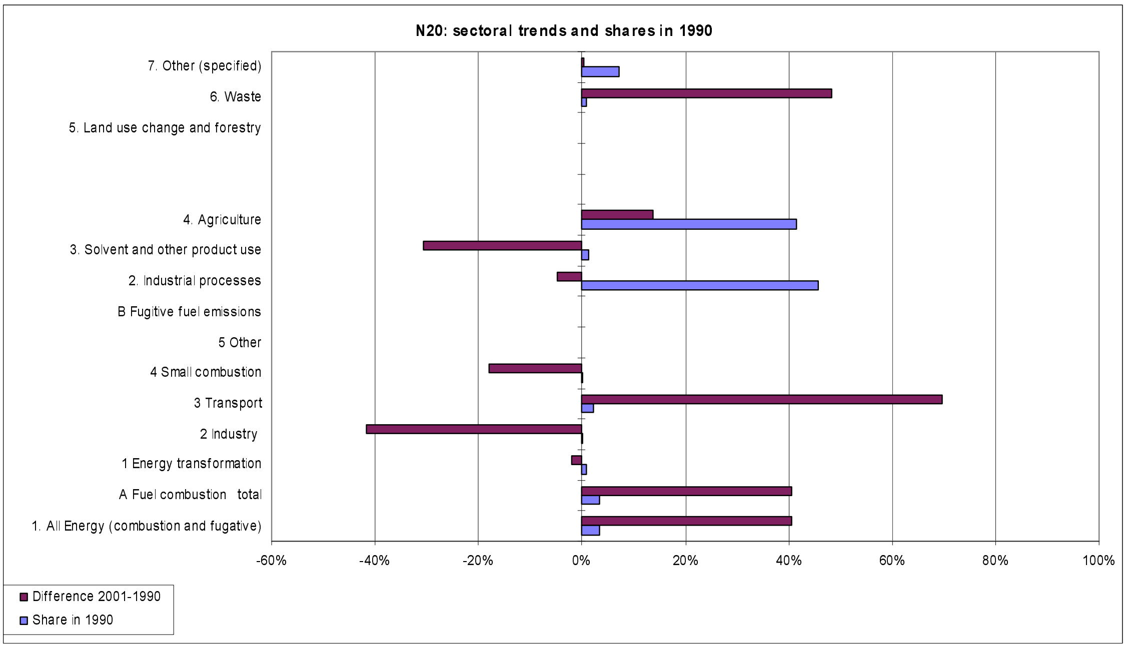

Figure 2.8. N_2O emission shares and trends per IPCC sector, 1990-2001

In *Table 2.6* and *Figure 2.9* the trend in F-gas emissions is presented per source category. In 2001, total emissions of all F-gases decreased by about 60% compared to the 1995 level (a 5% increase compared to 1990), which is equivalent to 5 Mton CO_2-eq. Emissions of HFCs and PFCs decreased by about 75% and 22% in 2001, respectively, while SF_6 emissions increased by 8%.

Table 2.6. Actual emissions of HFCs, PFCs and SF_6, 1990-2001 (Gg CO_2-eq.)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
HFC total	4432	3452	4447	4998	6487	6018	7676	8307	9360	4897	3875	1584
PFC total	2432	2437	2099	2118	1890	1867	2042	2154	1728	1444	1526	1456
SF_6 use	187	100	106	110	148	275	285	311	295	265	269	296
Total HFC/PFC/SF_6	**7050**	**5989**	**6652**	**7226**	**8525**	**8160**	**10003**	**10772**	**11383**	**6606**	**5670**	**3337**

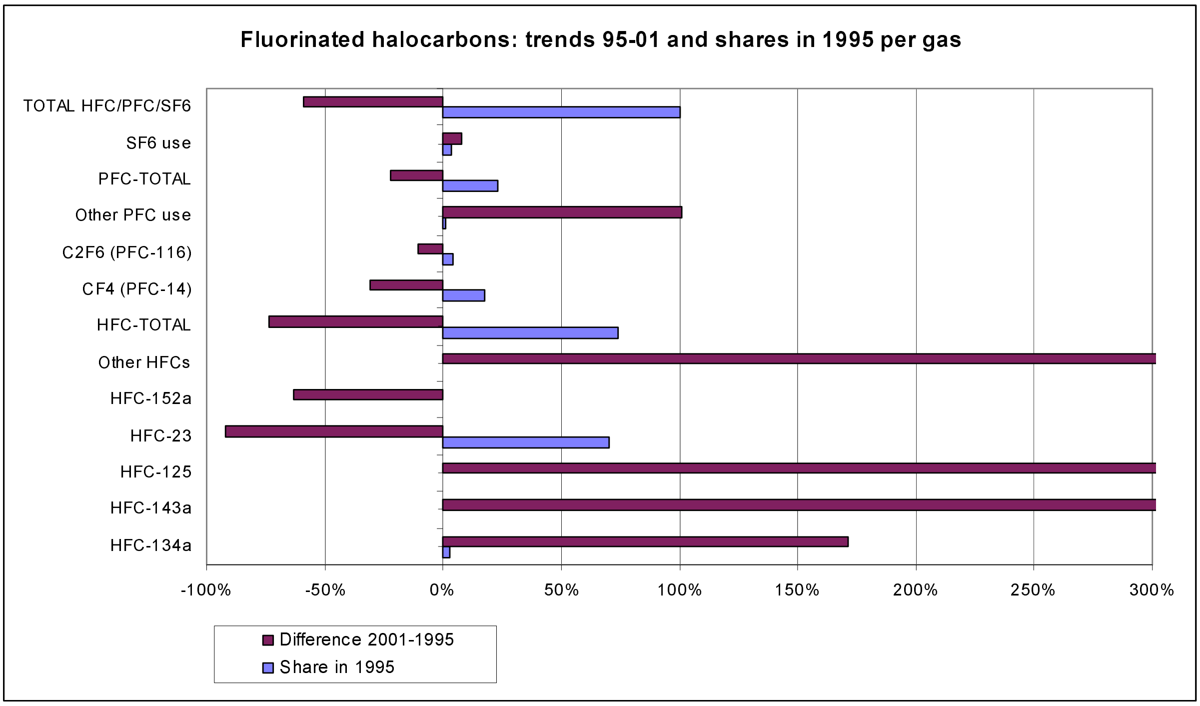

Figure 2.9. Shares and trends in actual emissions of fluorinated gases, 1995-2001

2.3 Emission trends by source

Table 2.7 provides an overview of the CO_2-eq. emission trends per IPCC source category. It clearly shows the energy sector (category 1) to be by far the largest contributor to national total greenhouse gas emissions with a share that increased from 75% in 1990 to about 81% in 2001. In contrast, emissions of the other main categories decreased, the largest being those of industrial processes (from 8 to 5% share), waste (from 6 to 4% share) and agriculture (from 8 to 7% in 2001).

In *Figures 2.4* and *2.10* the trend in *total* CO_2-eq. emissions (i.e. for all six gases jointly) is presented per IPCC source category. From *Figure 2.10* it can be concluded that the sector showing the largest growth in CO_2-eq. emissions since 1990 is the energy sector (26%), whereas the transport sector showed a growth of about 22%. Clear exceptions are the waste sector and agriculture, which showed a decrease in CO_2-eq. emissions of about 30% and 10%, respectively. Emissions from the residential and service sectors increased by 5%, but these are substantially influenced by weather effects: when the temperature correction was included, these emissions decreased by about 3%.

2.3.1 Energy Sector

The emissions from the energy sector (category 2) are dominated by CO_2 from fossil fuel combustion, with fugitive emissions from gas and oil (methane and CO_2) contributing a few per cent and CH_4 and N_2O from fuel combustion adding one per cent. Responsible for the increasing trend in this sector are the energy industries and the transport sector, of which CO_2 emissions increased by 26 and 22% since 1990. In contrast, the energy-related CO_2 emissions from manufacturing industries appears to have decreased a few per cent in 2000 and 2001 and the actual CO_2 emissions from the other sector (residential, services and agriculture) increased by about 5%. The relatively strong increases in emissions from the energy sector and the transport sector result in increases of their CO_2 share in the national

CO_2-eq. total by 5% and 2%-points, respectively, to 29% and 16% in the 2001. The 29% increase of the energy sector emissions is partly mitigated by about 10%-points due to the strong increase in net import of electricity since 1999 (see *Table 3.8*), which is equivalent to about 4 Mton of CO_2 coming from domestic fossil-fuel generated electricity. We note that fugitive methane emissions from oil and natural gas decreased by 25% since 1990.

Table 2.7. Summary of emission trend per source category and gas (unit: Tg CO_2-eq.)

Source category	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1A. Energy: fuel combustion	**157.8**	**166.8**	**165.4**	**167.8**	**168.5**	**170.8**	**178.4**	**166.3**	**171.9**	**168.3**	**172.2**	**178.3**
CO_2: 1. Energy industries	51.3	52.2	54.1	53.8	56.0	56.5	58.3	57.2	60.2	56.7	61.2	64.8
CO_2: 2. Manufacturing industries	41.9	42.7	42.5	39.9	41.0	42.6	43.0	38.9	42.4	42.3	39.7	40.2
CO_2: 3. Transport	29.1	29.2	30.4	30.9	31.2	32.2	32.6	33.1	33.8	34.8	35.2	35.6
CO_2: 4. Other sectors	34.2	40.4	37.3	40.1	38.5	37.9	42.7	35.9	34.0	33.1	34.5	36.1
CO_2: 5. Other	0.0	1.1	-0.4	1.7	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
CH_4	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.6	0.6	0.7	0.7	0.7
N_2O	0.6	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.8	0.8
1B2. Energy: fugitives from oil & gas	**4.1**	**4.4**	**3.8**	**3.7**	**3.9**	**4.4**	**5.0**	**4.3**	**4.6**	**4.5**	**4.3**	**4.5**
CO_2	0.3	0.5	0.4	0.4	0.2	0.8	1.0	1.0	1.6	1.5	1.6	1.7
CH_4	3.8	4.0	3.4	3.3	3.5	3.6	4.0	3.3	3.1	3.0	2.8	2.8
N_2O	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Industrial processes [1)]	**16.3**	**15.2**	**15.7**	**16.8**	**17.9**	**17.1**	**18.9**	**19.1**	**19.8**	**15.0**	**13.9**	**11.0**
CO_2	1.6	1.5	1.3	1.2	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.1
CH_4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
N_2O	7.6	7.7	7.7	8.3	7.9	7.5	7.5	7.5	7.5	7.2	7.1	6.6
HFCs	4.4	3.5	4.4	5.0	6.4	6.0	7.6	7.7	9.0	4.7	3.7	1.5
PFCs	2.4	2.4	2.1	2.1	1.9	1.9	2.0	2.2	1.7	1.4	1.5	1.5
SF_6	0.2	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Solvent and other product use [1)]	**0.2**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**
CO_2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH_4	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)	IE (7)
N_2O	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
4. Agriculture	**17.5**	**17.9**	**18.7**	**18.6**	**18.2**	**18.3**	**17.9**	**17.4**	**17.0**	**16.7**	**15.8**	**15.8**
CH_4: Enteric fermentation	8.4	8.6	8.4	8.2	8.0	7.9	7.7	7.4	7.2	7.0	6.7	6.8
CH_4: Manure management	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9
N_2O: Manure management	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
N_2O: Agricultural soils	6.7	6.8	7.8	7.9	7.8	8.1	8.0	7.8	7.6	7.6	7.0	7.0
5A. Changes in forest/biomass stocks	**-1.4**	**-1.5**	**-1.5**	**-1.8**	**-1.9**	**-1.2**	**-1.4**	**-1.2**	**-1.4**	**-1.2**	**-1.4**	**-1.4**
CO_2	-1.4	-1.5	-1.5	-1.8	-1.9	-1.2	-1.4	-1.2	-1.4	-1.2	-1.4	-1.4
6. Waste	**12.9**	**11.9**	**11.5**	**11.3**	**10.9**	**11.2**	**11.4**	**11.2**	**10.0**	**10.2**	**9.0**	**8.7**
CO_2	0.9	0.0	0.0	0.0	0.0	0.9	1.1	1.2	0.5	1.0	0.4	0.4
CH_4	11.9	11.8	11.4	11.1	10.7	10.1	10.2	9.7	9.4	9.0	8.5	8.2
N_2O	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2
7. Other (specified)	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
CH_4: Solvents and other product use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O: Polluted surface water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
NATIONAL TOTAL EMISSIONS [2)]	**210.0**	**217.8**	**216.6**	**219.5**	**220.8**	**223.3**	**232.7**	**219.5**	**224.7**	**216.2**	**216.6**	**219.6**
Memo item, not included in national total:												
International bunkers	**39.8**	**41.3**	**42.4**	**44.3**	**42.9**	**44.3**	**45.4**	**48.5**	**49.5**	**51.2**	**53.5**	**57.5**
CO_2 Marine	35.3	36.3	36.5	37.8	36.1	36.6	37.2	39.5	39.8	41.1	43.4	47.7
CO_2 Aviation	4.5	5.0	5.9	6.5	6.7	7.7	8.2	9.0	9.7	10.1	10.1	9.9

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

[2)] The national total does not include the CO_2 sink reported under category 5A. This CO_2 sink is not complete and refers to the definition under the *UN Framework Convention on Climate* Change (UNFCCC), which is different from the amount to be calculated under the *Kyoto Protocol (*see *Section 1.1.2).*

2.3.2 Industrial processes

The greenhouse gas emissions from industrial processes (category 2) have decreased by over 30% since 1990. As can be seen in *Table 2.7,* N_2O emissions, mainly from nitric acid manufacture, is the main contributor to this source category. However, the strong decreasing trend in HFC emissions of 2/3 reduction since 1990 and 3/4 reduction since 1995, notably of HFC-23 from HCFC-22 manufacture, are primarily responsible for the decreasing trend in this source category. The F-gas emissions had a share of almost 50% in total source category emissions in 1995; their share is now about 30%, of which HFCs and PFCs form by far the largest part. PFC emissions in the Netherlands stem mainly from aluminium production. CO_2 emissions from industrial processes contribute 10% to the group total and stem only for 1/3 of 1/4 from cement clinker production. A large fraction of cement production in the Netherlands uses imported cement clinker. Emissions of SF_6 contribute about 3% to the group total.

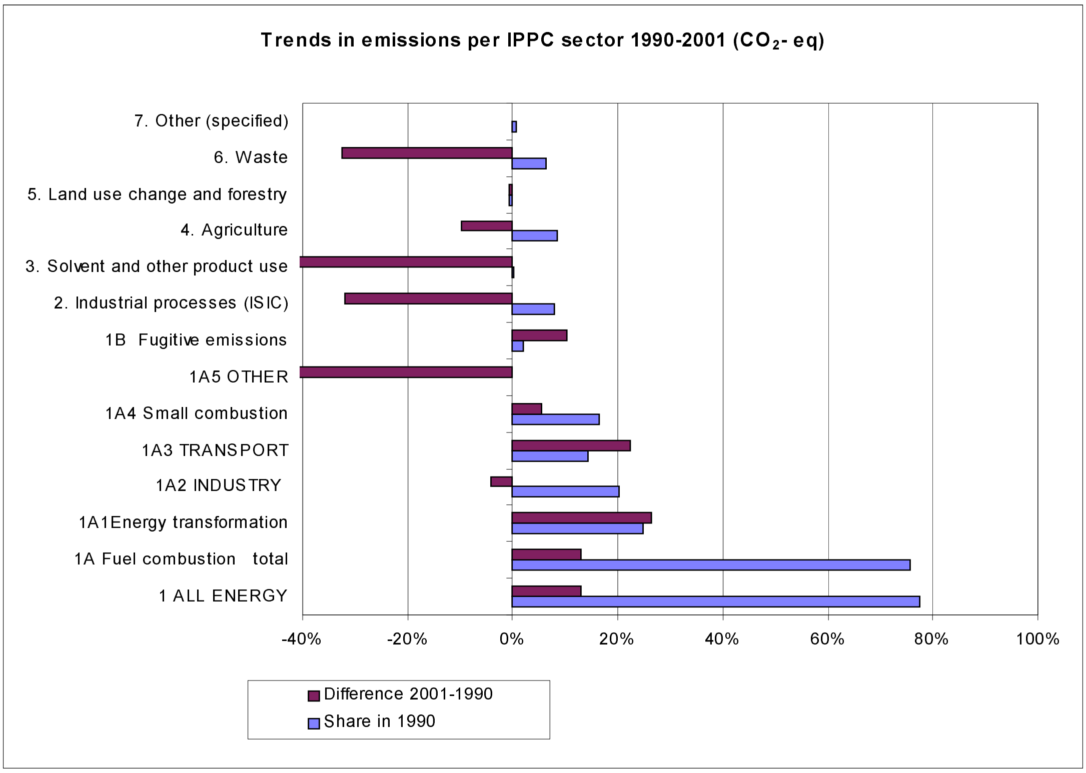

Figure 2.10. Shares and trends of greenhouse gas emissions per sector 1990-2001 (1995-2001 for F-gases), in CO_2-eq. (no temperature correction)

2.3.3 Solvents and other product use

The emissions from '*Solvent and other product use'* (category 3) should be discussed in conjunction with (very small) methane emissions reported under category 7, since the IPCC tables do not allow for methane emissions under category 3. This category contributes very little to the national total: only 0.1%, primarily stem from N_2O from dispersive uses. We note the CO_2 emissions related to the use of products from non-energy use of fuels (e.g. lubricants, waxes, etc.) are not reported in this category but are included in the fuel combustion emissions reported under the manufacturing industry (1A2).

2.3.4 Agriculture

The emissions of the agricultural sector (category 4) have decreased by 10% since 1990, mainly through a decrease in CH_4 emissions from enteric fermentation (4.A) of 20% by reduced livestock numbers. In its wake, CH_4 from manure management (4.B) has also decreased similarly over time. At present, enteric fermentation contributes about 45% to this category's emissions as does N_2O emissions from agricultural soils (4.D); N_2O from manure management only contributes 1% to the group total. N_2O from agricultural soils increased until 1995 due to changing practices in animal manure spreading on the fields (incorporation into the soil with the aim of reducing ammonia emissions). The decrease since 1998 is mainly due to a reduction of the use of synthetic fertilisers. At present, due to historical reasons the Netherlands reports no CO_2 emissions from agricultural soils. Indirect N_2O emissions from leaching and run-off of nitrogen from agricultural soils are reported under IPCC category 7, because the Netherlands' method provides only aggregated figures that include industrial sources as well.

2.3.5 Changes in biomass stocks (LUCF)

Of the Land Use Change and Forestry (LUCF) sector (IPCC category 5), the Netherlands presently only reports the net changes of CO_2 due to changes in forests and other biomass stocks (IPCC category 5.A). These result in a sink of about 1% on the national net total emissions. The variation over time is between -1.2 and -1.9 Mton CO_2.

2.3.6 Waste

The emissions from the waste sector (IPCC category 6) have decreased by about 30% since 1990, mainly through decreasing CH_4 emissions – predominantly from landfills – which is the dominating gas (CO_2 and N_2O emissions contributing the remaining 6%). The fossil-fuel related emissions from waste incineration are included in the fuel combustion emissions from the energy sector (1A1), since most large-scale incinerators also produce electricity or heat for energetic purposes. The CO_2 emissions from this sector, presently contributing 4% to the waste category total, have also changed considerably over time (decreased by 0.5 Mton in 1990-2001), but the interannual variation suggests that these figures may not be very reliable.

2.3.7 Other

The Netherlands uses IPCC category 7 to reports its – very minor – CH_4 emissions from solvents and other product use, because the present reporting framework does not allow for CH_4 emissions under IPCC category 3. Total indirect N_2O emissions from leaching and run-off of nitrogen from agricultural soils and industrial sources are reported here, because these aggregated figures also include industrial sources, which make reporting of this total figure in Sector 4 (Agriculture) inappropriate. The latter N_2O emissions are labelled as '*Polluted surface water*' and are kept constant over time under the present methodology.

2.3.8 International transport

Finally, we discuss the trend in emissions from international transport, which is not part of the national total but is reported under the UNFCCC as well. At present, the Netherlands only reports CO_2 emissions, not the – relatively minor – emissions of CH_4 and N_2O from these sources. Total CO_2 emissions from this source category have increased by 45% or 18 Mton since 1990. In particular, marine bunker emissions contributed to this increase (+35% or 12 Mton) due to the marine bunkers large share in this category, but percentage-wise the emissions from international aviation increased much more (+120% or about 5 Mton). Total international transport emissions increased as fraction of the national total greenhouse gas emissions from 19% in 1990 to 26% in 2001.

2.4 Emission trends for indirect greenhouse gases and SO_2

Trends in total emissions of CO, NO_x, NMVOC and SO_2 are presented in *Table 2.8* and in *Figure 2.11*. Because of the problems identified with annual environmental reports (see *Box 1.1*) emissions of CO are not validated; however, experts on these emissions suggested that possible errors are small. The CO and NMVOC emissions were reduced in 2001 by about 40-45% compared to 1990, for SO_2 even 55%, and for NO_x, the 2001 emissions are about 30% lower than the 1990 level. NO_x emissions are recalculated on basis of new information on emission factors for small combustion plants (<20 MW) for the years, 1990, 1995, 2000 and 2001 (not yet recalculated for 1999), resulting in about 10 Gg less emissions in 2000. We recall that 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 differ to some extent from the IPCC approach (see *Section 2.3.2*).

Except for NMVOC, most of the emissions stem from fuel combustion, of which the uncertainty in the emission factor for NO_x, CO and NMVOC is often estimated to be in the range of 10-50%. For SO_2 emission factors from fuel combustion (basically the sulphur content of the fuels) the uncertainty is estimated in the range of 10-25%. The uncertainty in the activity data is small compared to the accuracy of the emission factors. Therefore, the uncertainty in the overall total of sources included in the inventory is estimated to be in the order of 25% for CO, 10% for NO_x and SO_2, and about 25% for NMVOC (RIVM, 2002).

Table 2.8. Trend in emissions of ozone and aerosol precursors, 1990-2001

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Emissions in Gg												
Total NO_X	563.0	537.9	525.9	505.1	482.4	482.7	470.3	441.0	427.0	428.1	411.6	409.8
Total CO	1120.5	1022.5	966.3	948.6	905.1	854.8	866.6	785.7	740.5	704.2	681.2	661.6
Total NMVOC	492.4	460.6	436.2	403.2	387.7	363.3	306.3	271.1	301.6	291.1	278.3	271.2
Total SO_2	202.4	163.5	157.2	150.4	136.5	141.5	133.7	115.9	108.0	103.3	91.6	89.0
Index (1990 = 100)												
Index total NO_X	100	95.5	93.4	89.7	85.7	85.7	83.5	78.3	75.8	76.0	73.1	72.8
Index total CO	100	91.3	86.2	84.7	80.8	76.3	77.3	70.1	66.1	62.8	60.8	59.0
Index total NMVOC	100	93.5	88.6	81.9	78.7	73.8	62.2	55.1	61.2	59.1	56.5	55.1
Index total SO_2	100	80.8	77.7	74.3	67.4	69.9	66.1	57.3	53.4	51.0	45.2	44.0

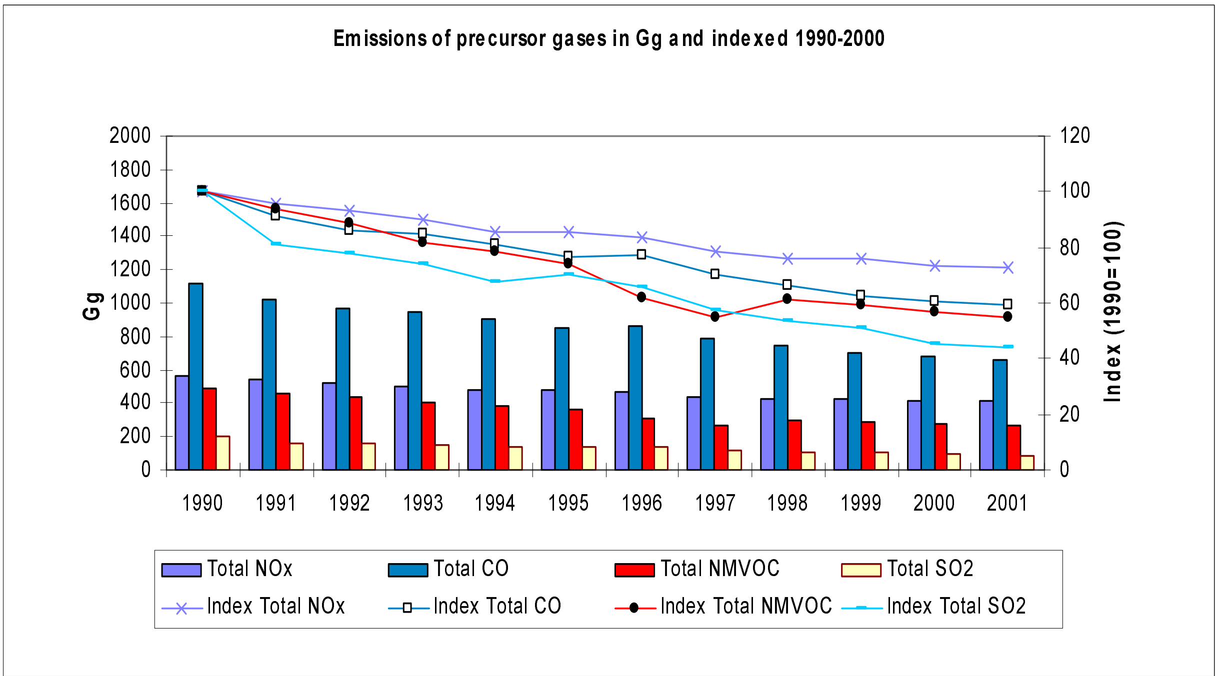

Figure 2.11. Trends in total emissions of NO_x, CO, NMVOC and SO_2, 1990-2001

3. ENERGY [CRF sector 1]

3.1 Overview of sector

All main subcategories of the energy sector are subdivided into two main subsectors: combustion (1A) and non-combustion (1B) fuel-related sources:

A. Fuel combustion emissions:
- Energy industries (power generation, refineries etcetera) (1A1)
- Manufacturing industry and construction (1A2)
- Transport (domestic) (1A3)
- Other sectors (residential, services, agriculture etcetera) (1A4)
- Other fuel use (1A5)

B. Fugitive emissions from fuels:
- Emissions from solid fuels (1B1)
- Emissions from oil and gas (1B2)

The trends in greenhouse gas emissions from the energy sector are summarised in *Table 3.1*. Obviously, CO_2 emissions from fuel combustion are the dominant source here, whereas most methane emissions stem from fugitive sources. From this table it can be observed that the emissions from the energy industries, notably electric power generation, and from transport increased substantially over time. Emissions from the other sectors tend to vary considerably across the years because of the variation of the winter weather over time requiring more or less space heating. As the IPCC inventory guidelines do not require corrections of the emissions for this yearly variation in space heating *no* corrections are reported in the CRF tables. To assess the effects of implemented policies on the trend of *anthropogenic* emissions a correction is calculated for CO_2 emissions from gas combustion for space heating to filter out the effect of interannual changes due to variation of weather. The results of the additional estimation from this so-called 'temperature correction for CO_2' can be found in *Section 3.1.1.*

Table 3.1. Trend of greenhouse gas emissions from the energy sector (unit: Tg CO_2-eq.)

Source category: Energy	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1A. Fuel combustion	**157.8**	**166.8**	**165.4**	**167.8**	**168.5**	**170.8**	**178.4**	**166.3**	**171.9**	**168.3**	**172.2**	**178.3**
CO_2: 1. Energy industries	51.3	52.2	54.1	53.8	56.0	56.5	58.3	57.2	60.2	56.7	61.2	64.8
CO_2: 2. Manufacturing ind.	41.9	42.7	42.5	39.9	41.0	42.6	43.0	38.9	42.4	42.3	39.7	40.2
CO_2: 3. Transport	29.1	29.2	30.4	30.9	31.2	32.2	32.6	33.1	33.8	34.8	35.2	35.6
CO_2: 4. Other sectors	34.2	40.4	37.3	40.1	38.5	37.9	42.7	35.9	34.0	33.1	34.5	36.1
CO_2: 5. Other [1)]	0.0	1.1	-0.4	1.7	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
CH_4	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.6	0.6	0.7	0.7	0.7
N_2O	0.6	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.8	0.8
1B2. Fugitives from oil & gas	**4.1**	**4.4**	**3.8**	**3.7**	**3.9**	**4.4**	**5.0**	**4.3**	**4.6**	**4.5**	**4.3**	**4.5**
CO_2	0.3	0.5	0.4	0.4	0.2	0.8	1.0	1.0	1.6	1.5	1.6	1.7
CH_4	3.8	4.0	3.4	3.3	3.5	3.6	4.0	3.3	3.1	3.0	2.8	2.8
N_2O	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1)] Including emissions related to statistical differences (which are negative in 1992).

Note: The yellow colour (shaded figures) indicates the parts of the inventory which are based mainly on individual company reports for which no recalculations or allocation improvements have been made in the past due to the data limitations.

We recall that CO_2 emissions reported here are only the fossil-fuel related emissions, since CO_2 emissions from biomass combustion is assumed not to contribute to net CO_2 emissions and are therefore not included in the national total. As default, the production of biomass is assumed to be sustainable (the carbon that is oxidised during combustion will be absorbed by plants for growth within a limited number of years). To the extent that this is not the case, a correction is made in the CO_2 from sources/sinks reported in the *Land Use Change and Forestry* sector (IPCC category 5). The inventory also provides separate information on CO_2 from organic sources (biomass combustion), which is discussed in *Section 3.1.2*).

The emissions from subcategories 1A1, 1A2 and 1B2 are based mainly on individual company reports (the part of the national pollutant emission register called 'ER-I') (see *Section 1.2*). Due to dataset limitations, the level of detail for these subcategories is often limited, for example, as we will show in subsequent sections in limited fuel-specified data for these categories. For other sources, i.e. other industries in the categories 1A1 and 1A2 and for other stationary and mobile sources, emissions are calculated using fuel consumption data and national default emission factors for CO_2 and N_2O, as well as source-specific emission factors for CH_4. Source-specific N_2O emission factors are applied to road transport (see *Section 3.2.3*). More details on the methodologies used are provided in *Annex 2*. The consistency of emissions over time of these subcategories may also sometimes be limited. Another consequence, shown in yellow in the table, is that for 1991-1994, no recalculations or allocation improvements have been made in past years.

Another aspect that limits consistency of fuel combustion emissions over time is the observation that *Statistics Netherlands* (CBS) did not revise the energy balance for the years 1991-1994, with the aim of improving the data and eliminating the statistical differences between apparent consumption and the sum of sectoral energy consumption by fuel type. This affected all source categories, thus, by not revising the energy consumption data for 1991-1994 several inconsistencies in the time series are likely to be caused by this anomaly (see previous NIR 2002 for more details on sectoral consequences in CO_2 emissions; Olivier *et al.*, 2002).

We recall that the Netherlands has reported its CO_2 emissions related to feedstock use of fuels and other non-energy use under fuel combustion from the '*Manufacturing industry*' (1A2), instead of under '*Industrial processes*' (source category 2). These figures also include the CO_2 emissions of non-energy products during their use. The emissions are allocated here instead of under '*Solvents and Other Product Use*', (source category 3), because they are calculated using the IPCC Tier 1 method for these sources and storage factors that integrate immediate emissions during manufacture and emissions during the use of the products. The same holds for coke input as reducing agent in the iron and steel industry, which according to the *Good Practice Guidance* is also an industrial process source. However, it is also allocated to the manufacturing industry because in the Netherlands all emissions from the steel manufacturing industry are reported at an aggregated level, also emissions due to coke production. Thus the latter is not reported under '*Fugitive emissions from solid fuels*' (1B2) but under '*Fuel Combustion*' (1A).

The characteristics of the Netherlands' country-specific circumstances are reflected in both the energy balance and the emissions presented in *Table 3.1*. The Netherlands produces large amounts of natural gas (and also some oil), both onshore (e.g. Groningen gas) and offshore (so-called 'small gas fields'). In addition, natural gas has a very large share in energy consumption and is used for space heating in the other sectors, in industry and power generation. Natural gas production generates related emissions such as fugitive emissions of methane and relatively low CO_2 emissions from fuel combustion. Furthermore, the Netherlands makes use of the location of Rotterdam harbour at the mouth of the Rhine, for housing many large refineries, which export about half of their products to the European market. As a consequence, the Netherlands has a relatively large petrochemical industry and the world's largest supply of marine bunker oils in Rotterdam. Moreover, Schiphol Airport is Western Europe's largest supplier of aviation bunker fuels (jetfuel). The large petrochemical industry is responsible for the Netherlands having the highest share of CO_2 from non-energy/feedstock use of fuels of all industrialised countries, i.e. OECD or Annex I countries, when referring to the Kyoto Protocol) (Olivier and Peters, 2001).

In the Netherlands, most domestic commercial shipping activities buy their fuels from marine bunkers; therefore their energy consumption is included under '*International bunkers*' and not domestic consumption. This also applies to fisheries, whose consumption is, at present, all allocated to International bunkers (see *Section 3.2.8*).

Key sources

Box 3.1 presents the key and non-key sources of the energy sector on the basis of level, trend or both. Since CO_2 emissions make up the largest fraction of the national total emissions, it is not surprising that all CO_2 sources are indeed key sources. This includes the feedstock use (non-energy use) of oil and gas. Feedstock use of coal is not a key source, since it excludes the large amount of coke consumption in the iron & steel industry, of which all CO_2 emissions – including those from coke input – are combined and reported together. CO_2 emissions from oil and gas feedstock, and from the iron and steel industry, are not reported under source category industrial processes (CRF sector 2), but are allocated by the Netherlands under fuel combustion by the manufacturing industry (1A2) as chemical industry (1A1c) and iron and steel production (1A1a), respectively.

Of the non-CO_2 combustion sources, only N_2O from road transport appears to be a key source. The summed CH_4 emissions from all combustion sources are also a key source. Methane from fuel combustion stems predominantly from gas losses during cooking in the residential sector (1A4b), which are also higher in this source category due to biofuel combustion. Of the non-combustion sources, only the CH_4 emissions from gas production and CH_4 emissions from gas distribution are key sources.

Box 3.1. Key source identification in the energy sector using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

1A1 CO_2	**Emissions from stationary combustion: Energy Industries**	**Key (L,T)**
1A2 CO_2	**Emissions from stationary combustion: Manufacturing Industries and Constr.**	**Key (L,T)**
1A2 CO_2	**Emissions from iron and steel industry**	**Key (L1,T1)**
1A2 CO_2	**Feedstock gas**	**Key (L,T1)**
1A2 CO_2	**Feedstock oil**	**Key (L,T1)**
1A2 CO_2	**Feedstock coal**	**Non-key**
1A3 CO_2	**Mobile combustion: road vehicles**	**Key (L,T)**
1A3 CO_2	**Mobile combustion: waterborne navigation**	**Key (L2)**
1A3 CO_2	**Mobile combustion: aircraft**	**Key (T1)**
1A3 CO_2	**Mobile combustion: other**	**Key (L)**
1A3 CH_4	Mobile combustion: road vehicles	Non-key
1A3 CH_4	Mobile combustion: other	Non-key
1A3 N_2O	**Mobile combustion: road vehicles**	**Key (L2)**
1A3 N_2O	Mobile combustion: other	Non-key
1A4 CO_2	**Emissions from stationary combustion : other sectors**	**Key (L,T1)**
1A CH_4	**Emissions from stationary combustion: non-CO_2**	**Key (L2)**
1A N_2O	Emissions from stationary combustion: non-$_{CO2}$	Non-key
1B1 CH_4	Coal mining	Not occurring
1B1 All	Coke production	Included in 1A2
1B2 CO_2	Misc. CO_2, of which 2/3 in category 1B2	Non-key
1B2 CH_4	**Fugitive emissions from oil and gas: gas production**	**Key (L,T1)**
1B2 CH_4	**Fugitive emissions from oil and gas: gas distribution**	**Key (L,T1)**
1B2 CH_4	Fugitive emissions from oil and gas operations: other	Non-key

These sources will be discussed in the following sections per main subcategory. Stationary and mobile combustion per fuel type will be discussed per IPCC subsector (1Ax) and feedstock emissions of CO_2 under industrial combustion (1A2).

3.1.1 Temperature correction for CO_2

All CO_2 figures presented in the CRF tables and most tables presented in this report are without temperature correction. However, the annual variation of heating-degree days in the Netherlands can be considerable, especially in the category *1A4 'Other sectors'*, where most of the fuel is used for space heating. In 1990, in particular, the winter was relatively very warm; however the 1992, 1994, 1999 and 2000 winters were relatively warm, whereas only the winter of 1996 was relatively cold.

For policy purposes, trends in CO_2 emissions are therefore often corrected for climate variation of fuel consumption for space heating. In *Table 3.2* we present the temperature correction used by RIVM in the trend analysis of sectoral CO_2 emission trends, which is only applied to natural gas consumption since the amount of other fuels used for space heating is negligible. A full description of the methodology for this correction is provided in *Annex 2.2* and in Spakman *et al*. (2003).

This correction factor for gas consumption varies between -11% in 1996 and +20% in 1990. In 2001, CO_2 emissions were corrected by 2.3 Tg or 1.3% of total national CO_2 emissions, while 1990 emissions were corrected by 6.2 Tg or 4% of total national emissions. Positive figures in the table indicate an addition of natural gas consumption and thus CO_2 emissions due to a relatively warm winter in that calendar year. With temperature correction, the 1990-2001 increase of CO_2 emissions is 3 per cent point less than without this correction.

Table 3.2. Temperature correction for energy and CO_2 emissions per IPCC sector 1990-2001

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Heating-Degree Days (HDD-t) [HDD]		2677	3163	2829	3076	2835	2917	3504	2929	2821	2676	2659	2880
HDD: 30-year moving average (HDD-av)		3211	3198	3203	3177	3156	3140	3124	3135	3133	3118	3098	3076
T correction factor (=HDD-av/HDD-t)		**1.20**	**1.01**	**1.13**	**1.03**	**1.11**	**1.08**	**0.89**	**1.07**	**1.11**	**1.17**	**1.17**	**1.07**
Space heating natural gas [PJ]													
1A1a	Electricity & heat production	2.8	0.2	2.0	0.5	2.0	1.4	-2.2	1.2	2.4	3.7	3.7	1.5
1A2a-e	Industry	13.7	0.9	8.0	2.1	7.1	5.1	-5.4	2.9	7.2	10.5	10.5	4.0
1A4a	Commercial/Institutional	17.9	1.4	16.1	4.3	14.3	9.6	-16.6	9.1	13.5	17.8	21.3	10.8
1A4b	Residential	52.6	3.2	36.1	9.1	29.8	21.4	-36.1	20.0	27.7	40.9	41.6	18.1
1A4c	Agriculture/Forestry/Fishing	24.1	1.3	15.0	3.9	13.6	8.8	-15.8	8.8	12.0	17.0	17.1	6.9
Total correction gas consumption		**111.0**	**7.0**	**77.1**	**19.9**	**66.8**	**46.3**	**-76.1**	**41.9**	**62.8**	**89.8**	**94.1**	**41.4**
CO_2 Emissions [Gg]													
1A1a	Electricity & heat production	160	10	110	30	110	80	-120	60	140	210	210	90
1A2a-e	Industry	770	50	450	120	400	290	-300	160	400	590	590	230
1A4a	Commercial/Institutional	1000	80	900	240	800	540	-930	510	760	1000	1190	610
1A4b	Residential	2950	180	2020	510	1670	1200	-2020	1120	1550	2290	2330	1010
1A4c	Agriculture/Forestry/Fishing	1350	70	840	220	760	490	-880	490	670	950	960	390
Total correction CO_2 emissions		**6230**	**390**	**4320**	**1120**	**3740**	**2600**	**-4250**	**2340**	**3520**	**5040**	**5270**	**2320**

Note: HDD = Heating Degree Day; T = Temperature

3.1.2 CO_2 emissions from biomass

In the Netherlands, biomass fuels are used in various subsectors: electric power generation (e.g. waste wood), the pulp and paper industry (e.g. paper sludge), the wood construction industry (e.g. wood waste), waste incineration (the organic part of the municipal waste), wastewater treatment plants and by landfill operators (e.g. recovered methane) and the residential sector (fuelwood and charcoal).

However, the Netherlands' energy statistics only include *organic waste gas* as biomass fuel. Other types of biomass are not identified as such in the national statistics. In the compilation of the Netherlands greenhouse gas inventory and the associated CRF files, fuel data from individual companies and other sources are used. Fuel data reported by individual companies may include information on the use of biomass fuel. However, this information is far from consistent, as up till now there is no well-defined procedure on how to report biomass consumption data. *Table 3.3* provides information on the biomass data currently reported in the CRF files. The data clearly show that the 1991-1994 time series for the energy industries is interrupted for reasons discussed the beginning of this chapter and these data are apparently included in the data for the 'Other' subcategory (1A5).

Table 3.3. Organic CO_2 emissions reported as memo item 'CO_2 from biomass' (from CRF 1A combustion)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1A Fuel combustion	**3394**	**2700**	**2600**	**3300**	**3500**	**3598**	**5207**	**6003**	**5366**	**4977**	**5182**	**5144**
1A1. Energy industries	1879	IE	IE	IE	IE	1933	3760	4553	3685	3417	3475	3424
1A2 Manufacturing industries	0	0	0	0	0	0	0	0	0	0	0	0
1A3 Transport	0	0	0	0	0	0	0	0	0	0	0	0
1A4 Other sectors	1275	1254	1220	1182	1048	1125	1123	1130	1106	1043	1158	1172
a. Commercial/Institutional	*83*	*98*	*100*	*98*	*NE*	*113*	*112*	*120*	*118*	*132*	*144*	*143*
b. Residential	*1192*	*1156*	*1120*	*1084*	*1048*	*1012*	*1011*	*1010*	*988*	*911*	*1014*	*1029*
c.Agriculture/Forestry/Fisheries	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
1.A.5 Other (not elsewhere)	125	1446	1380	2118	2452	357	240	233	368	348	393	393
Total memo CO_2 from biomass	**3394**	**2700**	**2600**	**3300**	**3500**	**3598**	**5207**	**6003**	**5366**	**4977**	**5182**	**5144**

Note: IE = Included Elsewhere; NE = Not Estimated.

Table 3.4. Biofuel consumption not reported under 'Biomass' as fuel due to inconsistent/incomplete emission of energy data (from CRF Documentation Boxes)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1A Fuel combustion	**1375**	**0**	**0**	**0**	**0**	**2231**	**1305**	**2385**	**2951**	**1387**	**2044**	**ND**
1A1. Energy industries						394	609	1503	1131	13	447	ND
1A2 Manufacturing industries	1366					1,837	696	862	1820	1374	1313	ND
1A3 Transport												
1A4 Other sectors:												
a. Commercial/Institutional	*9*							*20*			*284*	*ND*
b. Residential												
c. Agriculture/Forestry/ Fisheries												
1A5 Other (not elsewhere)												

ND = No Data

However, apart from the CO_2 from biomass combustion which are explicitly reported, some of the biofuel combustion could not be separated into meaningful activity data and (implied) emission factors due to lack of transparency and consistency in reporting by individual firms. This part of the energy consumption from biomass was therefore not included in the CRF data on fuel combustion. It was reported separately in the documentation box, since reporting of the emissions and activity data under other fuels would have resulted in erroneous extra fossil CO_2 emissions and fossil energy use. The biofuel consumption for which no organic CO_2 emissions have been reported is summarised in *Table 3.4.*, which also shows that some unknown biofuel consumption occurred in the service sectors.

An example of non-transparent reporting is found in the paper industry that uses paper sludge (biomass) as fuel, which is, however, reported by the companies as solid fuel. In these cases the identification of biofuel can only be established on the basis of specific process expertise of the inventory compiler. Furthermore, energy producers use more and more biomass as a supplementary fuel, but they do not explicitly report this. This also holds for the municipal waste incineration, where no division is made between emissions from biomass (organic carbon) in the wastes and emissions from fossil-derived wastes e.g. plastics (fossil-based carbon). In general, only the fossil fuels (gas or oil) are reported in TJ, although the associated CO_2 emissions *may* include the biomass emissions. Therefore these aggregated CO_2 emission figures have to be broken down into fossil and biomass parts. In the current situation this is done on the basis of general figures on the composition of the incinerated wastes, with large risks of misinterpreting the data.

In 2003, an initiative has been taken to establish a fixed reporting requirement in the annual environmental reporting of individual firms for biomass related emissions. This will eventually lead to a situation where each company reports its biomass fuel and the related emissions separately from its fossil-fuel related emissions. In this way, the quality of both the future biomass and fossil-fuel related CO_2 emissions will be improved. Additional research will be required to improve the estimation and allocation of biomass emissions for the whole 1990-2001 period.

3.2 Fuel combustion [CRF category 1A]

The trends per IPCC sector in emissions from fuel combustion have been summarised in *Table 3.5.* Since 1990, CO_2 emissions increased by about 13%, mainly due to the increase of the emission in the energy sector (26%) and transport sector (22%). The largest increase of emissions (6.5 Tg) occurred in the transport sector. The decrease in the electricity production sector (1A1a) in 1999 is due to the marked increase of imported electricity since 1999, which almost doubled compared with 1998, and to a relatively large shift from coal to oil and natural gas in 1999. The small decrease in fossil-fuel related emissions in the industry (1A2) of 4% appears to by caused by a decrease of feedstock emissions.

In 2000, total CO_2 emissions increased by 2% (3 Mton) compared to 1999 (according to the preliminary data for 2000 provided in the previous NIR 2002, this change was estimated at 1% or 1.3 Mton). This was mainly caused by the increased energy use in the energy, service and transport sectors, while the emissions from industry decreased by 2 Mton.

Table 3.5. Emissions and sinks for the energy sector 1990-2001 (no temperature correction) (Tg)

IPCC Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
1. All Energy (combustion and fugitive)	**156.8**	**165.9**	**164.4**	**166.7**	**167.3**	**170.1**	**177.9**	**166.0**	**172.0**	**168.3**	**172.3**	**178.4**
A Fuel combustion total	156.5	165.5	164.0	166.4	167.1	169.2	176.9	165.0	170.5	166.8	170.7	176.7
1 a Electricity and heat production	40.3	41.6	43.3	43.2	44.8	44.5	45.8	45.1	47.9	44.6	49.0	51.9
1 bc Other transformation	11.0	10.6	10.9	10.6	11.2	12.0	12.6	12.1	12.3	12.1	12.2	12.9
2 Industry: fuel combustion	33.6	32.9	33.1	31.6	32.3	33.4	34.2	29.4	33.2	32.7	29.7	30.2
Industry: feedstock emissions	8.3	9.8	9.4	8.3	8.7	9.2	8.8	9.5	9.2	9.6	10.0	10.0
3 Transport	29.1	29.2	30.4	30.9	31.2	32.2	32.6	33.1	33.8	34.8	35.2	35.6
4 a Commercial/Institutional	5.9	10.3	9.4	10.6	10.1	8.6	9.1	7.6	7.7	6.7	7.9	8.8
4 b Residential	19.8	21.6	19.5	20.6	19.6	21.2	24.8	20.8	18.8	19.3	19.6	20.4
4 c Agriculture/Forestry/Fisheries	8.4	8.5	8.5	8.8	8.8	8.1	8.9	7.5	7.5	7.1	7.1	7.0
5 Other	0.0	1.1	-0.4	1.7	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
B Fugitive fuel emissions	0.3	0.5	0.4	0.4	0.2	0.8	1.0	1.0	1.6	1.5	1.6	1.7
2 Crude oil and natural gas	0.3	0.5	0.4	0.4	0.2	0.8	1.0	1.0	1.6	1.5	1.6	1.7
CH_4												
1. All Energy (combustion and fugitive)	**213.2**	**223.8**	**199.0**	**192.4**	**202.2**	**207.0**	**225.3**	**185.9**	**177.4**	**177.5**	**164.7**	**168.9**
A Fuel combustion total	34.4	35.7	35.9	34.4	33.7	36.7	37.0	29.4	30.8	33.1	33.7	34.6
1 Energy	3.3	3.2	3.8	3.4	3.7	4.9	5.7	3.0	4.4	6.0	6.0	6.3
2 Industry	2.9	3.5	4.9	3.2	2.6	5.1	1.8	1.0	1.7	3.0	3.3	3.4
3 Transport	7.9	6.9	6.7	6.4	6.1	6.0	5.5	5.2	5.0	4.8	4.4	4.2
4 a Commercial/Institutional	0.8	1.1	1.0	0.9	1.4	0.5	1.1	0.5	1.0	0.8	1.1	1.1
4 b Residential	16.8	18.3	16.8	17.7	17.0	17.4	19.8	17.2	16.2	15.9	17.1	17.1
4 c Agriculture/Forestry/Fisheries	2.6	2.7	2.7	2.8	2.8	2.5	2.8	2.4	2.4	2.2	2.2	2.2
B Fugitive fuel emissions	178.8	188.1	163.1	158.0	168.5	170.3	188.3	156.5	146.6	144.3	131.0	134.3
2 Crude oil and natural gas	178.8	188.1	163.1	158.0	168.5	170.3	188.3	156.5	146.6	144.3	131.0	134.3
N_2O												
1. All Energy (combustion and fugitive)	**1.9**	**2.1**	**2.3**	**2.4**	**2.6**	**2.6**	**2.4**	**2.3**	**2.6**	**2.6**	**2.7**	**2.7**
A Fuel combustion total	1.9	2.1	2.3	2.4	2.2	2.6	2.4	2.3	2.6	2.6	2.7	2.4
1 Energy	0.5	0.5	0.5	0.5	0.2	0.5	0.0	0.0	0.5	0.5	0.5	0.5
2 Industry	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.1
3 Transport	1.2	1.4	1.6	1.7	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0
4 a Commercial/Institutional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 b Residential	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
4 c 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
B Fugitive fuel emissions	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Crude oil and natural gas	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The uncertainty in *annual* CO_2 emission estimates from fossil fuel combustion, which is related to uncertainty in activity data (energy statistics) and emission factors for CO_2 (basically, the carbon content of the fuels), is currently estimated to be about 3% (with order of magnitude-factor of 1.5). This has been based on a set of assumptions for the uncertainty in sectoral activity data and emission factors. The uncertainty in annual CO_2 emissions of stationary fuel combustion subsectors and road transport is also estimated to be about 3 to 4%. The uncertainty is not well known for other sources, in particular for feedstock use of oil products and for other mobile sources (see S*ection 1.7* for more details on individual assumptions). However, due to the minor share of these other sources, the uncertainty in the overall *annual* total is estimated to be about 3%; the Tier 1 *trend* uncertainty in national total CO_2 emissions has been calculated at ±3% points.

For CH_4 and N_2O emissions from fuel combustion the uncertainty in *annual* emissions is estimated to be of the order of 50%, except for other mobile combustion (i.e. non-road) for which the uncertainty is estimated to be of the order of a factor of 2.

3.2.1 Energy industries (CRF category 1A1)

3.2.1.1 Source category description

This source category consists of the subsources '*Public electricity and heat production'* (including emissions from waste incineration), '*Petroleum Refining'* and '*Other energy industries'* – all excluding CO_2 from organic sources, i.e. from biomass combustion – which are all together a key source for CO_2 emissions.

The share of CO_2 emission from the energy industries in the national total was 32% in 1990 and 36% in 2001. For CH_4 and N_2O emissions from the energy subsector the share is relatively small and not considered a key source (*Table 3.6*).

Table 3.6. Emissions from energy industries (1A1) (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
a. Public electricity and heat production	40.3	41.6	43.3	43.2	44.8	44.5	45.8	45.1	47.9	44.6	49.0	51.9
b. Petroleum refining	9.7	0.0	0.0	0.0	0.0	10.4	10.9	10.4	10.2	10.4	10.6	11.1
c. Manufacture of solid fuels/other	1.3	10.6	10.9	10.6	11.2	1.6	1.7	1.7	2.0	1.7	1.7	1.8
CH_4												
a. Public electricity and heat production	0.5	2.9	3.4	3.0	3.4	0.7	1.2	1.2	0.9	3.1	3.0	3.1
b. Petroleum refining	0.3	0.0	0.0	0.0	0.0	0.6	0.8	0.3	0.1	0.1	0.3	0.3
c. Manufacture of solid fuels/other	2.5	0.3	0.4	0.4	0.3	3.6	3.7	1.4	3.4	2.8	2.7	2.9
N_2O												
a. Public electricity and heat production	0.4	0.4	0.4	0.4	0.1	0.4	0.0	0.0	0.4	0.4	0.4	0.5
b. Petroleum refining	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1
c. Manufacture of solid fuels/other	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.2.1.2 Methodological issues

For fuel combustion in *energy industries* (1A1) a country-specific bottom-up (Tier2/Tier 3) method is used for calculating the emissions. The method is based on the emission data of the large individual point sources provided by the annual environmental reports of large companies and an additional estimation of the rest of the emissions based on the fuel consumption data per sector and country specific emission factors. A detailed description of the methodology of estimating the CO_2 emissions of this key source is provided in Spakman *et al.* (2003). Since the CO_2 emissions from the energy industries are considered to be a key source (see *Section 3.1*), the present Tier 2/3 methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

3.2.1.3 *Uncertainty and time-series consistency*

The uncertainty of this category is estimated to be 4% in annual emissions (see *Section 1.7* for more details).

The trend in emissions of CO_2 from the energy sector is summarised in *Table 3.7.* Between 1990 and 2001 total emissions increased by 26% from 51 to 65 Tg. A major part of this increase can be attributed to the increase of the emissions from electricity production which corresponds with (a) a large increase of the use of fossil fuel by power plants, (b) a shift from coal to natural gas, and (c) an increase of the efficiency of power plants.

As can be seen from *Table 3.7* the emissions of CO_2 increase up to 1998. In 1999 however the emissions of public electricity and heat production are suddenly 5% lower than in 1998, while the electricity consumption in the Netherlands in 1999 is 2% higher than in 1998 (*Table 3.8*). This is caused by an enormous increase of imported electricity, which almost doubled compared with 1998, and to a relatively large shift from coal to oil and natural gas in 1999 (see *Figure 3.1*). The higher import corresponds with an emission of about 4 Tg CO_2; the shift from coal to natural gas and oil with about 1 Tg CO_2 in 1999. In 2001, the net import of electricity decreased but this was compensated by the production from the public electricity sector, which increased with 10%. The total consumption of electricity increased by about 3% and total emissions of electricity production by about 6%.

Table 3.7. CO_2 emissions from the energy industries 1990-2001 (Tg)

Source	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Public electricity and heat production	40.3	41.6	43.3	43.2	44.8	44.5	45.8	45.1	48.0	44.6	49.0	51.9
o.w. Liquid fuels	*0.2*					*0.0*	*0.2*	*0.3*	*0.2*	*0.4*	*1.5*	*1.8*
o.w. Solid fuels	*21.8*					*22.1*	*21.8*	*24.0*	*26.6*	*22.0*	*0.1*	*21.6*
o.w. Gaseous fuels	*13.8*					*16.8*	*18.4*	*19.8*	*18.8*	*21.0*	*8.9*	*22.9*
o.w. Other fuels/Unspecified emissions [1]	*0.4*					*5.7*	*5.4*	*1.0*	*2.3*	*1.1*	*38.5*	*5.6*
Petroleum refining	9.7	IE	IE	IE	IE	10.4	10.9	10.4	10.2	10.4	10.6	11.1
Other energy industries	1.3	10.6	10.9	10.6	11.2	1.6	1.7	1.7	2.0	1.7	1.7	1.8
Total	**51.3**	**52.2**	**54.1**	**53.8**	**56.0**	**56.5**	**58.3**	**57.2**	**60.2**	**56.7**	**61.2**	**64.8**

Note: To reflect the degree of completeness, only emissions reported in the CRF files have been included here.

[1] The emissions not reported by fuel type have been summed and reported in the CRF under "Other fuels", as is total fuel consumption associated with these unspecified emissions. This may explain the invisibility in this table of the increase of liquid fuel emissions in 1999 observed in *Figure 3.1.*

In cases where CO_2 and related fossil fuel consumption were not reported per fuel type by individual companies or when they did not properly match, fuel consumption and CO_2 emissions have been allocated in the *CRF Sectoral Background Tables* under *'Other fuels'*. In *Table 3.7*, where these data are presented for the energy sector, it clearly shows that for the public electricity and heat production sector last years the fraction of unspecified fossil-fuel related CO_2 emissions is large thanks to the problems mentioned above. Inspection of the refinery data reveals that the high-unallocated fractions in recent years for the total energy sector also relate to refineries, of which all reported CO_2 emissions since 1999 could not be associated with reported fossil fuel consumption.

Table 3.8. Gross production, import, export, and gross consumption of electricity 1990-2000 (1000 mln kWh) Source: CBS, 2001a and www.statline.cbs.nl.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Gross production	71.9	74.4	77.2	76.9	79.7	81.0	85.2	86.7	91.0	86.7	89.4	94,2
Fossil fuel, non-CHP	*56.1*	*58.3*	*59.0*	*56.8*	*57.7*	*56.8*	*56.7*	*58.2*	*58.4*	*51.3*	*52.6*	*62.4*
Nuclear	*3.5*	*3.3*	*3.8*	*3.9*	*4.0*	*4.0*	*4.2*	*2.4*	*3.8*	*3.8*	*3.9*	
CHP and other	*12.3*	*12.8*	*14.4*	*16.2*	*18.0*	*20.3*	*24.4*	*25.9*	*28.7*	*31.5*	*32.9*	*31.9*
Import	9.7	9.8	8.9	10.6	10.9	12.0	11.3	13.1	12.2	22.4	23.0	17.3
Export	0.5	0.6	0.2	0.3	0.3	0.6	0.7	0.5	0.4	4.0	4.0	
Gross domestic use	81.1	83.5	85.9	87.3	90.2	92.4	95.8	99.2	102.8	105.1	108.3	111.5

Note: For 2001 and further years only the net import of electricity and the total production of power plants (fossil and nuclear together) has been published by Statistics Netherlands.

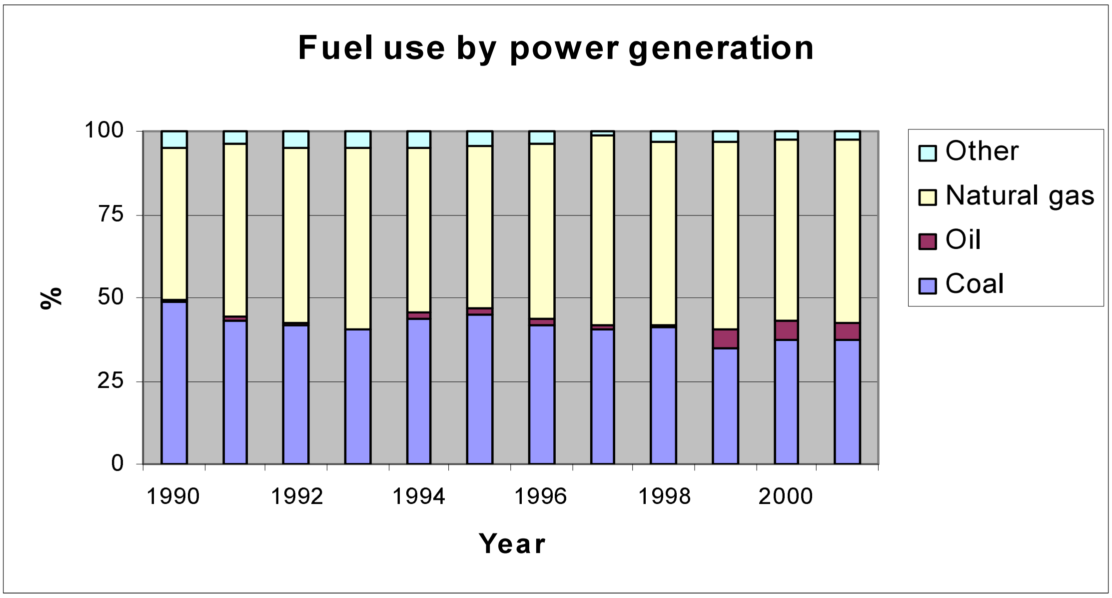

Figure 3.1. Shares of fuel use by power plants 1990-2000 (CBS, several years)

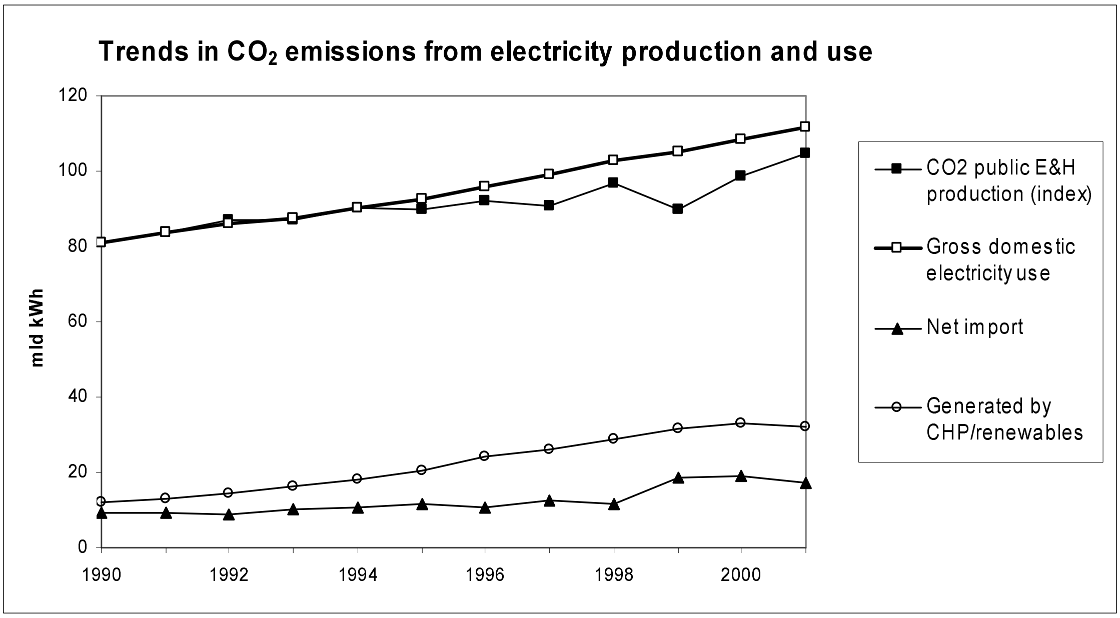

Figure 3.2. Trend in CO_2 emissions from electric power generation 1990-2001

3.2.1.4 Source-specific QA/QC and verification

In the NIR 2002 the emissions with no or incomplete activity data were allocated to the category '*Others*'. The allocation of emissions of derived fuels and LPG to the categories liquid, solid and gaseous fuels was done manually. Last year some flaws in the allocation of LPG were discovered; not all LPG was allocated under liquid fuels. Therefore in this NIR the fuel split was improved, using a standard query in the emission database. In this way we established a uniform fuel split (using the same rules) for all years. This action led to shifts in the fuel allocation especially for liquids (due to LPG) and solids (due to derived gases) compared to last submission (see also *Section 10.1*).

3.2.2 Manufacturing industries and construction (CRF category 1A2)

3.2.2.1 Source category description

Source category 1A2 consists of the combustion emissions of six sub-sources: iron and steel, non-ferrous metals, chemicals, pulp and paper, food processing and a category 'others' and includes all (process) emissions from metal production, coke production and feedstock emissions.

CO_2 emissions from manufacturing industries (1A2) are a key source. In addition, industrial process emissions of CO_2 from iron and steel industry and the CO_2 feedstock emissions of gas and oil are key sources (see *Box 3.1*). The share of the emissions from manufacturing industries and construction in the national CO_2 emission was 26% in 1990 and 22% in 2001. The share of the other greenhouse gas emissions of this category is only very small (*Table 3.9*).

Table 3.9. Emissions from manufacturing industries and construction (1A2) (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
a. Iron and steel [1)]	6.3	NA	NA	NA	NA	6.5	5.6	5.5	6.4	6.5	6.2	6.2
b. Non-ferrous metals	0.2	NA	NA	NA	NA	0.3	0.3	0.2	0.3	0.3	0.2	0.2
c. Chemicals [1)]	23.9	NA	NA	NA	NA	24.7	25.4	23.3	24.6	24.5	22.0	22.4
d. Pulp, paper and print	1.6	NA	NA	NA	NA	2.0	2.0	2.0	2.0	1.6	2.1	2.1
e. Food processing, beverages & tobacco	4.2	NA	NA	NA	NA	4.5	4.8	3.2	4.4	4.6	4.2	4.3
f. Other	5.8	42.7	42.5	39.9	41.0	4.7	4.9	4.7	4.8	4.9	4.9	4.0
CH_4												
a. Iron and steel	0.6	NA	NA	NA	NA	0.7	0.4	0.1	0.1	0.6	0.8	1.0
b. Non-ferrous metals	0.0	NA	NA	NA	NA	0.0	0.1	0.0	0.0	0.0	0.0	0.0
c. Chemicals	1.0	NA	NA	NA	NA	3.0	0.2	0.1	0.9	1.1	1.1	1.1
d. Pulp, paper and Print	0.1	NA	NA	NA	NA	0.3	0.2	0.1	0.0	0.2	0.2	0.2
e. Food processing, beverages & tobacco	0.5	NA	NA	NA	NA	0.5	0.5	0.2	0.3	0.6	0.5	0.5
f. Other	0.6	3.5	4.9	3.2	2.6	0.5	0.4	0.4	0.3	0.5	0.5	0.5
N_2O												
a. Iron and steel	0.0	NA	NA	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b. Non-ferrous metals	0.0	NA	NA	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
c. Chemicals	0.1	NA	NA	NA	NA	0.1	0.3	0.2	0.1	0.0	0.1	0.1
d. Pulp, paper and print	0.0	NA	NA	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
e. Food processing, beverages & tobacco	0.0	NA	NA	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
f. Other	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1)] Including non-energy use of fuels e.g. as chemical feedstock.

Note: To reflect the degree of completeness, only emissions reported in the CRF files have been included here: NA = Not Available (for 1991-1994 no break-up in sub-sectors has been made in the CRF files).

3.2.2.2 Methodological issues

For all emissions from manufacturing industries (1A2) a country-specific bottom-up (Tier 2/Tier 3) method is used calculating the emissions, except for the CO_2 emissions from non-energy (feedstock) use of fuels, for which effectively the IPCC Tier 1 method is used for calculating national total feedstock emissions. The method for fuel combustion is based on the emission data of the large individual point sources provided by the annual environmental reports of large companies and an additional estimation of the rest of the emissions based on the fuel consumption data per sector and country specific emission factors. A detailed description of the methodology of estimating the CO_2 emissions of these key sources is provided in Spakman *et al.* (2003).

Since the CO_2 combustion emissions from manufacturing industries are considered to be a key source (see *Section 3.1*), the present Tier 2/3 methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). The CO_2 emissions from non-energy/feedstock use of natural gas and of oil products are also considered to be key sources. The present use of the Tier 1 methodology for estimating national total CO_2 emissions from these sources does not fully comply with the *IPCC Good Practice Guidance*.

3.2.2.3 *Uncertainty and time-series consistency*

The uncertainty of this category is estimated to be 3% in annual CO_2 emissions from combustion. The uncertainty in feedstock-related CO_2 emissions is estimated at about 10% for non-energy use of gas and coal and about 50% for feedstock use of oil products (see *Section 1.7* for more details).

Between 1990 and 2001 the emission of CO_2 due to fossil fuel use by industry has decreased from 41.9 to 40.2 Tg (-4%) (*Table 3.10*), which is dominated by the chemical industry. This includes actual emissions of CO_2 from feedstock use of energy carriers of 8.3 and 9.5 Tg, respectively, which appears to be the main cause of the 1 Tg increase in industrial fossil fuel emissions. As shown in *Table 3.10* and *Table 3.12* the combustion emissions, also of other industrial sectors, remained fairly constant in this period. In the 1990-2000 period according to national energy statistics between 14 and 19 Tg CO_2 is annually stored in oil products (*Table 3.13*). Although the growth of industrial production in this period of 17% (in monetary units) emissions are decreased. The difference can be explained mainly by energy conservation. Between 1989 and 1999, the Netherlands' industry has attained an improvement of its energy efficiency of about 20%, which is equivalent with an energy conservation of 142 PJ (EZ, 2000) or about 8.5 Tg CO_2 emissions or more (depending on the fuel mix assumed). In addition, we note that the trend in energy consumption in the industry, and thus in CO_2 emissions, is influenced by the fraction of fuel used for privately owned cogeneration facilities.

Table 3.10. CO_2 emissions from fuel use in manufacturing industries and construction (1A2) (unit: Tg)

Subsector	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
a. Iron and steel [1)]	6.3	NA	NA	NA	NA	6.5	5.6	5.5	6.4	6.5	6.2	6.2
b. Non-ferrous metals	0.2	NA	NA	NA	NA	0.3	0.3	0.2	0.3	0.3	0.2	0.2
c. Chemicals [1)]	23.9	NA	NA	NA	NA	24.7	25.4	23.3	24.6	24.5	22.0	22.4
- Fuel combustion	*15.5*	*NA*	*NA*	*NA*	*NA*	*15.4*	*16.6*	*13.8*	*15.4*	*14.9*	*12.0*	*12.5*
- Feedstocks (Tier 1)	*8.3*	*9.8*	*9.4*	*8.3*	*8.7*	*9.2*	*8.8*	*9.5*	*9.2*	*9.6*	*10.0*	*10.0*
d. Pulp, paper and print	1.6	NA	NA	NA	NA	2.0	2.0	2.0	2.0	1.6	2.1	2.1
e. Food processing [2)]	4.2	NA	NA	NA	NA	4.5	4.8	3.2	4.4	4.6	4.2	4.3
f. Other	5.8	42.7	42.5	39.9	41.0	4.7	4.9	4.7	4.8	4.9	4.9	4.9
Total	**41.9**	**42.7**	**42.5**	**39.9**	**41.0**	**42.6**	**43.0**	**38.9**	**42.4**	**42.3**	**39.7**	**40.2**

[1)] Including non-energy use of fuels e.g. as chemical feedstock.
[2)] Including beverages and tobacco.
Note: NA = Not Available (for 1991-1994 no break-up in sub-sectors has been made in the CRF files).

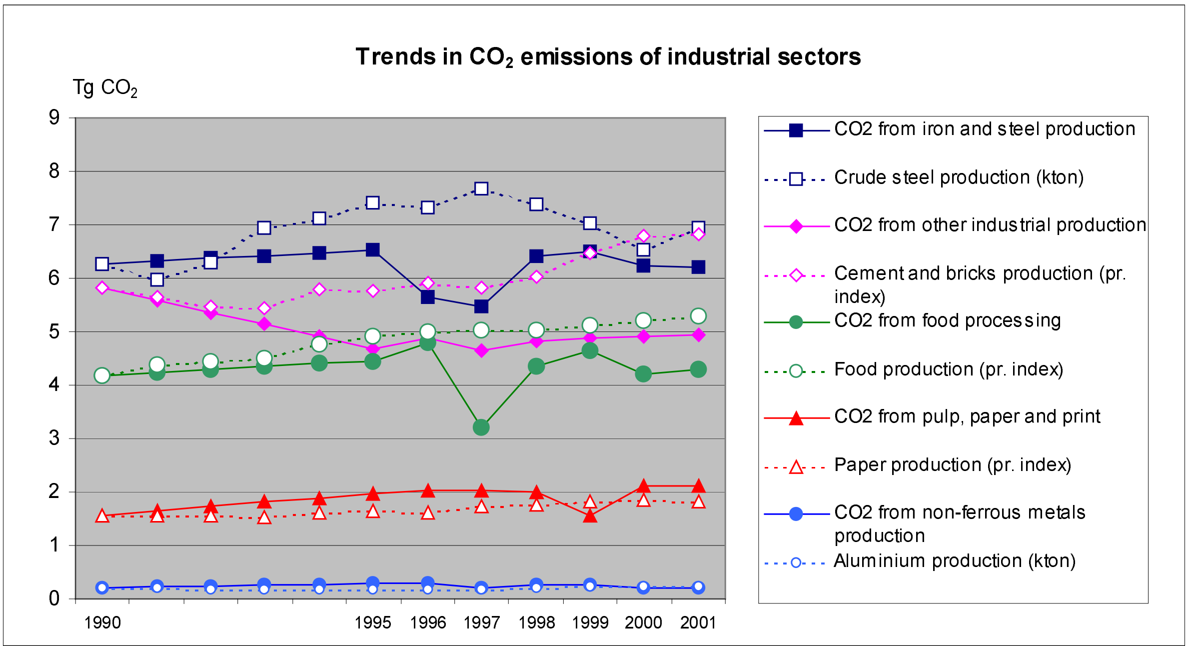

Figure 3.3. Trend analysis of CO_2 emissions in industrial subsectors, excluding the chemical industry, 1990-2001

Trends in subsectors are presented in *Figure 3.3*, in which trends of CO_2 emissions are compared to trends in underlying production data. It can be concluded that both trends appear to be rather closely related with a few exceptions (iron and steel production in 1996 and 1997; food processing in 1997; paper production in 1999). These exceptions could be either caused by large annual stock changes or by calculation errors. Further study has to disclose the exact nature of these discrepancies.

As mentioned in *Section 3.2.1* in cases where CO_2 and related fossil fuel consumption were not reported per fuel type by individual companies or when they did not properly match, fuel consumption and CO_2 emissions have been allocated in the *CRF Sectoral Background Tables* under *'Other fuels'*. In *Table 3.11*, where these data are presented for the total industry sector, it clearly shows that the fraction of unspecified fossil-fuel related emissions was about 23% in 1990, but increased to about 50% in the year 1997. Inspection of the subsectoral data reveals that the high fractions in recent years relate to the iron and steel industry, of which all CO_2 emissions are not related to fuel consumption and to the chemical industry, where about 50% of reported CO_2 emissions was not or not properly associated with reported fossil fuel consumption. In 1990, these fractions were only 5% and 31%, respectively.

Table 3.11. CO_2 emissions by fuel type in the manufacturing industries and construction (1A2) (unit: Tg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total industrial combustion	41.9	42.7	42.5	39.9	41.0	42.6	43.0	38.9	42.4	42.3	39.7	40.2
o.w. Liquid fuels	7.8	NA	NA	NA	NA	7.4	7.6	4.6	3.4	4.7	3.5	3.8
o.w. Solid fuels	6.1	NA	NA	NA	NA	5.2	1.2	0.7	0.7	1.4	0.5	0.5
o.w. Gaseous fuels	18.3	NA	NA	NA	NA	18.5	18.2	14.0	17.7	17.3	17.6	17.9
o.w. Other fuels [1)]	9.7	42.7	42.5	39.9	41.0	11.5	15.9	19.6	20.7	18.9	18.0	18.0
Fraction unspecified	*23%*	*100%*	*100%*	*100%*	*100%*	*27%*	*37%*	*50%*	*49%*	*45%*	*45%*	*45%*

[1)] Including unspecified emissions and incompatible fuel/emissions datasets.

Notes: To reflect the degree of completeness, only emissions reported in the CRF files have been included here: NA = Not Available (for 1991-1994 no break-up in sub-sectors has been made in the CRF files).

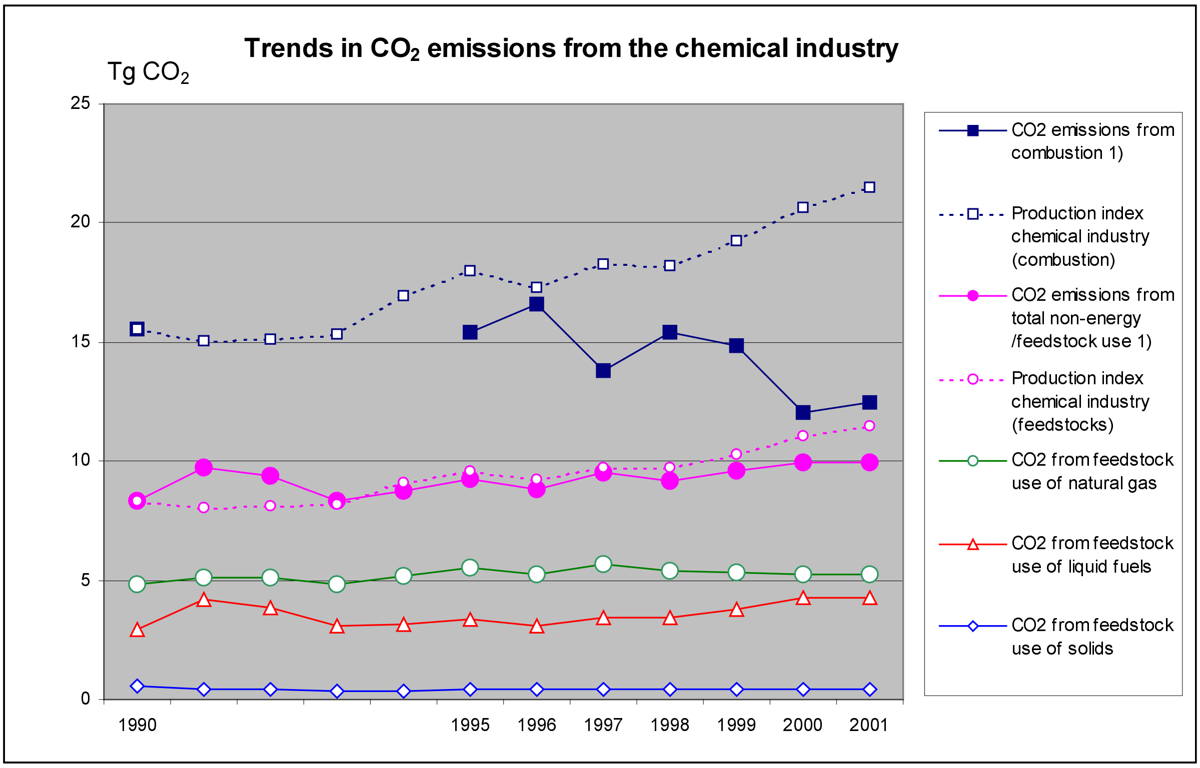

Figure 3.4. Trend analysis of CO_2 emissions in the chemical industry 1990-2001 (separate feedstock and combustion emissions based on IPCC Tier 1 analysis of feedstock-related emissions included in the sectoral total)

The industry in the Netherlands has a relatively large petrochemical industry, which shows up in actual CO_2 emissions associated with non-energy use of oil products and natural gas. For information we show in *Tables 3 .12* and *3.13* the CO_2 emitted and stored in feedstock products as included in the *IPCC Reference Approach* calculation for CO_2. We stress, however, that the amounts actually included in the sectoral approach, which are to a large extent based on reports by individual companies, may differ substantially. According to the *Reference Approach* calculation the feedstock emissions can vary substantially from year to year.

In *Figure 3.4* trends of CO_2 emissions trends in the chemical industry are presented from combustion and non-energy use – derived using the IPCC Tier 1 analysis of feedstock-related emissions included in the sectoral total – and compared with trends in production data. We can conclude that the trends in feedstock emissions follow the production index rather closely, but that the trend in emissions from fuel combustion, albeit showing a large interannual variation, is overall decreasing. This suggests that also in the chemical industry energy conservation is a major factor in explaining the trend in its CO_2 emissions. Note that, just as in *Figure 3.3,* 1997 combustion emissions show a substantial drop, which could be either caused by large sectoral changes or by calculation errors. Further study has to disclose, here too, the exact nature of this discrepancy.

Table 3.12. Trend in CO_2 emitted by feedstock use of energy carriers according to the IPCC Reference Approach [1)] (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Liquids	2 947	4 207	3 835	3 065	3 182	3 344	3 073	3 425	3 404	3 796	4 251	4 251
Solids [2)]	569	416	417	372	383	386	433	417	408	449	414	435
Gaseous	4 803	5 144	5 102	4 866	5 172	5 510	5 283	5 667	5 390	5 345	5 287	5 287
Total	**8 319**	**9 767**	**9 353**	**8 303**	**8 737**	**9 240**	**8 789**	**9 510**	**9 203**	**9 590**	**9 952**	**9 973**

1) Using country-specific carbon storage factors.

2) Due to change in definition of feedstock and energetic use of coke and coal in iron and steel production, data for 1999-2001 have been recalculated according to the old definition.

Table 3.13. Trend in CO_2 storage in feedstocks according to the default IPCC Reference Approach [1)] (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Liquid	13 141	18 776	16 790	14 265	14 536	13 916	12 563	14 242	13 857	15 801	17 769	19 006
Solid Fuels	610	544	550	702	558	601	632	576	594	157	224	321
Gaseous	534	534	567	541	575	612	587	630	599	594	587	518
Total	**14 285**	**19 855**	**17 907**	**15 508**	**15 669**	**15 129**	**13 781**	**15 448**	**15 050**	**16 552**	**18 580**	**19 845**

1) Using country-specific carbon storage factors.

3.2.2.4 Source specific QA/QC and verification

In the NIR 2002 the emissions with no or incomplete activity data were allocated to the subcategory 'Other fuels'. The allocation of emissions of derived fuels and LPG to the categories liquid, solid and gaseous fossil fuels has been done manually. Last year some flaws in the allocation of LPG were discovered; not all LPG was allocated under Liquid Fuels. Therefore in this NIR the fuel split was improved, using a standard query in the emission database. In this way we established a uniform fuel split (using the same rules) for all years. This action led to shifts in the fuel allocation especially for liquids (due to LPG) and solids (due to derived gases) compared to last submission (see also *Section 10.1*).

3.2.3 Transport (CRF category 1A3)

3.2.3.1 Source category description

The transport sector comprises road traffic; mobile off-road equipment such as tractors, and road and building construction equipment; rail transport; ships; and aircraft. The latter two can be separated into domestic (inland) transport and international transport (bunkers). In addition, pipeline transport (excluding natural gas) is also included in this sector. The transportation sector, dominated by road transport, has some particular features that warrant special attention:

- Allocation to transport or other sectors. This refers in particular to off-road mobile equipment;
- Allocation to domestic or international transport. This concerns shipping and aviation;
- Differences that may occur in road transport between fuel delivery statistics and fuel consumption estimated from vehicle-km statistics (top-down vs. bottom-up).

The first two issues will be discussed here, whereas the comparison of road transport statistics will be discussed in *Section 3.2.3.4* on verification.

General trend

The greenhouse gas emissions from the transport sector are summarised in Table *3.14*. Obviously, CO_2 emissions from road transport are the dominant source here whereas also most nitrous oxide emissions stem from this subcategory. From *Box 3.2* it can be observed that all CO_2 emissions as well as the N_2O emissions from road transport are key sources.

Table 3.14. Trend of greenhouse gas emissions from the transport sector (unit: CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
a. Civil aviation	0.5	0.3	0.2	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.3	0.2
b. Road transportation	25.4	25.6	26.9	27.5	27.8	28.4	29.2	29.5	30.2	31.1	31.5	32.0
c. Railways	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
d. Navigation	0.9	0.8	1.0	1.0	0.8	0.9	0.8	0.8	0.8	0.8	1.0	1.0
e. Other transportation	2.3	2.3	2.3	2.2	2.3	2.4	2.3	2.3	2.3	2.4	2.3	2.3
CH_4												
a. Civil aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b. Road transportation	7.5	6.5	6.4	6.1	5.8	5.6	5.1	4.8	4.6	4.5	4.0	3.8
c. Railways	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
d. Navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
e. Other transportation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
N_2O												
a. Civil aviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b. Road transportation	1.1	1.3	1.5	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9
c. Railways	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
d. Navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
e. Other transportation	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

By far the largest contributor to this sector is road transport, which accounted in 1990 for 87% (*Table 3.15*). Next are off-road vehicles, contributing about 8% in 1990. These off-road vehicles are used in agriculture and for building and road construction. Since 1990 CO_2 emissions from total transport have increased by 22%. This increase is predominantly caused by an increase in energy consumption by road transport, of which fuel consumption increased by 25% in this period. In *Table 3.18* fuel consumption by road transport is presented, both for the IPCC approach which is based on fuel deliveries and for the national approach which is based on transport statistics in terms of vehicle-km travelled. While the share of gasoline has remained rather constant over the whole period, there has been a shift from LPG to diesel fuel, effectively increasing the share of diesel in road transport fuel consumption from 45% in 1990 to 54% in 2001 (*Figure 3.5*).

Table 3.15. CO_2 emissions from transport in 1990 and 2001, by transport mode (Tg)

Transport mode	Emissions 1990 (Tg)	Share in 1990	Emissions 2001 (Tg)	Share in 2001	Increase 2001/1990 (Tg)	
b. Road transportation	25.4	87%	32.0	90%	6.6	26%
e. Other transportation (off-road)	2.3	8%	2.3	7%	0.1	2%
d. Domestic shipping	0.9	3%	1.0	3%	0.1	10%
a. Domestic aviation	0.5	2%	0.2	1%	-0.3	-60%
c. Railways	0.1	0%	0.1	0%	0.0	26%
Total	**29.1**		**35.6**		**6.5**	**22%**

We recall from *Section 3.1* that the Netherlands has relatively very large bunker fuel consumption due to its strategic position at the mouth of the Rhine and with Schiphol Airport as Western Europe's largest supply of aviation bunker fuels. To put this into perspective, the CO_2 emissions from international bunkers are about 150% of total domestic transport emissions of CO_2. This is equivalent to about 20% of total national greenhouse gas emissions in 1990 and increasing to 26% for the current year. The information presented in the CRF on the shares of international and domestic emissions in total shipping and aviation is presented as trend table in *Table 3.28* (see also *Table 2.3* in *Chapter 2*).

In *Box 3.2* the key and non-key sources of the transport sector are presented based on level, trend or both. All CO_2 sources are key sources. Of the non-CO_2 sources, only N_2O from road transport is a key source.

Box 3.2. Key source identification in the transport sector using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

1A3b	**CO_2**	**Mobile combustion: road vehicles**	**Key (L,T)**
1A3d	**CO_2**	**Mobile combustion: domestic shipping**	**Key (L2)**
1A3a	**CO_2**	**Mobile combustion: domestic aircraft**	**Key (T1)**
1A3e	**CO_2**	**Mobile combustion: other**	**Key (L)**
1A3b	CH_4	Mobile combustion: road vehicles	Non-key
1A3e	CH_4	Mobile combustion: other	Non-key
1A3b	**N_2O**	**Mobile combustion: road vehicles**	**Key (L2)**
1A3e	N_2O	Mobile combustion: other	Non-key

Allocation of emissions

Road transport

For national policy purposes, air pollution from road transport is in general calculated from statistics on vehicle-km. However, fuel consumption that is based on vehicle-km is smaller than the fuel consumption as included in the energy sales statistics of the Netherlands. The *Revised IPCC Guidelines* (IPCC, 1997) ask countries to report greenhouse gas emissions from combustion on the basis of fuel consumption within the national territory. Thus, road traffic emissions of the direct greenhouse gases CO_2, CH_4 and N_2O are calculated and reported according to these Guidelines (i.e. a correction is made to convert emissions related to vehicle-km to emissions related to energy sales statistics). Emissions of all other compounds, including ozone precursors and SO_2, which are more directly involved in air quality, are therefore calculated using traffic activity data (i.e. with fuel consumption figures that are somewhat different from energy supply statistics; see *Section 3.2.3.4* for more details).

Shipping

In the Netherlands, the national *Emission Registration* (ER) distinguishes between *inland shipping* and *international shipping,* the former based on fuel sold within the Netherlands and the latter based on fuel sold from so-called bunkers. In the Netherlands, most domestic commercial shipping activities buy their fuel from marine bunkers and therefore their energy consumption is included under 'International bunkers' an not in domestic consumption. International bunkers also include activities from fisheries, which are at present all allocated to '*International bunkers*' but should be reported under domestic source category 1A4c '*Commercial/Institutional/Fisheries*'.

In addition, a small part of inland ships also consume 'Dutch' fuel in other countries, e.g. when moving along international waterways, of which the emissions are excluded in the ER reports. It was chosen to copy this minor correction for reports in the IPCC format (although the Guidelines want all emissions from Dutch fuel to be allocated to the Netherlands). Conversely, international ships consume a small part of their bunkered fuel in the Netherlands' territorial waters. The corresponding non-CO_2 emissions are include in the official Netherlands' national inventory with emissions for all compounds, called the national *Pollutant Emission Register* (PER) (see *Table 3.16).* These (bunker) emissions are however excluded from National totals when reporting in the IPCC format. Therefore the emissions for NO_x, and SO_2 of the target group transport as reported in official Netherlands' inventories, are higher than the emissions from the IPCC *1A3 'Transport'* category. For other compounds however, this difference is rather small.

Table 3.16. Allocation of non-CO_2 emissions from shipping and aircraft in domestic national inventories and inventories submitted to the UNFCCC

Source/sector	PER	UNFCCC
Shipping emissions (non-CO_2)		
• National inventory	• Inland shipping emissions: Corrected for fuel use abroad	• Ibidem
• International	• International shipping: Only the small part emitted in territorial waters	• All shipping emissions according to bunker fuel sales in the Netherlands [1)]
Aircraft emissions (non-CO_2)		
• National inventory	• Emissions from LTO cycles at Schiphol Airport (other airports are neglected)	• Ibidem: - not corrected for the large fraction of LTO cycles related to combustion of bunkered fuel; - not corrected for the small emissions related to domestic cruise flights
• International	• Not recorded	• All international aircraft emissions according to bunker fuel sales in the Netherlands [1)]

[1)] Presently only reported for CO_2, including emissions from national fisheries that should be reported under domestic source category 1A4c '*Commercial/Institutional/Fisheries*'.

Air traffic

For calculating CO_2 emissions from domestic air transport domestic fuel sales figures for aircraft from the Netherlands' Energy Statistics were used. This is different from the emissions recorded in the national Emissions Registration, which accounts only for aircraft emissions associated with the LTO cycles of Schiphol Airport (other airports are neglected). Indeed, in the Netherlands by far the most aircraft activities (>90%) are related to Schiphol Airport.

For the emissions of non-CO_2 greenhouse gases, the inventory of the national *Pollutant Emission Register* (PER) is used (see *Table 3.16*). In the PER system, however, the emphasis is much more on air quality and therefore on local emissions. A good estimate of relevant emissions is the LTO emissions at Schiphol Airport (Amsterdam), i.e. LTO cycles at other airports are neglected. On the other hand, the main part of these LTO cycles concern the combustion of bunkered fuel, which should be reported - according to the Guidelines - as international emissions. In this report, no attempt was made to estimate specific emissions related to all *domestic* flights (including cruise emissions of these flights), since these emissions are almost negligible anyway.

Off-road mobile sources

This category comprises agricultural machinery such as tractors, road and building construction machinery. Emissions of these sources are reported under category *1A3e: 'Other Transport'.*

Description of road transport (CRF 1A3b)

CO_2 emissions

The share of road transport in national CO_2 emissions was 16% in 1990 and 18% in 2001. By far the largest contributor to this source category are passenger cars, which accounted in 1990 for 64%. Next are trucks contributing about 22% in 1990. CO_2 emissions from road transport have increased by 26% in the period 1990-2001. This increase is predominantly caused by an increase in energy consumption by passenger cars and vans. Energy use by passenger cars increased by 20% and energy use by vans more than doubled in this period 1990-2001. While the share of gasoline in fuel sales to road vehicles has remained rather constant over the whole period, there has been a shift from LPG to diesel fuel, effectively increasing the share of diesel in road transport fuel sales from 45% in 1990 to 54% in 2001 (*Figure 3.5*).

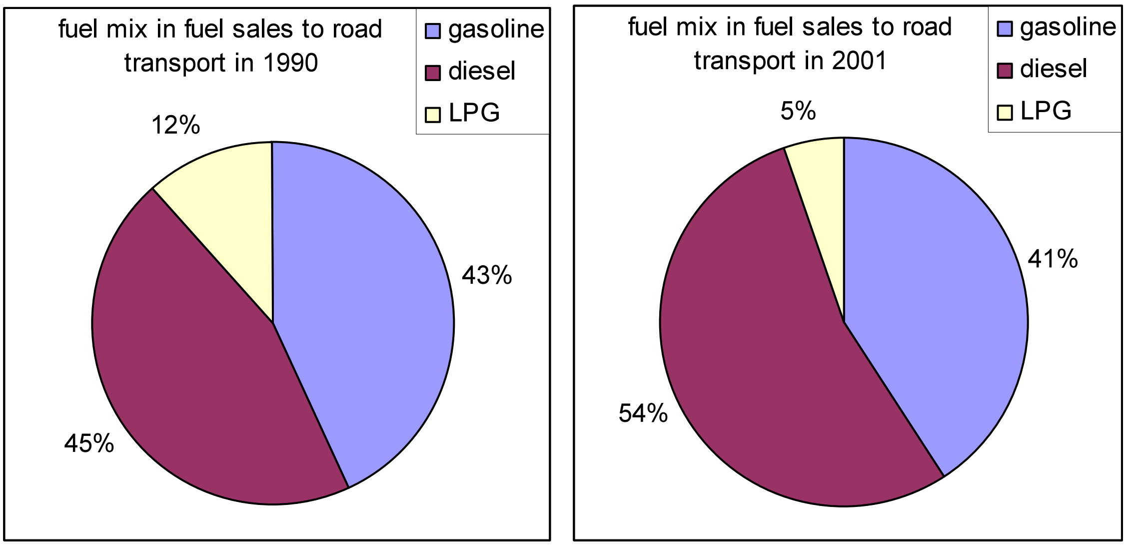

Figure 3.5. Shares of gasoline, diesel and LPG in fuel sales to road transport 1990 and 2001

Methane emissions

CH_4 emissions from road transport were calculated using mass fractions of total VOC from Veldt and Van der Most (1993). The mass fraction is dependent on 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 catalyst. Diesel-fuelled vehicles emit less CH_4 per unit of total VOC than petrol-fuelled vehicles without catalyst.

Total CH_4 emissions by road transport reduced by almost 50% between 1990 and 2001: 7.5 to 3.9 Gg (*Table 3.14*). In 2001 passenger cars were accountable for 65 to 70% of these CH_4 emissions. This reduction is related to the reduction of total VOC emissions, which was the result of European emission legislation for new road vehicles: total combustion and fugitive VOC emissions by road transport decreased by approximately 50% in the 1990-2001 period. This reduction was mainly the result of the penetration of catalyst-equipped cars into the passenger car fleet.

Nitrous oxide emissions

N_2O emissions from road transport increased from 1.1 Tg in 1990 to 1.9 Tg in 1999 and remained more or less constant between 1999 en 2001. The increasing trend up to 1999 could be expected from the increase in vehicles kilometres and from the increasing share of gasoline cars equipped with a catalytic converter, which have a much higher emission factor than cars without this emission control technology (*Table 3.17*). The fact that N_2O emissions from transport maintained constant between 1999 and 2001, despite the increase in vehicle kilometres, can be explained from a mix of developments:

- 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 gasoline cars, has increased over the last few years.

These trends have been summarised in *Table 3.4*. Both the decreasing emission factor for catalyst equipped cars as well as the increasing share of diesel cars with relatively low N_2O emission factors cause the overall emission factor for N_2O from road transport to maintain constant between 1999 and 2001. This has been visualised in *Figures 3.6* and *3.7.*

Description of domestic shipping (water-borne navigation) (CRF 1A3d)

The share of domestic water-borne navigation in national CO_2 emissions was less than 1% in both 1990 and 2001. The share of inland shipping in transport CO_2 emissions was around 3% in 1990 and 2001. Emissions in 2001 were about 1 Tg, almost equal to emissions in 1990.

Table 3.17. Trend in N_2O emission factors for passenger cars 1990-2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
A. N_2O emission factors (mg/km)												
Gasoline total	9	11	13	14	15	17	17	16	16	15	14	13
o.w. gasoline without cat.	5	5	5	5	5	5	5	5	5	5	5	5
o.w. gasoline with cat.	26	25	25	25	25	25	23	21	20	18	16	15
Share of cars with cat.	*22%*	*32%*	*41%*	*47%*	*53%*	*59%*	*64%*	*69%*	*73%*	*76%*	*81%*	*83%*
Diesel	5	5	5	5	5	5	6	6	7	8	8	9
LPG	10	13	15	16	18	20	20	19	19	18	17	16
ALL FUELS	9	10	12	13	14	15	15	14	14	14	13	12
B. Share of fuels in passenger car km												
Gasoline	63%	64%	66%	68%	67%	68%	69%	68%	67%	67%	66%	65%
Diesel	21%	20%	19%	19%	19%	20%	20%	20%	23%	24%	26%	27%
LPG	16%	16%	15%	14%	13%	13%	11%	11%	10%	9%	8%	8%

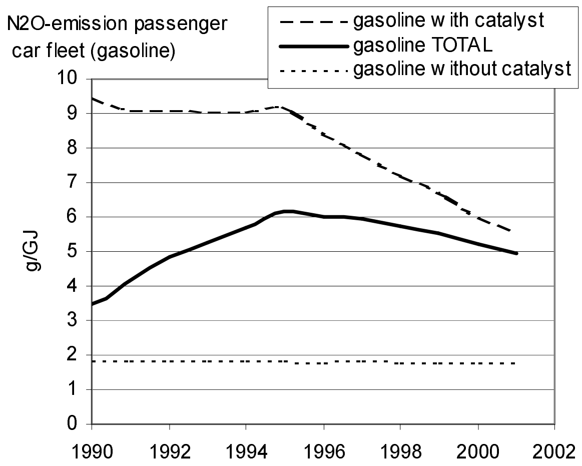

Figure 3.6. Trend in emission factors for N_2O from gasoline passenger cars in the Netherlands 1990-2001 due to increasing shares of cars equipped with a catalytic converter

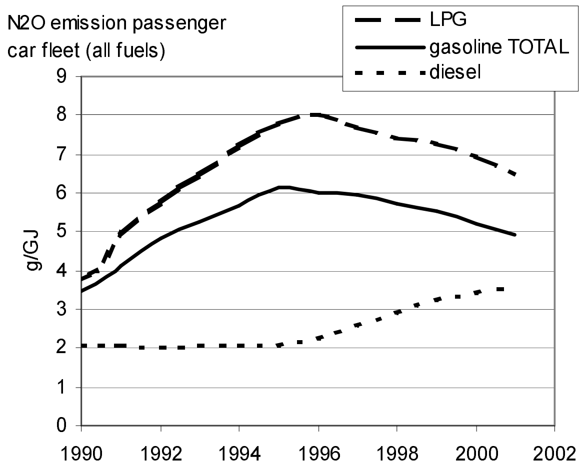

Figure 3.7. Trend in emission factors for N_2O from passenger cars in the Netherlands 1990-2001 by fuel type

Description of domestic aviation (CRF 1A3a)

The share of domestic aviation in national CO_2 emissions was less than 1% in both 1990 and 2001. Domestic aviation consists of domestic civil aviation between Dutch airports, of civil aviation from and to the same airport and of military aviation from Dutch military airports. Domestic aviation in the Netherlands emitted 0.5 Tg CO_2 in 1990 and 0.2 Tg in 2001.

Description of other transportation (CRF 1A3e)

The share of other transport, being mobile machinery and diesel rail transport, in national CO_2 emissions was around 1.5% in both 1990 and 2001. CO_2 emissions of this source category remained almost constant since 1990.

The share of non-road transport – including domestic water-borne navigation and domestic aviation – in total CH_4 and N_2O emissions by transport is between 5 and 10%. Total N_2O emissions by this source category amounted around 0.1 Tg in 1990 and remained almost constant since 1990.

3.2.3.2 Methodological issues

A detailed description of the methodology and data sources used to calculate transport emissions can be found in Klein *et al.* (2002).

Road transport (CRF 1A3b)

For CO_2 emissions from road transport IPCC Tier 2 methodologies are used. CO_2 emissions are calculated using Netherlands data on fuel sales to road transport from Statistics Netherlands (CBS) and country-specific emission factors, which are reported in Spakman *et al.* (2003).

For CH_4 emissions from road transport IPCC Tier 3 methodologies are used. VOC emissions by road transport are calculated using data on vehicle kilometres from *Statistics Netherlands* and VOC emission factors from the *Netherlands Organisation for Applied Scientific Research* (TNO). For every road transport sub-category the calculation methodology distinguishes between several vehicle characteristics like age, fuel type and weight. Besides the methodology distinguishes between three road types and takes cold starts into account.

For N_2O emissions from road transport a country-specific methodology is used, which is equivalent to the IPCC Tier 3 methodology. We calculated N_2O emission combining fuel deliveries with energy-specific emission factors. Fuel deliveries are obtained from Statistics Netherlands. The emission factors for passenger cars and light vehicles using gasoline or LPG are based on country-specific data (Gense and Vermeulen, 2002). Emission factors for diesel light duty vehicles, heavy-duty vehicles, motor cycles and mopeds are equal to IPCC defaults. However, recent research by TNO concluded that heavy duty diesel engines without exhaust gas after-treatment emit less than 10 mg/km N_2O, instead of the IPCC default suggesting an emission factor of 30 mg/km (Riemersma *et al*., 2003). From 2005 new heavy duty diesel engines will need exhaust after-treatment systems like 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). This information will be used for the next National Inventory Report.

Since the CO_2 and N_2O emissions from road transport are considered to be key sources (see *Section 3.1*), the present Tier 2 and Tier 3 methodologies do comply with the *IPCC Good Practice Guidance* (IPCC, 2000). CH_4 emissions from road transport are not a key source.

Domestic shipping (water-borne navigation) (CRF 1A3d)

CO_2 emissions from domestic shipping are based on fuel deliveries to water-borne navigation in the Netherlands and country-specific emission factors, which are reported in Spakman *et al.* (2003). Deliveries of fuel to internal navigation are excluded from this calculation, which is not in accordance with *IPCC Good Practice*. This is because in the Netherlands also domestic commercial inland ships are allowed to make use of bunker fuels. Also for national fisheries this is the case, but these emissions should be reported under another subcategory (1A4c, '*Commercial/Institutional/Fisheries*'). The result is an underestimation of fuel use and CO_2 emissions by domestic water-borne navigation. See For more information on the international transport emissions is provided in *Section 3.2.8.*

Since the CO_2 emissions are considered to be a key source (see *Section 3.1*), the present Tier 2 methodology level does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

Domestic aviation (CRF 1A3a)

CO_2 emissions of domestic aviation are based on fuel deliveries to domestic aviation in the Netherlands and country specific emission factors, which are reported in Spakman *et al.* (2001). Deliveries of bunkers to international aviation are excluded from this calculation. Fuel use by domestic civil aviation in the Netherlands is around 0.5 PJ (Brok *et al*., 2000) whereas total fuel deliveries to domestic aviation were about 7 PJ in 1990 and 3 PJ in 2001. From this one may conclude that military aviation must have a major share in CO_2 emissions by domestic aviation. This conclusion is supported by the fact that according to the Netherlands' Ministry of Defence in 2000 the Dutch military airforce used around 5 PJ of kerosene. However, it is unknown to what extent fuel sold for domestic purposes is used for international aviation and vice versa. Besides, it is uncertain whether the fuel deliveries to the military air force are indeed included in the fuel deliveries to domestic aviation. See *Section 3.2.8* for more information on the international transport (bunker) emissions.

Since the CO_2 emissions are considered to be a key source (see *Section 3.1*), the present Tier 2 methodology level does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

Other transportation (CRF 1A3e)

Information on fuel use by mobile machinery in the Netherlands is obtained via the Agricultural Economics Institute (LEI) and data on fuel use by diesel trains via Dutch Railways. These fuel use data are combined with country-specific emission factors for CO_2, which are reported in Spakman *et al.* (2003). Since the CO_2 emissions are considered to be a key source (see *Section 3.1*), the present Tier 2 methodology level does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

For CH_4 and N_2O emissions from other mobile combustion (i.e. non-road) IPCC Tier 1 methodologies are used. Activity data on fuel deliveries were used from Statistics Netherlands (CBS). For CH_4, the emission factors are based on total VOC emission factors (g/GJ) from the literature (Klein *et al.*, 2002) and the mass fraction of CH_4 in total VOC from Veldt and Van der Most (1993). For N_2O, the emission factors are equal to the IPCC defaults.

3.2.3.3 Uncertainty and time-series consistency

Road transport (CRF 1A3b)

The uncertainty in CO_2 emissions from road transport is estimated to be 3% in annual emissions. The trend shows an increase by 26%, which is mainly caused by the increase in passenger car use and the use of vans and the fact that both passenger cars and vans have not become significantly more energy efficient between 1990 and 1999. The commitment of the European, Korean and Japanese car manufacturers is to sell new cars in de European Union in 2008 emitting on average 25% less CO_2 per kilometre than in 1995. This has probably led to a slight decrease in average fuel use per kilometre driven in the last two of three years. However, this cannot be proven because data on car use became more and more uncertain since 1999. In 1999 Statistics Netherlands cancelled the annual passenger car use questionnaire which supplied data on car use and fuel efficiency per fuel type.

The uncertainty in CH_4 emissions from road transport is estimated to be about 50% in annual emissions. Data on the share of CH_4 in VOC are based on information in Veldt and Van der Most (1993) and have not been validated since. Possibly the mass fraction of CH_4 has changed due to for example recent changes in the aromatic content of road transport fuels or due to improvements in exhaust after-treatment technology.

The uncertainty in N_2O emissions from road transport is estimated to be 50% in annual emissions. Current emissions of heavy-duty diesel vehicles are probably overestimated, but for the whole period 1990-2001 the overestimation only slightly affects the emission trend.

Other modes of transport (shipping, aviation, other) (CRF 1A3d, a and e)

The uncertainty in CO_2 emissions from domestic aviation and from other transport is presently estimated to be about 50% in annual emissions; for domestic shipping the estimate is much higher, e.g. of the order of 100% due to the exclusion of commercial inland shipping. However, we observed that fuel deliveries to domestic aviation show large interannual variations in the period 1990-2001 (between 3 and 7 PJ), and no clear trend can be distinguished. One explanation could be a variation in the number of military operations, but information on this subject is kept confidential.

The uncertainty in CH_4 and N_2O emissions from non-road transport is estimated to be of the order of 100% in annual emissions. Data on the share of CH_4 in total VOC are based on information in Veldt and Van der Most (1993) and have not been validated since.

Table 3.18. Fuel consumption by road transport 1990-2001: fuel deliveries versus fuel consumption based on road transport statistics (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2001/1990
A. deliveries													
Gasoline	152.0	152.4	158.3	167.2	169.8	175.1	177.1	176.5	178.2	180.7	176.0	180.4	19%
Diesel	159.1	163.2	174.9	176.4	180.4	183.8	192.8	198.4	207.0	219.9	232.5	237.1	49%
LPG	41.0	39.8	39.0	37.2	35.3	34.1	33.5	33.3	32.8	29.1	25.6	23.5	-43%
Total	**352.1**	**355.4**	**372.2**	**380.8**	**385.5**	**393.0**	**403.4**	**408.2**	**418.0**	**429.6**	**434.1**	**441.0**	**25%**
B. consumption													
Gasoline	149.6	153.3	161.5	166.4	172.6	174.9	178.9	180.3	179.5	187.0	190.5	190.7	27%
Diesel	139.9	145.4	152.2	149.3	154.6	160.2	164.4	171.2	186.3	200.9	212.0	220.3	57%
LPG	35.6	36.1	34.1	30.6	30.9	29.5	26.0	26.6	24.5	23.8	22.6	21.6	-39%
Total	**325.2**	**334.8**	**347.8**	**346.3**	**358.1**	**364.6**	**369.3**	**378.0**	**390.3**	**411.8**	**425.1**	**432.6**	**33%**
Difference [(B-A)/A]													
Gasoline	*-2%*	*1%*	*2%*	*0%*	*2%*	*0%*	*1%*	*2%*	*1%*	*3%*	*8%*	*5%*	
Diesel	*-14%*	*-12%*	*-15%*	*-18%*	*-17%*	*-15%*	*-17%*	*-16%*	*-11%*	*-9%*	*-10%*	*-8%*	
LPG	*-15%*	*-10%*	*-14%*	*-21%*	*-14%*	*-16%*	*-29%*	*-25%*	*-34%*	*-22%*	*-13%*	*-9%*	
Total	***-8%***	***-6%***	***-7%***	***-10%***	***-8%***	***- 8%***	***-9%***	***-8%***	***-7%***	***-4%***	***2%***	***-2%***	

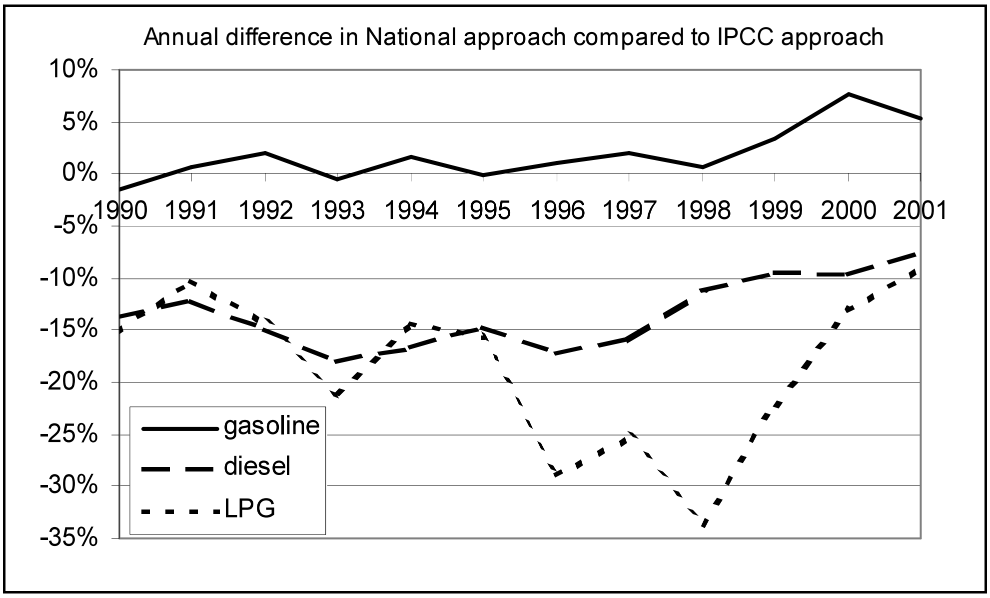

Figure 3.8. Annual differences per fuel type between fuel consumption (PJ) according to the national approach (based on vehicle-km statistics) and the IPCC approach (based on fuel deliveries to fuelling stations)

3.2.3.4 Verification of road transport: vehicle-km approach versus IPCC approach

In *Table 3.18* fuel consumption by road transport is presented, both for the IPCC approach which is based on fuel deliveries and for the national approach which is based on transport statistics in terms of vehicle-km travelled. From this table it can be concluded that there is a difference in fuel consumption inferred from transport statistics and from supply statistics of deliveries to fuelling stations of about 5-10% (bottom line of the table). This difference is not so much caused by gasoline, which shows only differences up to +8, with an average of around 2%, but rather by diesel and LPG figures, which differ annually up to -30%, with an average of about -13 and -19% for diesel and LPG, respectively (*Figure 3.4*). These differences can be explained to some extent, e.g. by fuel bought at both sides of the Netherlands' borders but consumed at the other side (Van Amstel *et al.*, 2000a), but not completely. Another explanation is the bad representation of company cars – which drive most kilometres per year (mostly using diesel or LPG) – in the passenger car questionnaire resulting in an underestimation of passenger car use. As illustrated in *Figure 3.8*, per fuel type the annual differences have more or less the same sign for the whole period. The discrepancy between total road fuel consumption and fuel deliveries tends to decrease in the last five years. It can be concluded that by and large, both methods show similar trends in fuel consumption by fuel type over the last 10 years.

3.2.3.5 Source-specific planned improvements

The exclusion of domestic commercial ships in the emission calculation of domestic water-borne navigation results in an underestimation of fuel use and emissions by domestic water-borne navigation. The same holds for national fisheries, which are presently included in the international bunker emissions instead of in domestic source category 1A4c '*Commercial/Institutional/Fisheries'*. Also, at present no non-CO_2 emissions are being calculated for international transport. In 2003 actions have been started to revise and to expand this calculation, respectively, to get in accordance with *IPCC Good Practice*.

3.2.4 Other sectors (CRF category 1A4)

3.2.4.1 Source category description

Source category 1A4 '*Other sectors'* comprises the following sub-sources:

- energy use by commercial and institutional services (1A4a)
- residential energy use (1A4b)
- energy use by agriculture (mainly greenhouses), forestry and fisheries (1A4c).

Only stationary emissions are included in this source category. Emissions from mobile machinery are located in the transport category '*Other transportation'* (off road vehicles, 1A3e). Also, emissions by national fisheries are not reported here (under 1A4c), but are reported under '*International bunkers'*. By far most energy is used for room and water heating; some energy is used for cooling. The major fuel used in these sectors is natural gas.

Table 3.19. Trend of greenhouse gas emissions from the 'Other sectors' (unit: CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
a. Commercial/Institutional	5.9	10.3	9.4	10.6	10.1	8.6	9.1	7.6	7.7	6.7	7.9	8.8
b. Residential	19.8	21.6	19.5	20.6	19.6	21.2	24.8	20.8	18.8	19.3	19.6	20.4
c. Agriculture/Forestry/Fisheries	8.4	8.5	8.5	8.8	8.8	8.1	8.9	7.5	7.5	7.1	7.1	7.0
CH_4												
a. Commercial/Institutional	0.8	1.1	1.0	0.9	1.4	0.5	1.1	0.5	1.0	0.8	1.0	1.1
b. Residential	16.8	18.3	16.8	17.7	17.0	17.4	19.8	17.2	16.2	15.9	16.5	17.1
c. Agriculture/Forestry/Fisheries	2.6	2.7	2.7	2.8	2.8	2.5	2.8	2.4	2.4	2.2	2.2	2.2
N_2O												
a. Commercial/Institutional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b. Residential	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1
c. 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

The greenhouse gas emissions from the '*Other sectors'* are summarised in Table *3.19*. Obviously, CO_2 emissions from fuel combustion are the dominant source here whereas most methane emissions stem from the residential sector. The residential sector is also the largest subcategory of the three for CO_2 emissions. As can be observed from the temperature correction data presented in *Section 3.1.1*, in particular this source category is quite sensitive to weather conditions since the largest part of the fuel use in these sectors is for space heating. Also from *Table 3.19* we can observe that the emissions from the 'Other sectors' tend to vary considerably across years due to the variation of the winter weather over time requiring more or less space heating. However, we also need to recall that consistency over time of fuel combustion emissions for the years 1991-1994 is limited due to revision of the energy balances for other years in order to eliminate the statistical differences between apparent consumption and the sum of sectoral energy consumption. This did affect all source categories and thus may cause some inconsistencies in the time series (see previous NIR 2002 for more details on sectoral consequences in CO_2 emissions; Olivier *et al.*, 2002).

Nevertheless, from the table it can be observed that CO_2 emissions from the service sectors increased substantially over time (+50%), while emissions from the agriculture decreased by about 17% since 1990. The CO_2 emissions from the residential sector remain almost constant – apart from the fluctuations caused by weather variation. When looking at the trend of methane and nitrous oxide emissions, which primarily originate from the residential sector, it shows that these are fairly constant over time, except for some anomalies for methane for specific years.

Box 3.3. Sub-sources of 'Other sectors' and identification as key source or non-key source (IPCC method 2) (L = Level, T = Trend)

1A4	**CO_2**	**Emissions from stationary combustion : Other Sectors**	**Key (L,T1)**
1A	**CH_4**	**Emissions from stationary combustion: non-CO_2**	**Key (L2)**
1A	N_2O	Emissions from stationary combustion: non-CO_2	Non-key

In *Box 3.3* the key and non-key sources of the '*Other sectors'* are presented based on level, trend or both. Total CO_2 emissions of the '*Other sectors'* is a key source and since CO_2 sources larger than 1.5 Mton are level-key sources (see *Section 1.7*), all three subcategories are key sources. In addition, *total* CH_4 emissions collectively from all combustion sources are a key source. Since methane from fuel combustion is predominantly stemming from gas losses from cooking in the residential sector (1A4b), which are also higher in this source category due to biofuel combustion, this key source should actually be attributed to the residential sector only (1A4b).

The share of CO_2 emissions of the 'Other sectors' in the national CO_2-eq. total was about 16% in 1990 and in 2001, with the residential sector alone having a share of 9%; the shares of CH_4 and N_2O in the national total is very small (both about 0.5%).

3.2.4.2 Methodological issues

For calculation of greenhouse gas emissions country-specific methodologies are used, which are equivalent to the IPCC 1A4 Tier 1 method. The emission factors are based on country-specific data. Since the emissions are considered to be a key source for CO_2 (see *Section 3.1*), the present methodology complies with the *IPCC Good Practice Guidance* (IPCC, 2000). For a brief description of the methodology and data sources used see *Annex 2.1.* A full description of the methodology is provided in Spakman *et al.* (2003).

3.2.4.3 Uncertainty and time-series consistency

Please note that the energy consumption data for the total category *1A4 'Other sectors'* is much more accurate than the data for the three subsectors. In particular energy consumption by the commercial and - to a lesser extent - the agricultural subsectors are less accurate monitored than the residential sector. So trend conclusions for these subcategories should be treated with some caution. The uncertainty of this category is estimated to be 3% in annual emissions of CO_2; the uncertainty in CH_4 and N_2O emissions is estimated to be much higher (about 50% and 100%, respectively) (see *Section 1.7* for more details). However, we stress that in the uncertainty estimate for the fuel consumption data the same figure of 3% is used as for other stationary combustion sources (energy and industry sectors). In practice, it is likely that the uncertainty of statistics for the '*Other sectors'* is higher due to the residual character of the data for this sector: consumption per fuel type is 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 by trend analysis of sectoral data (so-called BAK and BEK datasets of annual surveys of the residential sector and LEI data for agriculture). Again, the remainder of total consumption by the 'Other sectors' is assumed to be the energy consumption by the commercial and non-commercial service sectors.

From this process, it is clear that in practice the uncertainty in energy statistics for these three subsectors will likely be higher than 3%, in particular for the service sectors. Here we also have to recall that the consistency over time of fuel data for the years 1991-1994 is limited. In fact, the changes in the energy consumption data due to the revision of the energy balances for other years in order to eliminate the statistical differences may serve as an indication of the generic data quality of the 'final' data for 1990 to 2000. In *Table 3.20* we show the effect of these revisions on CO_2 emissions, as presented in the previous NIR. If these changes are indeed indicative for the data quality, then the uncertainty in the uncertainty in total CO_2 emissions from this source category is about 7%, with uncertainty of the composite parts of 3% for the residential sector, 15% for the agricultural sector and 20% for the service sector. This indeed confirms the general conclusion that the uncertainty for this source category is higher than presently used in the overall uncertainty assessment; in particular for the service sector the uncertainty could be quite high, up to 20% or so. This should be taken into account when drawing conclusions about the emission trends in this source category.

Table 3.20. Effect of recalculation of CO_2 emissions due to the revision of the energy balances to eliminate statistical differences (Tg)

	Source category		**1990**	**1995**	**1996**	**1997**	**1998**	**1999**	**Changes up to (%)**
1A4a	Commercial/Institutional	new	6.4	9.2	9.0	7.6	7.7	6.6	
1A4a	Commercial/Institutional	old	7.1	9.4	10.9	8.6	9.2	8.5	
1A4a	*Commercial/Institutional*	*diff.*	*-0.7*	*-0.2*	*-1.9*	*-1.0*	*-1.5*	*-1.8*	*20%*
1A4b	Residential	new	19.8	21.2	24.8	20.8	18.8	19.3	
1A4b	Residential	old	19.8	20.6	24.0	20.1	19.1	19.1	
1A4b	*Residential*	*diff.*	*0.0*	*0.6*	*0.8*	*0.6*	*-0.3*	*0.2*	*3%*
1A4c	Agriculture/Forestry/Fisheries	new	8.4	8.1	8.9	7.5	7.5	7.1	
1A4c	Agriculture/Forestry/Fisheries	old	7.4	8.9	10.3	7.7	7.5	7.8	
1A4c	*Agriculture/Forestry/Fisheries*	*diff.*	*1.0*	*-0.8*	*-1.4*	*-0.2*	*0.0*	*-0.7*	*15%*
1A4	Total Other sectors	new	34.6	38.5	42.7	35.9	34	33	
1A4	Total Other sectors	old	34.3	38.9	45.2	36.4	35.8	35.4	
1A4	*Total Other sectors*	*diff.*	*0.3*	*-0.4*	*-2.5*	*-0.5*	*-1.8*	*-2.4*	*7%*

Source: NIR 2002 (Olivier *et al.*, 2002)

Time series consistency

Keeping the qualification of the uncertainty in emissions in mind, we now look at the consistency of the emission trends. The 1990-2001 trend of CO_2 emissions shows an increase of 2 Tg or 6%. The main contributor to this increase was the service sector with an increase of about 3 Tg, which is equivalent to about 50%. Half of this increase was compensated by a 17% decrease in the agricultural sector. Methane emissions follow similar trends.

To be able to analyse the effect over time of the trend in *anthropogenic* activities and implemented policies, a temperature correction term has been calculated for all CO_2 emissions from gas combustion that tries to filter out the interannual changes due to variation of weather. Resulting emissions trends for the '*Other sectors'* with this correction incorporated are presented in *Table 3.21*. This method is discussed in more detail in *Section 3.1.1*, where also the time series with the CO_2 correction terms is presented. This temperature correction method aims at compensating for anomalous mild or cold years by using heating-degree days as input for the calculation. As will be presented in the next section, this correction is to be considered as a *proxy* for the weather influence, since it is a simple method and space heating behaviour of the public will be influenced by more factors than only the average outside temperature.

Table 3.21. Temperature-corrected CO_2 emissions from Other sectors (1A4) (in Tg)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Residential sector	22.8	21.8	21.5	21.2	21.2	22.4	22.8	21.9	20.4	21.6	21.9	21.4
Commercial/Institutional	6.9	10.4	10.3	10.9	10.9	9.2	8.1	8.1	8.4	7.7	8.9	9.8
Agriculture and forestry	9.8	8.5	9.3	9.0	9.5	8.6	8.0	8.0	8.2	8.0	8.0	7.3
Total	**39.5**	**40.7**	**41.1**	**41.0**	**41.7**	**40.2**	**38.9**	**38.0**	**37.0**	**37.3**	**38.8**	**38.5**

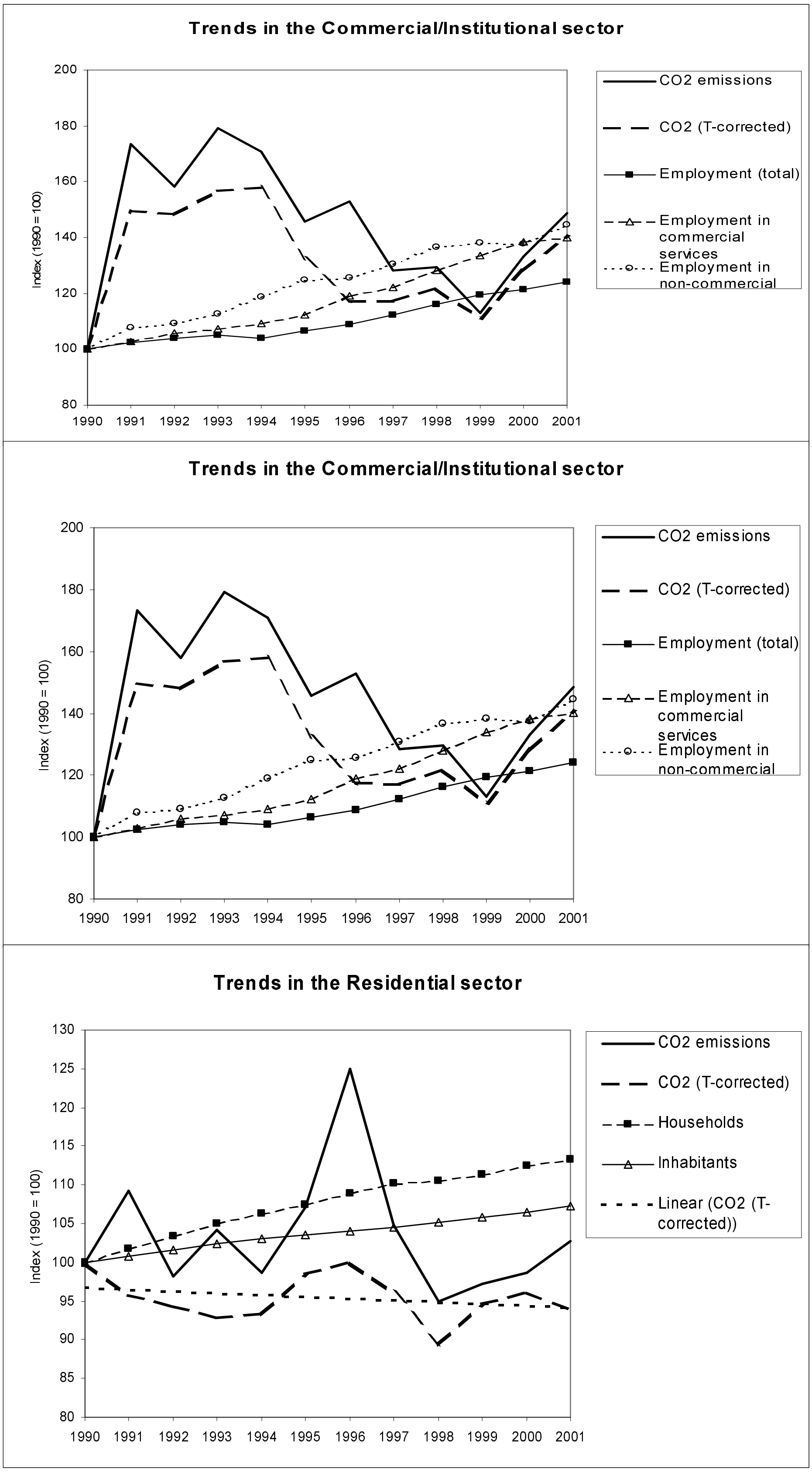

Figure 3.9. Trend analysis of CO_2 emissions from the 'Other sectors' (1A4): residential (top); commercial/institutional services (middle); agriculture (bottom)

In *Figure 3.9* the actual trend data for CO_2 of the three subsectors are compared with temperature corrected emissions and basic activity indicator trends of the residential, service and agricultural sectors. From these graphs we can draw the following conclusions:

- The temperature correction is indeed a *proxy* for the weather influence, since it shows that although the largest interannual variation is removed by the correction, the resulting time series is still not very smooth. This is in particular not the case for the residential sector, where the primary data quality is assumed to be rather good. The year 1996 clearly shows as a particular cold year, whereas other years are relatively warm (see *Section 3.1.1* for details).
- In the residential sector CO_2 emissions increased by 3% since 1990, but taking into account a temperature correction, the structural, anthropogenic trend shows a decrease of 6% in this period. This can be compared with the number of households that increased by 13% since 1990. The number of residential dwellings increased similarly by 14% in the period 1990-2000 (data for 2001 are not available yet), but their energy use has decreased by 4% over this period. This decrease is mainly due to improved insulation of dwellings and increased efficiency of heating apparatus (increased use of high-efficient boilers for central heating). In 2001 this decrease continued.
- In the commercial and institutional service sector CO_2 emissions increased by about 50% since 1990, but taking into account a temperature correction, the structural, anthropogenic trend shows a somewhat lower increase of 40% in this period. The much higher emissions in the 1991-1994 period, both without and with temperature correction, may be a consequence of the generic uncertainty in this particular source category as discussed above combined with an artefact for these years due to not revision of the energy balances for these years. Therefore the emission trend presented here should be considered as not very robust.
  The commercial and institutional sector has grown strongly during this period: the amount of manpower (in man-years) increased by 32% in the period 1990-2000, while their energy consumption increased by 28% in this period. This increase is roughly compatible with the structural increase of about 40% of the emissions. As can be seen from *Tables 3.19* and *3.20* the preliminary estimate for 2001 shows a considerable extra increase for this sector of about 10% (about 1 Mton), but the trend indicator data do not confirm this.
- In the agricultural sector CO_2 emissions decreased by 17% since 1990, but taking into account a temperature correction, the structural, anthropogenic trend shows a decrease of even 25% in this period. This is mainly due to energy conservation measures in the greenhouse horticulture, which account for approximately 85% of the primary energy use of the agricultural sector. Space heating and artificial lighting are the dominant uses here. This sector has improved its energy efficiency in the past decade significantly (Van Harmelen *et al.*, 2000). The total area of heated greenhouses increased by 8% since 1990 and now occupies over 95% of the total area of greenhouses. In particular cultivation of flowers and plants showed a large in areas of 15%. Thus we may conclude that heated greenhouses have reduced their energy consumption, although their surface area increased by 8%, and physical production only decreased by 5% over this period (LEI/CBS, 2002).
  We should note, however, that included in the CO_2 emissions from the agricultural sector is fuel consumption for privately owned co-generation facilities, which may also provide electricity to the public grid.

3.2.5 Others (CRF category 1A5)

3.2.5.1 Source category description

There are two methods to collect information on the national energy use. One method is the national energy consumption, which is the sum of indigenous production plus import minus export minus bunkers plus/minus stock change. The other method is a bottom-up sum of all sectoral energy demands. In theory both methods should result in the same value, but as statistical observations are never 100% accurate, in practice there is often a (small) difference between the two methods. The fuel use related tot these *statistical differences* was included in the national inventory reports as a source of CO_2, since it is assumed that the associated fuel use is real and not accounted for in individual end use sectors. Usually, the statistical differences between supply and demand was smaller than 2%, but became much larger in the second half of the 1990's. Therefore the Energy Statistics Division of Statistics Netherlands (CBS) started a project to eliminate this statistical difference which resulted in 2001 in a total revision of the national energy balances for all years from 1990 onwards, except for 1991-1994. So, no more CO_2 emissions related to statistical differences are reported in the inventory other then for the years 1991-1994 (*Table 3.22*).

At present, there are no plans to revise the energy balances for the years 1991-1994 to eliminate the statistical differences since the CO_2 emissions related to the statistical differences for these years are relatively small compared to more recent years. Furthermore, revision of the energy balances of these years is expected to be much more difficult than the revisions made due to a major change in the sector classification in the Dutch statistics since 1993.

Table 3.22. CO_2 emissions from statistical differences 1991-1994

Fuel type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
A. Energy (PJ)												
Coal		0	-4	9	-9							
Oil		25	15	26	24							
Natural gas		-14	-20	-20	-8							
B. CO_2 emissions (Tg)												
Coal		0.0	-0.4	0.8	-0.8							
Oil		1.8	1.1	1.9	1.8							
Natural gas		-0.8	-1.1	-1.1	-0.4							
Total	**0.0**	**1.0**	**-0.4**	**1.6**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Source: CBS, 1990-1999 (NEH/Energy Monitor).

3.2.6 Comparison of the Sectoral Approach with the Reference Approach

The *IPCC Reference Approach* (RA) for CO_2 from energy use uses apparent consumption data per fuel type to estimate CO_2 emissions from fossil fuel use. This can be used as a means of verification of the sectoral total CO_2 emissions from fuel combustion (IPCC, 2000). As a result of improved quality assurance an error in the (automatic) calculation of the CO_2 emissions in the *Reference Approach* was detected. These error corrections resulted in differences of up to 2% compared to last year's calculation. More details on the calculation and the recalculation differences can be found in *Annex 4*.

In *Table 3.23* the results of the *Reference Approach* calculation are presented for 1990-2001 and compared with the official national total emissions reported as fuel combustion (source category 1A). The annual difference varies between -1.6% for 1992 and +4.2% for 1997 with an average of 0.4%. Presently, the difference in 1990 is 2%. The 1990-2001 trend differs by 3%-point: 13% for the *National Approach* (NA) (= sum of sectoral emissions in source category 1A) and 10% for the *Reference Approach*. The *Reference Approach* (based on national energy balance data) shows an 12% increase in emissions from liquid fuels and 16% increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period by 3%.

Table 3.23. Comparison of CO_2 emissions: Reference Approach (RA) versus National Approach (Tg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001[1)]
Reference Approach												
Liquid fuels	52.3	51.4	52.4	53.5	54.3	54.6	55.4	54.9	55.4	56.3	56.6	58.4
Solid fuels	34.7	32.1	31.3	32.8	33.2	35.9	34.4	33.6	34.1	30.4	31.9	33.7
Gaseous fuels	72.5	80.2	77.7	80.1	77.9	79.6	88.9	83.5	82.9	80.6	81.7	83.9
Total RA	**159.6**	**163.7**	**161.4**	**166.4**	**165.3**	**170.1**	**178.7**	**172.0**	**172.4**	**167.3**	**170.1**	**175.9**
National Approach	**156.5**	**165.5**	**164.0**	**166.4**	**167.1**	**169.2**	**176.9**	**165.0**	**170.5**	**166.8**	**170.7**	**176.7**
Difference	*2.0%*	*-1.1%*	*-1.6%*	*0.0%*	*-1.1%*	*0.5%*	*1.0%*	*4.2%*	*1.2%*	*0.3%*	*-0.3%*	*-0.5%*

1) Preliminary data.

We stress that the results of the *IPCC Reference Approach* are for the Netherlands rather sensitive for the carbon content of crude oil input figures due to the relatively high amounts of crude oil refined and oil products exported. However, the general picture of NA/RA comparison results after the recalculation does not change substantially, although the largest differences found last year in the base year 1990 and in 1997 still increased somewhat. In general there are several reasons for differences in the two approaches, some are country-specific other are inherent to the comparison method itself (see *Annex 4*).

Specific reasons that cause the large discrepancy of 4% in 1997 can not be given. However, we do note the relative weakness of the data collection from large companies since 1996 as discussed in *Section 1.2* and the large revision in the energy statistics, in particular for 1997 described in the previous NIR (Olivier *et al.*, 2002).

3.2.7 Feedstocks and non-energy use of fuels

3.2.7.1 Source category description

Emissions from the use of feedstocks are all allocated under categories 1A2 '*Manufacturing Industry and Construction'*. Most feedstocks are used in the iron and steel industry and the chemical industry. The feedstocks of oil and gas are considered a key source for CO_2 emissions. The share of CO_2 emissions in the national total was 5% in 1990 and 6% in 2001 (see *Table 3.24*).

A fraction of energy carriers is stored in such products as plastics or asphalt. The non-stored fraction of the carbon in the energy carrier or product is oxidised, resulting in carbon dioxide emissions, either during the use of the energy carriers in the industrial production (e.g. fertiliser production), or during the use of the products (e.g. solvents, lubricants), or in both (e.g. monomers).

Table 3.24. Allocation of CO_2 from Non-energy use of energy carriers (in Tg) (according to CRF documentation box)

Allocation	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total; of which:	14.1	1.8	3.2	3.0	3.1	13.9	19.5	23.3	22.8	23.5	21.7	21.7
- Industrial processes [1)] and waste combustion [2)]	11.9	0.0	0.0	0.0	0.0	11.1	16.6	20.4	19.9	20.3	18.0	18.0
- Chemical feedstocks [1A2c]	2.1	1.8	3.2	3.0	3.1	2.8	3.0	2.8	2.8	3.2	3.7	3.7

1) The Netherlands reports this still under fuel combustion by manufacturing industries (1A2).

2) The Netherlands reports this under fuel combustion by the energy sector (1A1a).

3.2.7.2 Methodological issues

For the emissions of feedstocks country-specific methodologies are used with country-specific emission factors (see *Annex 2.1*). A full description of the methodology is provided in Spakman *et al.* (2003).

3.2.7.3 Uncertainty and time-series consistency

The uncertainty of CO_2 emissions from non-energy use of natural gas and coal (products) is estimated to be about 10% of annual emissions. The uncertainty of CO_2 emissions from use as chemical feedstock of oil products is estimated to be 50% in annual emissions (see *Section 1.7* for more details).

The industry in the Netherlands has a relatively large petrochemical industry, which shows up in actual CO_2 emissions associated with non-energy use of oil products and natural gas. For information we show in *Tables 3 .25* and 3.*26* the CO_2 emitted and stored in feedstock products as included in the *IPCC Reference Approach* calculation for CO_2. We stress, however, that the amounts actually included in the sectoral approach, which are to a large extent based on reports by individual companies, may differ substantially. According to the *Reference Approach* calculation the feedstock emissions can vary substantially from year to year.

Between 1990 and 2001 the emission of CO_2 due to fossil fuel use by industry has decreased from 41.9 to 40.2 Tg (-4%) (*Table 3.7*), which is dominated by the chemical industry. This includes actual emissions of CO_2 from feedstock use of energy carriers of 8.3 and 9.9 Tg, respectively (*Table 3.26*).

Table 3.25. Trend in CO_2 emitted by feedstock use of energy carriers according to the IPCC Reference Approach (Gg)*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Liquids	2 947	4 207	3 835	3 065	3 182	3 344	3 073	3 425	3 404	3 796	4 251	4 251
Solids**	569	416	417	372	383	386	433	417	408	449	414	435
Gaseous	4 803	5 144	5 102	4 866	5 172	5 510	5 283	5 667	5 390	5 345	5 287	5 287
Total	**8 319**	**9 767**	**9 353**	**8 303**	**8 737**	**9 240**	**8 789**	**9 510**	**9 203**	**9 590**	**9 952**	**9 973**

* Using country-specific carbon storage factors.

** Due to change in definition of feedstock and energetic use of coke and coal in iron and steel production, data for 1994 and 1999-2001 have been recalculated according to the old definition.

Table 3.26. Trend in CO_2 storage in feedstocks according to the default IPCC Reference Approach (Gg)*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Liquid	13 141	18 776	16 790	14 265	14 536	13 916	12 563	14 242	13 857	15 801	17 769	19 006
Solid fuels	610	544	550	702	558	601	632	576	594	157	224	321
Gaseous	534	534	567	541	575	612	587	630	599	594	587	518
Total	**14 285**	**19 855**	**17 907**	**15 508**	**15 669**	**15 129**	**13 781**	**15 448**	**15 050**	**16 552**	**18 580**	**19 845**

* Using country-specific carbon storage factors.

3.2.8 International bunker fuels

3.2.8.1 Source category description

In *Table 3.27* both energy consumption and CO_2 emissions from international air transport and international shipping are presented per fuel type. In 2001, bunker emissions of CO_2 have increased by about 17.7 Tg or 45% compared to 1990. In particular international aviation has shown a very high growth of about 120%, whereas international shipping increased by 35%. Due to the much higher growth of international air traffic its share in international bunker emissions increased from about 11% in 1990 to about 17% in 2001.

3.2.8.2 Methodological issues

Marine bunker sales include fuel deliveries to professional domestic inland shipping. Besides, bunker sales include fuel deliveries to deep-see fishing boats whereas the *Revised IPCC Guidelines* prescribe that emissions from combustion of fuels delivered to both domestic inland shipping and fishing boats have to be considered as national emissions. In a subsequent submission this incompliance will be eliminated. At present a few per cent of total marine and aviation emissions of CO_2 are reported as domestic and included in national total greenhouse gas emissions (*Table 3.28*). At present no non-CO_2 emissions have been reported because of a lack of country-specific emission factors.

Table 3.27. International bunkers: energy consumption (PJ) and related CO_2 emissions (Tg) 1990-2001

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy consumption												
Marine bunkers	**463**	**476**	**478**	**495**	**474**	**478**	**488**	**518**	**522**	**539**	**571**	**625**
- heavy fuel oil	370	396	398	411	386	377	393	429	429	448	475	524
- gasoline	89	80	80	84	88	97	90	84	88	86	88	94
- lubricant	4	ND	ND	ND	ND	4	5	5	5	5	6	7
Aviation Bunkers	**61**	**68**	**81**	**89**	**92**	**105**	**113**	**122**	**133**	**138**	**138**	**138**
- jetfuel (kerosene)	61	68	81	89	92	105	113	122	133	138	138	135
- aviation gasoline	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Total Bunkers	**524**	**544**	**559**	**584**	**566**	**586**	**601**	**639**	**655**	**677**	**707**	**763**
Emissions												
Marine bunkers	**35.3**	**36.3**	**36.5**	**37.8**	**36.1**	**36.6**	**37.2**	**39.5**	**39.8**	**41.1**	**43.4**	**47.6**
- heavy fuel oil	28.5	30.5	30.7	31.7	29.7	29.0	30.3	33.0	33.0	34.5	36.6	40.3
- gasoline	6.5	5.8	5.9	6.1	6.4	7.1	6.6	6.1	6.4	6.3	6.4	6.8
- lubricant	0.3	ND	ND	ND	ND	0.3	0.4	0.4	0.4	0.4	0.4	0.5
Aviation Bunkers	**4.5**	**5.0**	**5.8**	**6.5**	**6.7**	**7.7**	**8.3**	**8.9**	**9.7**	**10.0**	**10.0**	**9.8**
- jetfuel (kerosene)	4.5	5.0	5.8	6.5	6.7	7.7	8.3	8.9	9.7	10.0	10.0	9.8
- aviation gasoline	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Total Bunkers	**39.7**	**41.3**	**42.3**	**44.3**	**42.8**	**44.3**	**45.5**	**48.4**	**49.5**	**51.2**	**53.5**	**57.4**

Source: CBS, 1990-2001 (NEH/Energy Monitor, Table 1.1; revised data).
N.B. Aviation gasoline is included under jetfuel; ND = No Data.

Table 3.28. Allocation of marine and aviation fuel consumption: domestic vs. international (from CRF Documentation box)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Marine fuel consumption:												
- Domestic	3%	2%	3%	3%	2%	3%	2%	2%	2%	2%	2%	2%
- International	97%	98%	97%	97%	98%	97%	98%	98%	98%	98%	98%	98%
Aviation fuel consumption:												
- Domestic	10%	6%	3%	2%	3%	4%	3%	3%	4%	4%	3%	2%
- International	90%	94%	97%	98%	97%	96%	97%	97%	96%	96%	97%	98%

3.2.8.3 Uncertainty and time-series consistency

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

3.2.8.4 Source-specific planned improvements

The inclusion of commercial ships with national destinations and national fishing boats in bunker fuel use and international bunker emissions results in an overestimation of international transport emissions. In 2003 actions have been started to correct the calculation for these two sources to get in accordance with *IPCC Good Practice*.

Also, at present no non-CO_2 emissions are being calculated for international transport. A recent study on CH_4 and N_2O factors for international shipping showed that the IPCC default values may be outdated (Denier van der Gon *et al.*, 2002). However, since the main purpose of reporting international bunker emissions is to get a complete picture of total anthropogenic emissions, it has been decided to use the IPCC default values to estimate these emissions. The results of this calculation will be included in the next NIR.

3.3 Fugitive emissions from solid fuels, oil and natural gas [CRF category 1B]

3.3.1 Source category description

Fugitive emissions in this source category are from the production of oil and gas, the transmission and distribution of gas and from oil refining (*Table 3.29*). Methane emissions from gas production and from gas distribution are key sources according to *Box 3.4*. Emissions from oil production and refineries have been identified as non-key sources.

In the Netherlands there are no fugitive emissions from solid fuels because no coal mining and handling activities [1B1] take place anymore since the last mine closed in the early 1970's. In addition, we recall that emissions from coke production are included in fuel combustion emissions from the iron and steel industry (1A2a), since these are reported in an integrated and aggregated way (see *Section 3.2.2*).

Table 3.29 Fugitive emissions from oil and gas (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
a. Oil	0.2	0.0	0.0	0.0	0.0	0.7	0.7	0.7	1.3	1.4	1.4	1.5
b. Natural gas	0.1	0.0	0.0	0.0	0.0	0.2	0.3	0.3	0.3	0.1	0.2	0.2
c. Venting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
d. Other	0.0	0.5	0.4	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH_4												
a. Oil	0.3	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.3	0.3	0.0	0.0
b. Natural gas	178.5	0.0	0.0	0.0	0.0	170.1	188.1	156.1	146.3	144.0	130.9	134.3
c. Venting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
d. Other	0.0	188.1	163.1	158.0	168.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O												
a. Oil												
b. Natural gas												
c. Venting												
d. Other					0.4							

Box 3.4. Key source identification in the fugitive emissions sector using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

1B2	CO_2	Misc. CO_2, of which 2/3 part in 1B2	Non-Key
1B1	CH_4	Coal mining	Not Occurring
1B1	all	Coke production	Included in 1A2
1B2	**CH_4**	**Fugitive emissions from oil and gas: gas production**	**Key (L,T1)**
1B2	**CH_4**	**Fugitive emissions from oil and gas: gas distribution**	**Key (L,T1)**
1B2	CH_4	Fugitive emissions from oil and gas operations: other	Non-key

Fugitive emissions from oil and natural gas [1B2]

The CO_2 emissions from category 1B2 comprise non-combustion emissions from refineries, flaring and venting emissions from oil and gas production and compressor emissions from gas transport and distribution networks. The increasing trend is due to a large increase in non-combustion emissions as reported by refineries, which have by far the largest share in this subcategory. However, this does not necessarily correspond with a large rise in CO_2 emissions since the separation between combustion and process emissions as officially reported by refineries varies substantially over time.

The fugitive emissions are mostly CH_4 emissions that originate from production, transmission and distribution of natural gas. Production and distribution of gas are specified as key sources for the emission of CH_4. The share of these sources in the CH_4 emissions of the national greenhouse gas is about 1-2% in the period 1990-2001. For the other emissions these categories have a small share in the national total and are no key-sources.

Only for 1994 some N_2O emissions are reported here. This will probably be due to an incorrect source allocation or some other error in the ER-I emissions.

3.3.2 Methodological issues

For the emission estimation of fugitive CH_4 emissions from oil and gas, country-specific top-down emission estimates comparable with the IPCC Tier 1 method are used. The emission factors for CH_4 from gas flaring and venting are country-specific, mean values from a study that combined available literature data and a few measurements. The present method does not fully comply with the *IPCC Good Practice Guidance*; the data for production of oil and gas can not be divided into the IPCC categories exploring, production/processing, venting and flaring. Thus, only totals for the production of oil and gas are available which are presented in the CRF under the category 1B2b *'Production/processing of gas'*. A full description of the methodology is provided in Spakman *et al.* (2003).

The present Tier 1 method for gas distribution reflects interannual changes in domestic gas consumption – due to its use as activity data – which are not real variations in gas leakage emissions. Since CH_4 emissions from gas production and gas distribution are considered to be key sources (see *Box 3.4*), the present Tier 1 methodology does not comply with the *IPCC Good Practice Guidance* (IPCC, 2000). Note that CO_2 emissions from fugitive sources are not a key source.

Fugitive emissions from refineries in category 1B2 are provided by the annual environmental reports of the Dutch companies. However, as mentioned above, the separation between combustion and process emissions as reported by refineries varies substantially over time.

3.3.3 Uncertainty and time-series consistency of fugitive emissions

The uncertainty in annual CO_2 emissions from this source category is estimated to be about 50%. The uncertainty in methane emissions from gas production and gas distribution is estimated to be 25% and 50% in annual emissions, respectively (see *Section 1.7* for more details).

The emission trends are summarised in *Table 3.30.* As discussed above, the strong increase in non-combustion emissions from refineries are probably due to inconsistent reported splits in combustion and non-combustion emissions from refineries. In the period 1990-2001 the estimated emission of CH_4 decreased from 179 to 134 Gg per year (-25%).

Table 3.30. CH_4 emissions of production of oil and gas and the transmission and distribution of gas 1990-2001 (Gg).

Source category	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Production/processing	100	101	90	86	102	95	104	87	81	82	70	69
Transmission	6	7	7	7	6	6	7	5	4	4	3	4
Distribution	73	81	75	78	69	70	78	65	62	59	58	61
Total	**179**	**189**	**172**	**171**	**177**	**170**	**188**	**156**	**146**	**144**	**131**	**134**

Note: For 1991-1994 these data differ from the figures in the CRF files, which are old, original submissions to the emission registration system for these reporting years. The CH_4 emissions in the CRF reported in the CRF for subcategory 1B are listed in *Table 3.29* and include refineries reported under 1B2d *'Other'*.

Table 3.31. Activity data of production, transmission and distribution of oil and natural gas, 1990-2001 (source: EZ, 2002; Gasunie, 2001 and 2002)

Source	**Unit**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Oil production	mln m^3	3.99	3.67	3.21	3.01	4.02	3.21	2.65	1.48	2.03	1.89	1.71	1.63
Gas production	PJ	2292	2608	2628	2659	2482	2478	2839	2590	2529	2280	2144	2287
Gas transmission	PJ	2292	2608	2652	2738	2598	2630	2968	2660	2527	2385	2310	2560
Gas distribution	PJ	657	759	731	784	717	757	879	762	763	725	715	756

Table 3.32. Development of the natural gas distribution pipeline network (in 1000 km) (from CRF documentation box)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Length of network	99.3	101.1	103.1	105.0	107.7	108.3	109.9	111.6	113.6	116.1	117.5	120.0

This substantial emission reduction is not the result of a decrease in activity data: both amounts of gas distribution and gas transmission increased, while gas production decreased only slightly, although there was a movement towards more offshore production of gas and less onshore production (*Table 3.31*). Emission reductions are mainly the result of the implementation of cost-effective measures to prevent venting of natural gas during production (NOGEPA, 1996, 1999; NAM, 1999a, 1999b). These measures have been applied in accordance with the *Netherlands Emission Directives* for the production of natural gas and oil (NER, 1996).

The gas leakage from distribution networks is assumed to decrease because of the gradual replacement of old cast iron pipes by modern materials. *Table 3.32* shows the trend in the total length of the gas distribution network. In *Figure 3.10* the trends of the production and transmission of natural gas and related CH_4 emissions are shown (including emissions from oil). The peak emissions in 1996 are due to the relatively cold winter, in which the amount of gas consumption and production was much higher than in other years.

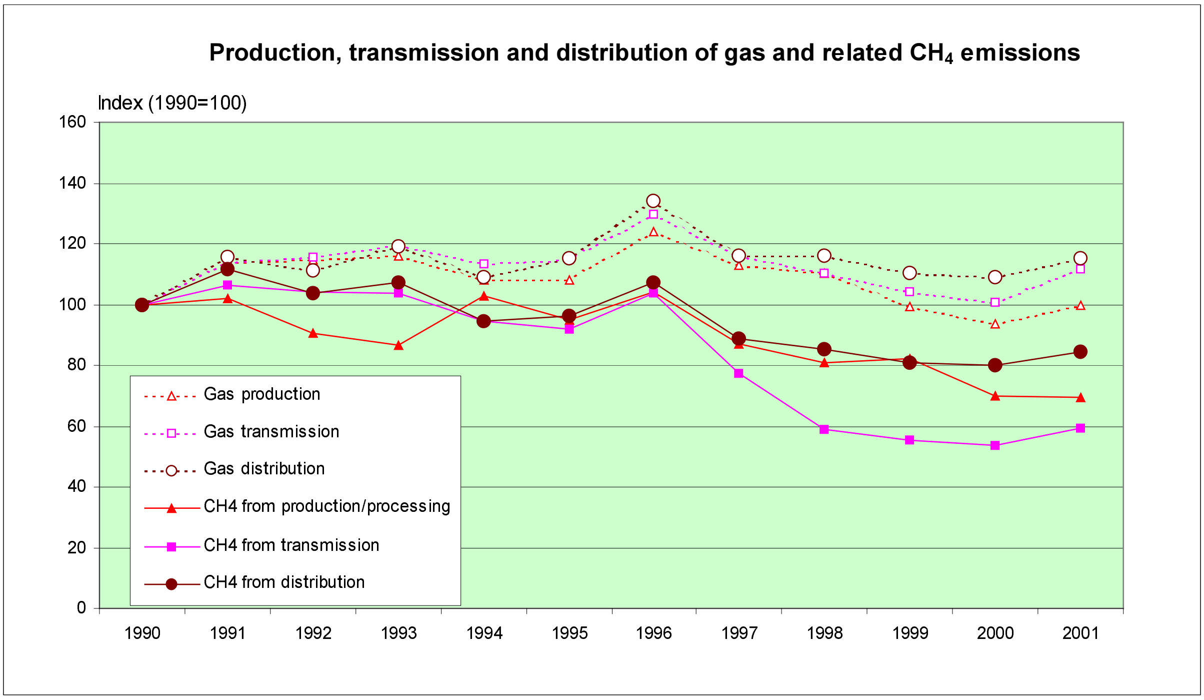

Figure 3.10. Trends in production, transmission and distribution of natural gas and oil and related CH_4 emissions in the period 1990-2001

3.3.4 Source-specific planned improvements

As of 2003, al oil and gas production companies operating in the Netherlands will submit a *annual environmental report* (MJV) with a detailed format for reporting of greenhouse gas emissions. The rationale of this new inventory structure of company data is to collect enough detailed information to be able to produce a bottom up (Tier 3) emission inventory of this source category for recent years, that can be reported in the next NIR.

4. INDUSTRIAL PROCESSES [CRF sector 2]

4.1 Overview of sector

This sector comprises all *non-combustion* emissions from manufacturing industry activities including construction and *all* emissions from the use of the F-gases HFCs, PFCs and SF_6 (thus including use in other sectors). Non-combustion emissions from the energy sector are reported under IPCC category 1B 'Fugitive emissions' with the exception of CO_2 from flue gas desulphurisation which we report under category 2G. The sector Industrial Processes consists of the following subsectors:

- Mineral products (2A)
- Chemical industry (2B)
- Metal production (2C)
- Other production (i.e. Pulp & paper and Food & drinks) (2D)
- Production of halocarbons and SF_6 (2E)
- Consumption of halocarbons and SF_6 (2F)
- Other industrial (2G).

The trends in greenhouse gas emissions from industrial processes are summarised in Table *4.1*. No greenhouse gas emissions are reported for the '*Other production'* subsector (2D). Also no CO_2 emissions are reported for the chemical industry (2B) because all feedstock emissions are reported in the energy sector (1A2). Essentially the same holds for metal production (2C), of which CO_2 from the use of coke as reducing agent is also reported in the energy sector (see *Section 3.2.2*). In addition, no methane emissions from metal production are reported.

HFC and PFC emissions from the use of these compounds have increased substantially over time, as a result of substitution for traditional (H)CFCs and halons. The Netherlands has a few industries where F-gases are used or produced as by-product:

- HFC-23 is emitted at one HCFC-22 production facility;
- PFCs are emitted by two primary aluminium smelters;
- PFCs (and SF_6) are used at one semiconductor manufacture location;
- SF_6 is used at one production facility of Gas Insulated Switchgear (GIS).

In addition, there are other, more diffuse, industries and service sectors where F-gases are used. Total F-gas emissions have been strongly reduced due to a substantial reduction of by-product emissions: an afterburner was installed at the HCFC-23 production plant in 1998 and the switch from side feed to point feed technology at one of the two aluminium smelters in 1998.

Box 4.1 Key source identification for category 2 (industrial processes) using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

2A	CO_2	Emissions from cement production	Non-key
2G	CO_2	Other industrial: CO_2	Non-key
2A	CO_2	Emissions from lime consumption	Non-key
2B	CO_2	Chemical industry: feedstock use / non-energy use	Included in 1A2
2C	CO_2	Metal production: steel production; aluminium production	Included in 1A2
2G	CH_4	Other industrial: CH_4	Non-key
2B	**N_2O**	**Emissions from nitric acid production**	**Key (L,T1)**
2B	N_2O	Other: N_2O	Non-key
2C	**F-gas**	**PFC emissions from aluminium production**	**Key (L,T1)**
2E	**F-gas**	**HFC-23 emissions from HCFC-22 manufacture**	**Key (T)**
2E	F-gas	HFC by-product emissions from HFC manufacture	Non-key
2F	**F-gas**	**Emissions from ODS substitutes: HFC**	**Key (T1,L2)**
2F	F-gas	PFC emissions from PFC use	Non-key
2F	**F-gas**	**SF_6 emissions from SF_6 use**	**Key (L2)**

We recall that for 1991-1994 no recalculations or allocation improvements have been made in past years for most source categories that are based on individual company reports (the part of the national pollutant emission register called 'ER-I') (see *Section 1.2*). As a consequence, consistency over time of CO_2 and CH_4 emissions at subcategory level is limited. These areas have been indicated shaded (in yellow colour) in the table, where most subcategory emissions are reported under '*Other*' (2G).

In *Box 4.1* specific sources in this category are listed and characterised as key or non-key source. The N_2O emission from nitric acid production is a major key source, both in terms of level and trend. Its share of N_2O emissions in the national greenhouse gas total is presently 2.4% (and 2.9% in the base year 1990). Of the F-gases, both by-product sources and the use of HFCs and of SF_6 are identified as key sources.

Table 4.1. Trend in greenhouse gas emissions from industrial processes (category 2) (CO_2 in Tg; CH_4 and N_2O in Gg; F-gases in 1000 kg)

Gas/subcategory	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
2A. Mineral products	1.1	1.1	0.7	1.1	1.1	1.1	0.9	1.1	1.0	1.0	0.9	0.9
2B. Chemical industry	-	-	-	-	-	-	-	-	-	-	-	-
2C. Metal production	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2D. Other production [1)]	-	-	-	-	-	-	-	-	-	-	-	-
2G. Other	0.6	0.4	0.6	0.2	0.4	0.3	0.8	0.7	0.3	0.3	0.3	0.3
CH_4												
2A. Mineral products	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2B. Chemical industry	3.0	0.0	0.0	0.0	0.0	2.5	5.2	2.5	2.2	2.5	1.4	1.3
2C. Metal production	-	-	-	-	-	-	-	-	-	-	-	-
2D. Other production [1)]	-	-	-	-	-	-	-	-	-	-	-	-
2G. Other	0.0	3.5	3.7	4.9	5.3	0.0	0.1	0.1	0.1	0.0	0.0	0.0
N_2O												
2B. Chemical industry	24.4	24.7	24.9	26.7	25.5	24.3	24.2	24.2	24.1	23.1	23.0	21.2
B2. Nitric acid production	20.4	20.7	20.9	22.7	21.5	20.3	20.2	20.2	20.1	19.1	19.0	17.2
B3. Adipic acid production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B5. Other	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
HFCs												
2E. By-product HCFC-22 prod												
HFC-23	379	295	378	423	537	492	589	573	666	294	207	38
2F. From Use												
HFC-23	0	0	0	0	0	0	0	0	0	0	0	0
HFC-32	0	0	0	0	0	2	0	3	1	0	1	12
HFC-125	0	0	0	0	0	4	9	16	36	46	62	79
HFC-134a	0	0	18	12	93	181	435	687	710	746	629	492
HFC-152a	0	0	10	29	24	18	25	0	0	0	22	7
HFC-143a	0	0	0	3	6	2	35	13	36	37	78	46
HFC unspecified	0	0	0	7	20	1	21	204	136	74	55	30
PFCs												
2C. By-product aluminium prod												
CF_4	301	301	258	260	228	223	247	261	195	154	160	155
C_2F_6	48	48	41	41	38	38	39	40	39	35	38	34
2F. From use												
PFC unspecified	4	5	5	6	7	8	9	11	12	14	16	16
SF_6												
2F. From use												
SF_6	8	4	4	5	6	12	12	13	12	11	11	12

[1)] Pulp & paper and Food & drinks.

In the next sections a description of these subcategories and their source categories will be given, per main category, except for the minor sources listed in *Table 4.1*:

- CH_4 emissions from mineral products (2A) (only 0.1 Gg);
- CH_4 emissions from the chemical industry (2B) (only about 2 Gg);
- CO_2 emissions from metal production (2C) (only 0.02 Tg or smaller);
- CH_4 emissions from other industries (2G) (about 5 Gg).

4.2 Mineral products (2A)

4.2.1 Source category description

The subsector '*Mineral products*' (2A) consists of the sources specified as non-key source in *Box 4.1.* Its share of CO_2 emissions in the national greenhouse gas total was 0.6% in 1990 and 0.5% in the last reported year.

4.2.2 Methodological issues

For both source categories for CO_2 country-specific methodologies are used. The CO_2 emissions from the source category '*Cement clinker production*' are based on (measured) data reported by producing companies. We note that CO_2 emissions from cement production are correlated to clinker production, not cement production. The Netherlands import a large fraction of the cement clinker used for cement production, so comparison with emission factors based on cement production would give a wrong picture.

Since the emissions are considered to be no key source for CO_2, the present level of methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). A full description of the methodology is provided in Spakman *et al.* (2003).

4.2.3 Uncertainties and time-series consistency

The uncertainty in CO_2 emissions from cement production is estimated to be about 10% in annual emissions (see *Section 1.7* for more details).

Table 4.2 provides an overview of the trend in CO_2 emissions from the subcategories cement clinker production and lime use. The emissions remained rather constant in this period, because no measures were taken to control these emissions.

Table 4.2. Emissions of CO_2 from mineral products (2A) 1990-2001 (Tg)

Subsource	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
2A1. Cement clinker production	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.4	0.4
2Ax. Lime use for mineral products	0.7	0.7	0.3	0.7	0.7	0.8	0.6	0.7	0.6	0.5	0.5	0.5
Total	**1.1**	**1.1**	**0.7**	**1.1**	**1.1**	**1.1**	**0.9**	**1.1**	**1.0**	**1.0**	**0.9**	**0.9**

4.3 Chemical industry (2B)

4.3.1 Source category description

The subsector '*Chemical industry*' (2B) consists of the sources specified as key or non-key source in *Box 4.1*. Its share of N_2O emissions in the national N_2O total was 47% in 1990 and 40% at present (2.4% in the national greenhouse gas total). The most important industrial non-combustion process in the Netherlands with associated N_2O emissions is nitric acid production; no adipic acid manufacture occurs in the Netherlands. However, in the Netherlands some other industrial process sources of N_2O were identified and included in this subsector (caprolactam production, others).

We recall that all CO_2 emissions due to non-energy use are reported under category 1A 'Fuel combustion', subsector 1A2c '*Chemical industry*'.

4.3.2 Methodological issues

For source category '*Nitric acid production*' the IPCC Tier 2 method for N_2O is used. The emission factors are based on plant specific measured data. Since the emissions are considered to be a key source for N_2O, the present methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). A full description of the methodology is provided in Spakman *et al.* (2003). The N_2O emission from the '*Other chemical industry*' (mainly caprolactam) is based on data reported by the manufacturing industry. These data are also included in the Netherlands' *Pollutant Emission Register* (PER).

Since the CO_2 emissions from non-energy/feedstock use of fuels by the chemical industry are included in subsector 1A2a, no methodological tier assessment for CO_2 emissions is applicable here.

4.3.3 Uncertainties and time-series consistency

The uncertainty in N_2O emissions from nitric acid production is estimated to be about 50% in annual emissions (see *Section 1.7* for more details). This estimate was made before recalculation was made based on measurement data instead of using the default IPCC emission factor.

In *Table 4.3* an overview is presented of the trend in N_2O emissions from the chemical industry in the period 1990-2001. The emissions remained rather constant in the 1990-2000 period because no measures were taken to control these emissions. The reduction of 8% in 2001 compared to 2000 was realised by a technical measure applied at one of the nitric acid plants.

Table 4.3. N_2O emissions from chemical industry processes (2B) 1990-2001 (Gg N_2O)

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2B2. Nitric acid production	20.4	20.7	20.9	22.7	21.5	20.3	20.2	20.2	20.1	19.1	19.0	17.2
2B5. Other chemical industry	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Total	**24.4**	**24.7**	**24.9**	**26.7**	**35.5**	**24.3**	**24.2**	**24.2**	**24.1**	**23.1**	**23.0**	**21.2**

4.3.4 Source-specific recalculation

Last year a recalculation was made for the years 1990, 1995 and 1998-1999, which were the years that have been updated in the PER 2002 dataset. This year for 1991-1994 and 1996-1997 a similar recalculation has been made. Only emissions data have been published, the underlying activity data and emission factors are confidential. *Table 4.4* provides an overview of the effect of the recalculation on the level and trend of the N_2O emissions.

Table 4.4. Effects of recalculation of N_2O emissions from nitric acid production 1990-1999 (in Gg)

Submission	1990*	1991	1992	1993	1994	1995*	1996	1997	1998*	1999*
NIR 2003	20.4	20.7	20.9	22.7	21.5	20.3	20.0	20.2	20.1	19.1
NIR 2002	20.4	28.3	26.4	26.0	27.6	20.3	27.7	31.0	20.1	19.1
Difference	*0.0*	*7.6*	*5.5*	*3.3*	*6.1*	*0.0*	*7.7*	*10.8*	*0.0*	*0.0*

* Last year emissions for 1990, 1995, 1998 and 1999 have been recalculated.

4.4 Metal production (2C)

4.4.1 Source category description

The subsector '*Metal production*' (2C) consists of the source categories specified as key or non-key source in *Box 4.1*. The CO_2 emission from steel production is included in 1A2a. The share of PFC emissions from primary aluminium production in the national total of F-gases was 34% in 1990 and 47% (0.6% in the national total greenhouse gas emissions) in the last reported year.

We recall that all CO_2 emissions due to non-energy use in the iron and steel industry and in primary aluminium production are reported under category 1A '*Fuel combustion*', subsectors 1A2a 'Iron and steel' and 1A2b '*Non-ferrous metals*', respectively.

4.4.2 Methodological issues

For one of the two producers of primary aluminium for PFCs the IPCC Tier 3b method is used. The other producer is using the Tier 2 method. Since the emissions are considered to be a key source for PFCs, the present higher tier methodologies do comply with the *IPCC Good Practice Guidance* (IPCC, 2000). A full description of the methodology is provided in Spakman *et al.* (2003).

Since the CO_2 emissions from non-energy/feedstock use of fuels by the iron and steel industry and in primary aluminium production are included in subsector 1A2, no methodological tier assessment for CO_2 emissions is applicable here.

4.4.3 Uncertainties and time-series consistency

The uncertainty in PFC emissions from aluminium production is estimated to be about 20% in annual emissions (see *Section 1.7* for more details). In *Table 4.5* an overview of the trend in PFC emissions from primary aluminium industry during the period 1990-2001 is given.

PFC emissions from aluminium production decreased by about 30% during the period 1995-2001. Switching from side feeding to point feeding at one of the producing companies is the main cause. Interannual changes of about 10% can be observed, which relate to variations in annual production levels.

Table 4.5. Actual PFC emissions per compound from aluminium production (2C) 1990-2001 (Gg CO_2-eq.)

Compound	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
CF_4 (PFC-14)	1 957	1 957	1 677	1 690	1 482	1 450	1 606	1 697	1 269	1 000	1 043	1008
C_2F_6 (PFC-116)	442	442	377	377	350	350	359	368	356	326	348	313
PFC total	2 398	2 398	2 054	2 067	1 832	1 799	1 964	2 065	1 625	1 326	1 390	1321

4.5 Production of halocarbons and SF_6 (2E)

4.5.1 Source category description

The subsector '*Production of halocarbons and SF_6*' (2E) consists of one source: HCFC-22 manufacture, identified as key source in *Box 4.1*. In addition, under this subsector some *handling* emissions of HFCs are reported. However, these emissions are discussed in the next section on the *consumption* of halocarbons (and included in the emissions tables). The share of HFC emissions from production of halocarbons and SF_6 (2E) in total F-gas emissions was 70% in the base year 1995 and 13% (0.2% in the national total greenhouse gas emissions) in 2001.

4.5.2 Methodological issues

For source category '*HFC-23 emissions from HCFC-22 manufacture*' the IPCC Tier 2 method for HFC-23 is used. Since the emissions are considered to be a key source for F-gases, the present methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). A full description of the methodology is provided in Spakman *et al.* (2003).

4.5.3 Uncertainties and time-series consistency

The uncertainty in HFC emissions from HCFC-22 production is estimated to be about 30% in annual emissions (see *Section 1.7* for more details). In *Table 4.6* an overview of the trend in HFC-23 emissions from the HCFC-22 production is presented for the 1990-2001 period.

Table 4.6. Actual HFC-23 emissions from HCFC-22 production (2E) 1990-2001 (Gg CO_2-eq.)

Compound	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
HFC-23	4 432	4 820	4 540	5 066	6 278	5 759	6 887	6 709	7 791	3 440	2 421	450
HFC total	**4 432**	**4 820**	**4 540**	**5 066**	**6 278**	**5 759**	**6 887**	**6 709**	**7 791**	**3 440**	**2 421**	**450**

Due to an increase of production in the 1995-1998 period, the emissions of HFC-23 from the HCFC-22 manufacture increased by 35%. In the 1998-2000 period, the emission of HFC-23 from the HCFC-22 manufacture decreased by 69% because a thermal afterburner was installed. A reduction of 80% in 2001 compared to 2000 was realised by an increase of the operation time of the thermal afterburner (95% in 2001 compared to 84% in 2000).

4.6 Consumption of halocarbons and SF_6 (2F)

4.6.1 Source category description

The subsector consumption of halocarbons and SF_6 (2F) consists of the source categories specified as key or non-key source in *Box 4.2.* The share of HFC emissions from consumption of HFCs, PFCs and SF_6 (subcategory 2F) in the national total F-gas emissions was 7% in the base year 1995 and presently 47% (0.7% in the national total greenhouse gas emissions). These consumption emissions include some *handling* emissions of HFCs at the site of the halocarbon manufacture, which have been reported in the CRF under 2E3 *'Other'*. The subsources of the consumption source categories are presented in *Box 4.2.*

Box 4.2. Subsources of HFCs, PFCs and SF_6 emissions and calculation methods

Source category	Subsource	Calculation method
HFC emissions from substitutes for ODS-substitutes	2F1 Stationary refrigeration	country-specific
	2F1 Mobile air conditioning	country-specific
	2F4 Aerosols	IPCC Tier 2
PFC emissions from PFC use	2F6 Semiconductor manufacturing	IPCC Tier 2c
SF_6 emissions from SF_6 use	2F7 Semiconductor manufacturing	IPCC Tier 2c
	2F6 Electrical equipment	IPCC Tier 2
	2F8 Sound-proof windows	country-specific
	2F8 Electron microscopes	country-specific

4.6.2 Methodological issues

The type of methods used to calculate the emissions from HFC, PFC and SF_6 consumption are presented in *Box 4.2*. The country-specific methods for HFC and SF_6 emissions are equivalent to IPCC Tier 2. A full description of the country-specific methods is provided in Spakman *et al.* (2003). Since HFC emissions and SF_6 emissions from the use of these substances are considered to be key sources (see Box *4.1*), the use of higher tier methodologies does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

4.6.3 Uncertainties and time-series consistency

The uncertainty in HFC emissions from HFC consumption is estimated to be about 50% in annual emissions (see *Section 1.7* for more details).

Trends in *actual* emissions from 1990 onwards are presented in *Table 4.7,* whereas *potential emissions* (or so-called *apparent consumption*) are shown in *Table 4.8.* It shows that HFC emissions are a factor of 3 higher in 2001 than in 1995, largely because of an increase in HFC consumption – in particular of HFC-134a – as a substitute for (H)CFC use (see *Table 4.7*). The sometimes large interannual variation of consumption and emissions of some sources can be explained by the variation in production/handling levels of specific industries and service sectors. In the period 1995-2001 the actual emissions of SF_6 remained almost constant.

Table 4.7 Actual emissions per compound from the use of HFCs, PFCs and SF_6 1990-2001 (Gg CO_2-eq.).

Compound	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
HFC-134a	0	0	0	0	121	236	565	893	923	969	818	640
HFC-143a	0	0	0	0	0	6	131	48	136	139	296	177
HFC-125	0	0	0	0	0	10	25	43	102	128	172	220
HFC-152a	0	0	0	0	3	3	4	0	0	0	3	1
HFC-32	0	0	0	0	0	2	0	2	1	0	0	8
Other HFCs [1)]	0	0	0	0	0	2	63	611	408	221	164	89
HFC Total	*0*	*0*	*0*	*0*	*124*	*259*	*788*	*1597*	*1570*	*1457*	*1453*	*1135*
PFC use [2)]	34	39	44	51	59	68	78	89	103	118	136	136
SF_6 use	187	100	106	110	148	275	285	311	295	265	269	296
Total HFC/PFC/SF_6	**221**	**139**	**150**	**161**	**331**	**602**	**1151**	**1997**	**1968**	**1840**	**1858**	**1567**

Note: Including handling emissions of HFCs, reported under CRF subcategory 2E3.
[1)] Average GWP of other HFCs: 3000.
[2)] Average GWP of other PFCs: 8400.

Table 4.8 Potential emissions per compound from the use of HFCs, PFCs and SF_6 1990-2001 (Gg CO_2-eq.).

Compound	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
HFC-134a	0	0	0	0	356	590	1187	1398	1365	1386	1011	702
HFC-143a	0	0	0	0	0	129	315	350	456	642	828	828
HFC-125	0	0	0	0	0	140	286	274	333	543	655	753
HFC (unspecified)	0	0	0	0	8	69	168	138	147	57	300	150
HFC total	*0*	*0*	*0*	*0*	*364*	*928*	*1956*	*2160*	*2301*	*2628*	*2794*	*2433*
PFC use	C	C	C	C	C	C	C	C	C	C	C	C
SF_6 use	C	C	C	C	C	C	C	C	C	C	C	C
Total HFC/PFC/SF_6 [1)]	**0**	**0**	**0**	**0**	**364**	**928**	**1 956**	**2 160**	**2 301**	**2 628**	**2 794**	**2433**

Note: C = Confidential Business Information.
[1)] Only HFCs are included in the F-gas total due to confidentiality of PFC and SF_6 use.

4.6.4 Source-specific recalculations

Actual emissions of HFCs and SF_6 for 1994 onwards have been recalculated due to more detailed information on the use of HFCs in stationary refrigeration and mobile air-conditioning and SF_6 in soundproof windows (see *Table 4.9*).

Table 4.9 Effects of recalculation of HFC and SF_6 emissions (2F) 1994-2000 (in Gg).

Gas	**Submission**	**1990***	**1991***	**1992***	**1993***	**1994**	**1995****	**1996**	**1997**	**1998**	**1999**
HFCs	NIR 2003					124	259	788	1597	1570	1457
	NIR 2002					67	220	502	1506	1422	1393
	Difference	*0*	*0*	*0*	*0*	*57*	*39*	*286*	*91*	*148*	*64*
SF_6	NIR 2003					148	275	285	311	295	265
	NIR 2002					148	361	365	386	369	336
	Difference	*0*	*0*	*0*	*0*	*0*	*86*	*80*	*75*	*74*	*71*

* Not recalculated.
** Base year for F-gases in the Kyoto Protocol.

4.7 Other industrial processes (2G)

4.7.1 Source category description

The subsector '*Other industrial processes'* (2G) consists of CO_2 from flue gas desulphurisation and other sources and is according to *Box 4.1* no key source.

4.7.2 Methodological issues

For this source category country-specific methodologies are used. Since the emissions are considered to be no key source for CO_2, the present methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). A full description of the methodology is provided in Spakman *et al.* (2003).

4.7.3 Uncertainties and time-series consistency

The uncertainty in CO_2 emissions of other production is estimated to be about 20% in annual greenhouse gas emissions (see *Section 1.7* for more details).

In *Table 4.10* an overview of the trend in CO_2 emissions of the source categories from this subsector is provided.

Table 4.10. Emissions of CO_2 from 'Other industrial processes' (2G) 1990-2001(Tg)

Subcategory	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Flue gas desulphurisation	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3
Other sources	0.4	0.2	0.4	0.0	0.1	0.0	0.4	0.4	0.0	0.1	0.0	0.0
Total	**0.6**	**0.4**	**0.6**	**0.2**	**0.4**	**0.3**	**0.8**	**0.7**	**0.3**	**0.3**	**0.3**	**0.3**

The emissions in the subcategory *'Other sources'* vary considerably over the years because the emissions in this category largely depend on the quality of the environmental reports of individual companies.

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

5.1 Overview of sector

Please note that this sector comprises all *non-combustion* emissions from other sectors than the manufacturing industry and the energy industries. There is, however, one exception. Emissions from the use of the F-gases HFCs, PFCs and SF_6 are according to the IPCC reporting guidelines all reported under source category 2 '*Industrial processes*' (thus including use in the residential and commercial sectors).

The Netherlands reports in this sector some N_2O emissions originating from use of N_2O as anaesthesia and as propelling agent in aerosol cans (e.g. for whipped cream). In addition some very minor CO_2 emissions are reported that stem from individual company reports and were classified as non-combustion sources.

Table 5.1. Trend in greenhouse gas emissions from solvents and other product use (category 3) (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
3A. Paint application	-	-	-	-	-	-	-	-	-	-	-	-
3B. Degreasing and dry cleaning	-	-	-	-	-	-	-	-	-	-	-	-
3C. Chemical products, manuf. & proc.	-	-	-	-	-	-	-	-	-	-	-	-
3D. Other [1)]	0	0.1	0.1	0	0	0	0	0	0	0	0	0
CH_4												
Included in category 7 [2)]	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
N_2O												
3A. Paint application	-	-	-	-	-	-	-	-	-	-	-	-
3B. Degreasing and dry cleaning	-	-	-	-	-	-	-	-	-	-	-	-
3D. Other	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.5	0.5	0.4	0.4
- Use of N_2O for anaesthesia	0.65	0.50	0.50	0.50	0.50	0.50	0.50	0.42	0.37	0.36	0.31	0.28
- N_2O from aerosol cans	0.08	0.10	0.10	0.10	0.10	0.10	0.15	0.14	0.15	0.15	0.13	0.12

[1)] Some minor sources were originally allocated to this category. As mentioned in *Chapter 1*, the allocation of emissions for the years 1991-1994 has not been changed/improved over time.

[2)] Methane emissions from solvents and other product use, although very small, have been reported under IPCC sector 7 ('*Other*'), since CRF emission tables for category 3 erroneously do not allow for methane to be reported here.

In *Box 5.1* the subsources in this category are listed and characterised as non-key source. Its share of CO_2 and N_2O emissions in the national total is negligible (0.0% and 0.1% in 1990, respectively, and presently even less). The relatively most important sub-source of category 3 is the use of N_2O as anaesthetic gas in hospitals.

Box 5.1. Key source identification for solvent and other product use using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

3D.	CO_2	Misc. CO_2: minor part in category 3	Non-Key
3D.	*CH_4*	*Solvents and other product use*	*Included in 7*
3D.	N_2O	Misc. N_2O; part in category 3:	Non-Key

5.1.1 Source category description

This source category comprises all non-industrial, non-combustion sources except for the uses of F-gases, which are all reported under IPCC category 2F. Source category 3 '*Solvents and other product use'* consists of the following subsources, all classified under subcategory 3D '*Other'*:

- CO_2 from miscellaneous non-industrial, non-combustion sources;
- Use of N_2O for anaesthesia;
- N_2O from aerosol cans.

In addition, some minor sources of CH_4 emissions from non-industrial, non-combustion sources have been included in the Netherlands' inventory, but these are reported under category 7 *'Other'*, since CRF emission tables for category 3 erroneously do not allow for methane to be reported here. We recall that all CO_2 emissions due to non-energy use are reported under category 1A '*Fuel combustion'*, subcategory 1A2a '*Chemical industry'*, including the emissions during the use of the (final) products.

5.1.2 Methodological issues

For the N_2O sources in this sector country-specific methodologies are used. The major supplier of the gas reports the use of anaesthetic gas every year and the Dutch association of aerosol producers reports the annual sales of N_2O containing spray cans. Since the emissions in this source category are considered to be no key source for CO_2 and N_2O (see *Section 1.5*), the present methodology level does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). For a brief description of the methodology and data sources used see *Annex 2/3*. A full description of the methodology is provided in Spakman *et al.* (2003).

Since no CH_4 emissions from solvent and other product use are reported here – but in sector 7 *'Other'* – no methodological tier assessment for CH_4 emissions is applicable here.

5.1.3 Uncertainties and time-series consistency

The uncertainty of N_2O and CO_2 emissions is not explicitly estimated for this category, but is expected to be rather small. For N_2O emissions the uncertainty will be of the order of 50% due to uncertainty in activity data of N_2O use of about 50% and 0% in the emission factor (since all gas will be released).

The trend in emissions of this category is summarised in *Table 5.1*. It clearly shows that the CO_2 emissions reported for 1991 and 1992 only do not constitute a consistent trend. This is due to incomplete or changed reporting by individual firms in past years and the exclusion of the years 1991-1994 in recalculations performed in recent years. However, these emissions are only very minor. The use of N_2O for anaesthesia in hospitals and other medical institutes appears to have decreased over time; the very limited use of N_2O in spray cans has increased over time.

6. AGRICULTURE [CRF sector 4]

6.1 Overview of sector

In the Netherlands the agricultural sector comprises three subcategories:

- enteric fermentation by ruminants: CH_4 emissions only (4A);
- manure management: CH_4 and N_2O emissions (4B);
- agricultural soils: N_2O emissions only (4D).

The other IPCC subcategories of rice cultivation (4C), prescribed burning of savannas (4E), field burning of agricultural residues (4F) and 'other' (4G) do not occur in the Netherlands. Burning in the field is prohibited by law and negligible in practice. Manure management (4B) refers to all emissions from confined animal waste management systems (AWMS); emissions from animal waste dropped on the soil during grazing on grasslands are reported under subcategory 4D.

The trends in greenhouse gas emissions from the agricultural sector are summarised in Table *6.1*. It clearly shows that methane emissions from enteric fermentation are the largest source of methane within this sector and that direct soil emissions of N_2O (4D1) are the largest source of nitrous oxide reported under the IPCC sector 'Agriculture'. In fact both total direct and indirect N_2O emissions from agricultural soils (subcategory 4D) rank among the top-5 key level sources.

Due to historical reasons the Netherlands does not use the IPCC method to estimate indirect N_2O emissions (subcategory 4D3). Instead (enhanced) background emissions from foregoing application of manure and fertilisers on agricultural soils have been calculated and are therefore reported as a fixed value of 4.7 Gg N_2O under 4D4 *'Other'* as *'Background emissions from agricultural soils'*. These have been calculated using a country-specific method (see *Annex 3.1* for more detailed information). Since this method does not compare well with the IPCC definition of indirect N_2O emissions from atmospheric deposition (subcategory 4D3a), this subcategory is labelled 'NE' (= Not Estimated).

Table 6.1. Trend in greenhouse gas emissions from agriculture (category 4) (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
4D Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CH_4												
4A Enteric fermentation	402	412	401	393	382	377	366	353	341	334	319	322
4B Manure management	103	105	105	105	101	100	98	93	93	91	91	88
4G Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
N_2O												
4B Manure management	0.7	0.7	0.7	0. 7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6
4D Agricultural soils	21.5	220	25.2	25.4	25.3	26.1	25.7	25.3	24.6	24.6	22.6	22.5
4D1 Direct soil emissions	13.0	13.4	16.8	17.0	17.2	18.0	17.4	17.1	16.8	17.2	15.4	15.4
a. Synthetic fertilisers	*6.9*	*6.7*	*6.6*	*6.6*	*6.3*	*6.8*	*6.5*	*6.7*	*6.8*	*6.5*	*5.7*	*5.7*
b. Animal wastes applied to soils	*5.8*	*6.5*	*10.0*	*10.3*	*10.7*	*10.9*	*10.7*	*10.2*	*9.8*	*10.5*	*9.5*	*9.4*
c. N-fixing crops	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
d. Crop residue [1)]	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*
e. Cultivation of histosols [1)]	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*
4D2 Animal production	3.8	3.8	3.7	3.7	3.4	3.4	3.5	3.5	3.1	2.7	2.5	2.5
4D3 Indirect emissions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
a. Atmospheric deposition	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*	*NE*
b. Nitrogen leaching &run-off	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*	*IE*
4D4 Other [2)]	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
4G Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

[1)] Included in 4D4. In the CRF files and in *Table 10.3* accidentally the wrong notation key 'NE' was used.
[2)] Background agricultural soils, due to past nitrogen loading of the soils.

Indirect N_2O emissions from leaching and run-off of nitrogen (subcategory 4D3b) are reported as a fixed value of 3.8 Tg N_2O, however not under this sector but under IPCC sector *7* ‘Other sources’ as *‘Polluted surface water’*, since this value does also include nitrogen from non-agricultural sources. Three-quarters of these emissions, however, stem from agricultural sources. This is discussed in more detail in *Chapter 9*.

As mentioned above, methane from enteric fermentation (4A) – in particular from cattle – and direct and indirect N_2O emissions from agricultural soils (4D) are major sources. Their share in national total greenhouse gas emissions is about 3% each. From *Box 6.1*, in which the key and non-key sources of the agricultural sector are presented based on level, trend or both, we can conclude that also methane emissions from manure management of cattle and swine are (level) key sources.

Box 6.1. Key source identification in the agricultural sector using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

4A	**CH_4**	**CH_4 emissions from enteric fermentation: cattle**	**Key (L,T1)**
4A	CH_4	CH_4 emissions from enteric fermentation: swine	Non-key
4A	CH_4	CH_4 emissions from enteric fermentation: sheep	Non-key
4A	CH_4	CH_4 emissions from enteric fermentation: other	Non-key
4B	**CH_4**	**Emissions from manure management: cattle**	**Key (L2)**
4B	**CH_4**	**Emissions from manure management: swine**	**Key (T1,L2)**
4B	CH_4	Emissions from manure management: poultry	Non-key
4B	CH_4	Emissions from manure management: other	Non-key
4B	N_2O	Emissions from manure management	Non-key
4C	CH_4	Rice cultivation	Not Occurring
4D	**N_2O**	**Direct N_2O emissions from agricultural soils**	**Key (L)**
4D	**N_2O**	**Indirect N_2O emissions from nitrogen used in agriculture**	**Key (L)**
4E	all	Prescribed burning of savannas	Not Occurring
4F	n-CO_2	Emissions from agricultural residue burning	Not Occurring

6.2 Enteric fermentation [CRF category 4A]

6.2.1 Source category description

Source category enteric fermentation consists of the subsources specified in *Box 6.1*. Buffalo, camels and llamas, mules and asses are not occurring in the Netherlands. The enteric fermentation of poultry is not estimated. Major level and trend key source is enteric fermentation by cattle. Its share of CH_4 in the national total was 31% in 1990 and is currently 33%. The most important subsources of enteric fermentation are cattle, swine and sheep.

6.2.2 Methodological issues

For source category enteric fermentation for CH_4 IPCC methodologies are used, which are for key subsource cattle equivalent to the IPCC Tier 2 method for CH_4. The emission factors for cattle are based on a country-specific IPCC Tier 2 analysis made for the Dutch cattle in 1990. For subsequent years these emission factors are not changed, which is equivalent to the IPCC Tier 1 method. However, specific factors are applied to 4 and 3 subcategories within dairy and non-dairy cattle, respectively. Due to changing animal numbers for the subsequent years, the implied emission factor for the categories Dairy cattle and Non-dairy cattle varies over the years (see *Table 6.4*). The emission factors for the other subsources are based on default IPCC Tier 1 emission factors.

Since the CH_4 emissions by cattle are considered to be a key source (see *Section 1.5*), the present methodology (Tier 1 for years after 1990) does not fully comply with the *IPCC Good Practice Guidance* (IPCC, 2000). For a brief description of the methodology and data sources used see *Annex 3.1*. A full description of the methodology is provided in Spakman *et al.* (2003) (and more detailed data sources in Van Amstel *et al.* (1993)).

6.2.3 Uncertainty and time-series consistency

The uncertainty of CH_4 emissions from enteric fermentation by cattle is estimated to be about 20% in annual emissions (see *Section 1.7* for more details).

The trend in CH_4 emissions due to enteric fermentation is summarised in *Table 6.2.* The annual emission by dairy cattle as well as non-dairy cattle is determined on the basis of the number of cattle in that year and emission factors (amount of CH_4 per animal per year). Since 1990 the number of dairy and non-dairy cattle in the Netherlands has decreased from 3.61 to 2.90 million animals (-20%) and from 1.32 to 1.15 million animals (-13%), respectively (*Table 6.3).* It is obvious that these smaller numbers of cattle are the main cause of the decrease of the CH_4 emissions. Livestock numbers of cattle are influenced mainly by the EU policy on milk quota and by the Dutch manure policy. Milk production per cow increases autonomously and as a consequence – when milk quota remain the same – dairy cattle numbers will be reduced. Manure policy regulates livestock numbers by regulating the amount of manure production and manure application to the field.

Table 6.2. CH_4 emissions due to enteric fermentation (4A) 1990-2001 (Gg)

Animal type	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Cattle	365.6	374.8	362.3	352.8	343.4	339.3	328.5	315.2	307.0	299.0	285.7	288.3
- Dairy cattle	*290.8*	*291.0*	*280.0*	*271.0*	*263.9*	*265.5*	*262.3*	*252.1*	*247.8*	*241.6*	*230.5*	*235.1*
- Non-dairy cattle	*74.9*	*83.8*	*82.3*	*81.8*	*79.6*	*73.8*	*66.1*	*63.0*	*59.2*	*57.4*	*55.3*	*53.2*
Sheep	13.6	15.1	15.6	15.3	14.1	13.4	13.0	11.7	11.2	11.2	10.5	10.4
Goats	0.5	0.6	0.5	0.5	0.5	0.6	0.8	1.0	1.1	1.2	1.4	1.8
Horses	1.3	1.4	1.6	1.7	1.8	1.8	1.9	2.0	2.0	2.1	2.1	2.2
Swine	20.9	19.8	21.2	22.5	21.9	21.6	21.6	22.8	20.2	20.4	19.7	19.6
Poultry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**401.9**	**411.6**	**401.2**	**392.7**	**381.7**	**376.7**	**365.9**	**352.6**	**341.4**	**333.9**	**319.4**	**322.2**

Table 6.3. Number of animals 1990-2001 (1000 head) (CBS/RIVM, 2002)

Animal type	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Cattle	4 926	5 062	4 920	4 797	4 716	4 654	4 551	4 411	4 283	4 206	4.070	4 047
- Dairy cattle	*3 607*	*3 627*	*3 490*	*3 360*	*3 277*	*3 298*	*3 276*	*3 150*	*3 061*	*2 972*	*2.840*	*2 896*
- Non-dairy cattle	*1 319*	*1 435*	*1 429*	*1 436*	*1 439*	*1 356*	*1 275*	*1 261*	*1 222*	*1 233*	*1.231*	*1.151*
Sheep	1 702	1 882	1 952	1 916	1 766	1 674	1 627	1 465	1 394	1 401	1.308	1.296
Goats	61	70	63	57	64	76	102	119	132	153	179	221
Horses	70	77	86	92	97	100	107	112	114	115	118	120
Pigs	13 915	13 217	14 160	14 964	14 565	14 398	14 419	15 189	13 446	13 567	13.118	13 073

In *Figure 6.1* the development of the number of cattle and their emission of CH_4 due to enteric fermentation is shown. There is a close relation between the trends of the number of cattle and the emission of CH_4 due to enteric fermentation. The remainder of the difference in the trend of cattle can be explained by the shift in shares of the subtypes considered in the emission calculation, each having a different emission factor (see *Table 6.4)*.

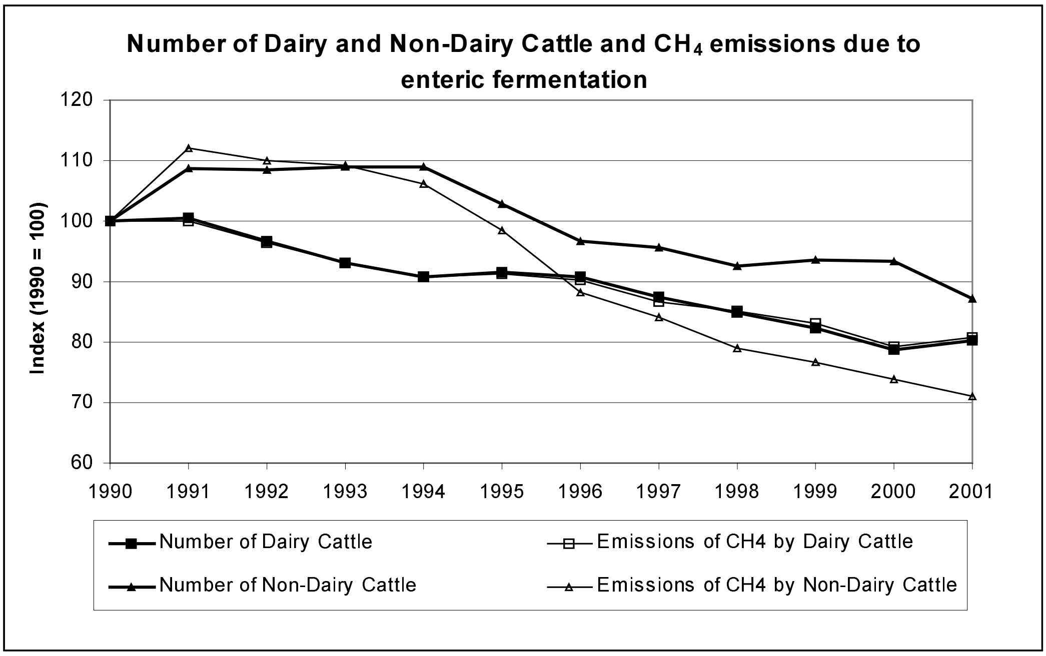

Figure 6.1. Number of cattle and emissions of CH_4 due to enteric fermentation from cattle

Table 6.4. Subtypes of dairy and non-dairy cattle (1000 head) and resulting trend in Implied Emission Factors (IEF)

Animal (sub)type	CH_4 EF [1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Dairy cattle													
< 1 yr	49.25	806	820	774	737	735	740	760	698	658	634	600	644
> 1 yr young female	62.80	880	908	893	836	803	808	805	822	757	714	699	669
female	102.13	1878	1852	1775	1747	1698	1708	1665	1591	1611	1588	1504	1546
> 1 yr male	93.22	43	48	48	41	41	42	46	40	36	36	37	38
IEF Dairy cattle		80.6	80.2	80.2	80.6	80.5	80.5	80.0	80.0	80.9	81.3	81.2	81.2
Non-dairy cattle													
Veal calves	17.65	602	622	638	656	690	669	678	704	711	753	783	712
Steers	87.01	598	674	646	624	603	541	451	412	366	328	285	277
Female > 1 yr [2]	102.13	120	139	146	156	146	146	146	145	145	153	163	162
IEF Non-dairy cattle		56.8	58.4	57.6	56.0	55.3	54.4	51.9	50.0	48.5	46.6	44.9	46.2

[1] Emission factor for CH_4 from enteric fermentation in kg CH_4/head/year. Source: Van Amstel *et al.* (1993).
[2] Suckling cows.

6.3 Manure management [CRF category 4B]

6.3.1 Source category description

Source category manure management consists of the subsources specified in *Box 6.1*. Emissions from manure management from buffalo, camels and llamas, mules and asses are not occurring in the Netherlands. Manure emissions from horses are not estimated because most horses are part of non-agricultural activities like riding schools. Major level and trend key source is manure management of cattle and swine.

Its share of CH_4 in the national total was 8% in 1990 and presently 9%. Its share of N_2O in the national total is about 1%. The most important subsources of CH_4 emissions by manure management are cattle, swine and poultry. For N_2O emissions by manure management no subsources are distinguished. Manure management is no level or trend key source of N_2O emissions.

6.3.2 Methodological issues

For CH_4 from manure management systems the IPCC Tier 2 methodology is used. The country-specific emission factors for CH_4 are based on default IPCC emission factors (using adjusted IPCC values). The emission factors are multiplied with the amount of annually produced manure per animal category, after deducting the amount of manure produced in the meadows. The amount of annual produced manure per animal category varies during the last years, as does the number of animals in the different animal categories. Since the emissions are considered to be a key source for CH_4 (see *Section 1.5*), the present Tier 2 methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

Since the N_2O emissions from manure management are no key source (see *Box 6.1*), the present country-specific Tier 2 methodology complies with the *IPCC Good Practice Guidance* (IPCC, 2000). For a brief description of the methodology and data sources used see *Annex 3.1*. A full description of the methodology is provided in Spakman *et al.* (2003) (and more detailed data sources in Van Amstel *et al.* (1993)).

6.3.3 Uncertainty and time-series consistency

The uncertainty of CH_4 emissions from manure management from cattle is estimated to be about 100% in annual emissions. The uncertainty of CH_4 emissions from manure management from swine is estimated to be 100% in annual emissions (see *Section 1.7* for more details).

The trend in emissions of CH_4 due to manure management is summarised in *Table 6.5.* In the period 1990-2001 the emission of CH_4 decreased from 103.5 to 88.4 Gg (-15%). The trend in emissions of N_2O due to manure management decreased from 0.68 to 0.61 Gg (-10%) between 1990 and 2001 *(Table 6.6*). As can be seen from *Table 6.5* the decrease in CH_4 is mainly due to the decrease of emissions from manure management of swine (8.8 Gg), dairy cattle (2.0 Gg), and non-dairy cattle (2.8 Gg).

Table 6.5. Trend in CH_4 emissions from manure management (4B) 1990-2001 (Gg)

Animal type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Cattle	43.1	44.7	43.7	43.0	42.1	41.5	39.7	38.5	37.7	37.1	38.5	38.3
- Dairy cattle	*25.9*	*25.8*	*24.8*	*24.2*	*23.5*	*23.6*	*23.3*	*22.3*	*22.1*	*21.7*	*23.4*	*23.9*
- Non-dairy cattle	*17.2*	*18.9*	*18.9*	*18.8*	*18.6*	*17.8*	*16.5*	*16.2*	*15.5*	*15.4*	*15.1*	*14.4*
Sheep	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.6
Goats	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5
Swine	49.2	49.3	49.2	51.0	49.3	48.6	47.7	45.2	45.6	44.1	42.5	40.4
Poultry	10.3	10.4	10.6	10.2	9.2	9.4	9.4	8.5	9.1	8.9	9.0	8.7
Total	**103.5**	**105.5**	**104.6**	**105.1**	**101.5**	**100.3**	**97.7**	**93.2**	**93.3**	**91.1**	**91.1**	**88.4**

Table 6.6. Trend in N_2O emissions from manure management (4B) 1990-2001 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total 4B	0.68	0.71	0.71	0.74	0.72	0.74	0.72	0.69	0.67	0.65	0.62	0.61

As has been described in the previous section, the number of dairy cattle in the Netherlands has decreased by 20% in the 1990-2001 period. This decrease is reflected in the amount of stable manure and the related emissions of CH_4 and N_2O (*Table 6.5 and 6.6*). Livestock numbers of cattle are influenced mainly by the EU policy on milk quota and by the Dutch manure policy. Milk production per cow increases autonomously and as a consequence – when milk quota remain the same – dairy cattle numbers will be reduced. Manure policy regulates livestock numbers by regulating the amount of manure production and manure application to the field.

Table 6.7 shows that the number of fattening pigs and sows has declined between 1990 and 2001 with 13%. However for swine the decrease of the CH_4 emissions from manure management (-18%) is related to the decrease of the amount of manure produced per swine. During the last years the annual amount of manure per swine has decreased by approximately 9% as a result of changes in agricultural practice in the Netherlands. These changes originated from the Dutch manure policy, forcing farmers to export their surpluses of manure to other farms. To save on expenses for storage, transport and spreading of animal manure on the land, the water content of the manure was kept as low as possible (*Table 6.7* and *Figure 6.2*). The increase of the number of swine in 1997 is due to the outbreak of classical swine fever in that year. In areas with this disease transportation of finished pigs, sows, and piglets to the slaughterhouse was not allowed and the animals had to stay on the pig farms. For that reason the annual census of 1997 gives high pig numbers. Later in the year the pigs in classical swine fever areas were destructed and there was no replacement in 1997. So the annual manure production in 1997 (based on the average number of swine) was lower than in normal years.

Table 6.7. Number of swine and manure from swine 1990-2001 (CBS/RIVM, 2002)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Number of swine[1] (mln)												
Fattening pigs	7.0	7.0	7.1	7.5	7.3	7.1	7.1	7.4	6.6	6.8	6.5	6.2
Sows	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.8	1.8	1.6	1.5	1.4
Total	8.7	8.8	8.9	9.3	9.0	8.8	8.8	9.2	8.4	8.3	8.0	7.6
Manure production by swine (mln m^3)												
Total	16.4	16.4	16.3	17.0	16.4	16.1	15.8	15.0	15.2	14.7	14.1	13.4

[1] When piglets are included the amount of swine is considerably higher (cf. *Table 6.3*). Since the manure produced by piglets is attributed to the sows, piglets are not relevant for the calculation of the amount of manure.

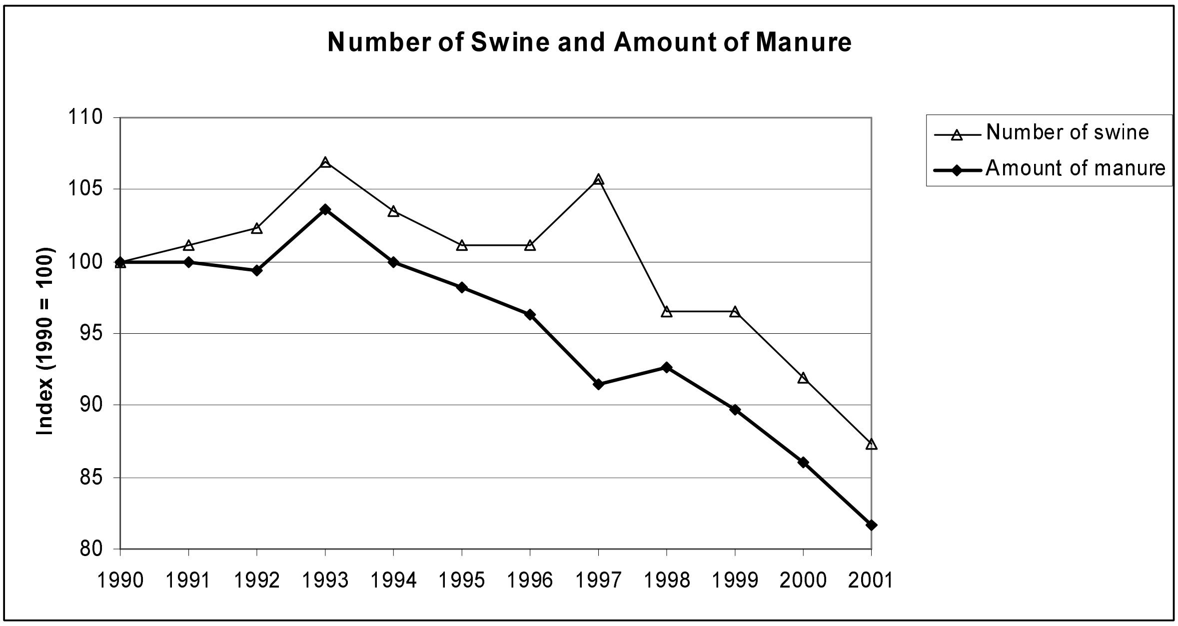

Figure 6.2. Trend of the number of swine and the amount of manure from swine between 1990 and 2001

6.4 Agricultural soils [CRF category 4D]

6.4.1 Source category description

This source category consists in the Netherlands of the N_2O subsources specified in *Table 6.1:*

- direct soil emissions from the application of synthetic fertilisers, animal wastes applied to soils, N-fixing crops (4D1);
- animal production (4D2);

- indirect emissions from nitrogen leaching and run-off (4D3);
- other emissions, being background emissions from agricultural soils (4D4).

Indirect N_2O emissions from *atmospheric deposition* (another part of category 4D3) are not yet estimated. Indirect N_2O emissions from leaching and run-off are included elsewhere (under IPCC sector 7 as *'Polluted surface water'*). The latter category 7 is calculated as a fixed value that comprises leaching and run-off from agricultural activities (3/4) and from other nitrogen sources (1/4), including human sewage. Since this figure includes more than only agriculture related emissions the Netherlands does not report these emissions under 4D but as a separate category in IPCC sector '7'. N_2O emissions from human sewage are reported partly under subcategory 6B *'Wastewater handling'* and partly under a subcategory of sector 7 as *'Polluted surface water'.*

Direct N_2O emissions include emissions caused by application of synthetic fertilisers, animal wastes (manure) to soil and by N-fixing crops. Furthermore direct N_2O emissions include animal production of manure in the grasslands (pasture). Direct N_2O emissions from cultivation of histosols (organic soils) and emissions from crop residues left in the field are included in the subsource 4D4 '*Other*' (specified as '*Background agricultural soils'*). These background N_2O emissions result also from manure and fertiliser applications in the past and from lowering the groundwater tables in the last century. The subsource background agricultural soils is the arithmetic difference between the actual background emissions and the natural background emissions for one or two centuries ago (Kroeze, 1994).

Methane emissions from agricultural soils are regarded as 'natural' (non-anthropogenic) and are estimated on the basis of the methane background document (Van Amstel *et al.*, 1993). They are not reported as anthropogenic emissions under IPCC category 7.

Major level and trend key sources of N_2O emissions by agricultural soils are direct emissions from agricultural soils and indirect N_2O emissions from nitrogen used in agriculture. The share of total N_2O from agricultural soils in national greenhouse gas emissions is about 3%. Most important subsources of agricultural soils are direct emissions caused by application of synthetic fertilisers and animal wastes (manure) to soil and background emissions.

6.4.2 Methodological issues

For direct N_2O emissions from agricultural soils country-specific methodologies and country-specific emission factors are used, which are equivalent to the IPCC Tier 1b method. Since the emissions are a key source (see *Box 6.1*), the present Tier 1b methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

The Netherlands does not use the IPCC method to estimate indirect N_2O emissions. Atmospheric deposition is not estimated and leaching and run-off emissions are included elsewhere (sector 7 'Other'). Since the emissions are a key source (see *Box 6.1*), the present methodology does not fully comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

For a brief description of the methodology and data sources used see *Annex 3.1*. A full description of the methodology is provided in Van Amstel *et al.* (1993), Kroeze (1994) and Van der Hoek (2002).

6.4.3 Uncertainty and time-series consistency

The uncertainty of direct N_2O emissions from agricultural soils is estimated to be 61% in annual emissions and 15%-points in 6% source trend. The uncertainty of indirect N_2O emissions from nitrogen used in agriculture is estimated to be more than a factor of 2 in annual emissions.

The trend in N_2O emissions from agricultural soils is summarised in *Table 6.8.* In the period 1990-2001 the emission of N_2O has increased from 21.5 to 22.5 Gg (+5%). This increase is almost completely due to the increase of the emissions related to the application of animal manure to agricultural soils. In *Table 6.9* the nitrogen flows from synthetic fertilisers and from animal waste management systems are presented. It appears that about 85% of total collected manure is applied to Dutch soils. The remainder of about 15% is emitted as ammonia during manure application in the field and a small part of the manure is exported abroad. Although in the period 1990-2001 the amount of nitrogen in manure that has been applied to agricultural soils decreased by 6%, the related emissions of N_2O are much higher because the application method has changed considerably. Before 1990 manure was applied by surface spreading *on* grasslands as well as *on* agricultural soils. As a result of the Dutch policy for reduction of ammonia emissions, in the past 11 years this practice has changed to incorporation of manure *into* the soil (injection and ploughing in). Due to this new incorporation method the local concentration of nitrogen in the upper layer of the soil is higher, which leads to changes in the microbial environment and in microbial processes and ultimately to an increase of N_2O emissions per amount of manure applied.

Incidentally, in 1998 the emission was lower than in 1997 due to the rainy weather in the second half of 1998. Therefore part of the manure could not be applied in 1998 and part of the manure application was postponed to 1999. Consequently, the emissions in 1999 have been relatively high.

In 2000 and 2001 emissions are lower than preceding eight years. This is a result of the Dutch manure policy aimed at reduction of N leaching and run-off. As a consequence of this manure policy application of synthetic fertilisers and animal wastes to soil was reduced.

Table 6.8. N_2O Emissions from agricultural soils (4D) 1990-2001 (Gg N_2O)

Source	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
4D1 Direct soil emissions	13.0	13.4	16.8	17.0	17.2	18.0	17.4	17.1	16.8	17.2	15.4	15.4
a. Synthetic fertilisers	*6.9*	*6.7*	*6.6*	*6.6*	*6.3*	*6.8*	*6.5*	*6.7*	*6.8*	*6.5*	*5.7*	*5.7*
b. Animal wastes applied to soils	*5.8*	*6.5*	*10.0*	*10.3*	*10.7*	*10.9*	*10.7*	*10.2*	*9.8*	*10.5*	*9.5*	*9.4*
c. N-fixing Crops	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
4D2 Animal production	3.8	3.8	3.7	3.7	3.4	3.4	3.5	3.5	3.1	2.7	2.5	2.5
4D3 Indirect emissions	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE	NE/IE
4D4 Background agricultural soils	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Total	**21.5**	**22.0**	**25.2**	**25.4**	**25.3**	**26.1**	**25.7**	**25.3**	**24.6**	**24.6**	**22.6**	**22.5**

Notes: Excluding emissions from animal houses, which have been included in IPCC category *4.B* Manure management (see *Table 6.6*). NE/IE = Not Estimated (atmospheric deposition) / Included Elsewhere (leaching and run-off).

Table 6.9. Additional information on nitrogen flows related to direct soil emissions

Nitrogen flows (ton N/year)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Use of synthetic fertilisers	404	389	381	379	362	395	379	390	392	373	330	330
N input from manure applied to soils	327	344	370	375	370	357	349	331	319	335	303	297
As % of total in AWMS	*78%*	*79%*	*86%*	*84%*	*87%*	*83%*	*83%*	*83%*	*82%*	*89%*	*85%*	*85%*
Dry pulses and soybeans produced [1)]	15	14	14	14	14	13	13	13	13	13	13	13

[1)] In kiloton N/year.

6.4.4 Source-specific planned improvements

In 2002 a recalculation was carried out on N_2O emissions from animal wastes (manure) applied to soils leading to higher emissions of N_2O in 1990 till 1995. Recalculation of the ammonia emissions during manure application in the field appeared to be higher and as a consequence the N input from manure to soils decreased. In the base year 1990 the N_2O emissions from animal wastes applied to soils is now 0.2 Gg lower (Van der Hoek, 2002). The figures for N_2O emissions in *Table 6.8* have not yet been corrected for this lower nitrogen input to soils.

The present methodologies used to estimate the direct and indirect N_2O emissions from agricultural soils do not fully comply with *IPCC Good Practice Guidance* (IPCC, 2000). For this reason actions are taken in the Netherlands to revise and expand calculations to be in accordance with *IPCC Good Practice Guidance* (IPCC, 2000).

7. LUCF [CRF sector 5]

7.1 Overview of sector

The IPCC source/sink category 5 '*Land Use Change and Forestry*' (LUCF) consists of the sub-sources specified in *Box 7.1*. In 1990 2905 km^2 or 8% of total landuse was forested area. By 1998 this had increased by 11% to 3233 km^2. The existing stock is estimated at around 40-million m^3 of roundwood, with an annual growth of approximately 1.7 million m^3. The annual amount of harvested wood is around 1.2 million m^3 with a net harvest of 1 million m^3. Approximately 70% comes from thinning and 30% from logging (RIVM/CBS, 2002). In the last 15 years the forests have become more mature, better-structured and mixed forests. Around 45% of all forests are unmixed.

The Netherlands only reports data in category 5A for temperate forests (2); the Netherlands has neither tropical or boreal forests nor tundra. Data for changes in grasslands (4) are not estimated. For changes in grasslands (5A4) and the other sub-categories 5B to 5E new data are being evaluated and the preliminary results are still under discussion. Therefore, CO_2 sinks data are only related to forestry and other woody biomass stocks (Table 5A).

Box 7.1. Summary of sub-sources/sinks in Land-Use Change and Forestry (LUCF) (IPCC category 5)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**Net CO_2 emissions/ removals**	**CH_4**	**N_2O**
A. Changes in Forest and Other Woody Biomass Stocks	**-1,413.26**	**NA**	**NA**
1. Tropical Forests	NO		
2. Temperate Forests	-1,413.26		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NE		
5. Other *(please specify)*	0.00		
Harvested Wood (1)	NE		
B. Forest and Grassland Conversion (2)	**NE**	**NE**	**NE**
1. Tropical Forests	NO	NO	NO
2. Temperate Forests	NE	NE	NE
3. Boreal Forests	NO	NO	NO
4. Grasslands/Tundra	NE	NE	NE
5. Other *(please specify)*	0.00	0.00	0.00
C. Abandonment of Managed Lands	**NE**	**NA**	**NA**
1. Tropical Forests	NO		
2. Temperate Forests	NE		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NE		
5. Other *(please specify)*	0.00		
D. CO_2 Emissions and Removals from Soil	**NE**	**NA**	**NA**
Cultivation of Mineral Soils	NE		
Cultivation of Organic Soils	NE		
Liming of Agricultural Soils	NE		
Forest Soils	NE		
Other *(please specify)* (3)	0.00		
E. Other *(please specify)*	**NE**	**NE**	**NE**

(1) Following the IPCC Guidelines, the harvested wood should be reported under *'Changes in Forest and Other Woody Biomass Stocks'* (Volume 3. Reference Manual, p.5.17).

(2) Include only the emissions of CO_2 from *'Forest and Grassland Conversion'*. Associated removals should be reported under section D.

(3) Include emissions from soils not reported under sections A, B and C.

7.2 CO_2 from changes in forestry and other woody biomass stock [5A]

7.2.1 Source category description

The Netherlands has only temperate forests and grasslands, no tropical or boreal forests nor tundra. At present, the Netherlands reports no data in category 5A4 for grasslands (also harvested wood, which is a memo item only, is not reported). Data for changes in grasslands and harvested wood are not reported. The share of this CO_2 sink as calculated according to the *UNFCCC Guidelines* – which are different from the Kyoto Protocol (see *Section 1.1.2*) – in the net national total was 0.7% in 1990 and 0.6% in the last reported year.

7.2.2 Methodological issues

For the period 1990-2000/2001 the data on carbon stock (C) and changes forestry are based on three elements:

- forest stock (in ha);
- average annual growth by category (in m^3/ha/year);
- harvest by category (in m^3/ha/year).

The forest stocks were based on various data sources on forest area (divided into coniferous and broad-leaved forests) and other forested area (divided into coniferous and broadleaved forests smaller than 0.5 ha, line plantations, solitaires, orchards and nurseries). The development of forests in the Netherlands was monitored from around 2,500 permanent measuring stations, one-fifth of which are visited annually. The growth increment and harvest was also based on different data sources. The amount of fuelwood consumed is implicitly included in these variables, so including them separately would result in double counting.

The carbon emission factors used are 0.25 and 0.30 ton C/m^3 for coniferous and broadleaved forests, respectively. Other characteristics of this source are illustrated by the implied carbon uptake factors presented in *Table 7.1*. More details are provided in Spakman *et al.* (2003) and in *Annex 3.2.* The latter also explains the deviations of the Netherlands' definition of forest area compared to the FAO definition of TFBTA2000.

Table 7.1. Implied carbon uptake factors (in ton C/k ha) in changes in forest and other woody biomass stocks (IPCC category 5A2)

Implied carbon uptake factor	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Coniferous forest	2.51	2.40	2.34	2.32	2.31	2.37	2.33	2.37	2.37	2.35	2.33	2.33
Broadleaved forest	2.54	2.56	2.55	2.63	2.69	2.78	2.80	2.85	2.86	2.85	2.84	2.84

An update to 2001 of data for forest biomass stocks and of stocks of carbon in soils and emissions of CO_2 from agricultural soils in the Netherlands was discussed. However, for 2001 no comparable data were available because of the discontinuation of the old monitoring network and transition to a new monitoring network '*Meetnet Functievervulling*' (see *Section 7.2.4* for more information). Therefore it was decided to use the data for 2000 as estimate for 2001.

Finally, we stress that the present calculation of the CO_2 sinks for this subcategory is based on the *UNFCCC Guidelines*; a calculation according to *Kyoto Protocol Guidelines* has not yet been done.

7.2.3 Uncertainty and time-series consistency

The total annual increment is about 900 to 1,000 Gg C, with exception of 1992, when the increment is 877. In that year the carbon uptake increment is only 3,217 Gg CO_2 (see *Table 7.2*). The areas of biomass increase slowly; in the period 1990-2001 by 19 kha. About ¾ of the growth was for the broadleaved forestland area that increased from 151 kha in 1990 through 156 kha in 1995 to 164 ha in the year 2001. The coniferous forest area increased from 190 kha in 1990 through 195 kha in 1995 to 196 kha in 2001.

On average, trees in the Netherlands are growing older and heavier. Since 1990, a slow reduction in growth rate (because of maturing forests) has been slightly overcompensated by planting fast-growing species like poplar and Douglas The average annual growth rate for broadleaved forest increased from 5.11 t dm/ha in the year 1990 to 5.68 in 2000/2001. Because of fellings, part of the volume increment of biomass is reduced. In the years 1990-1994 the fellings reduced slightly, but from 1995 onwards yearly about 2200 km^2 wood is removed. The resulting carbon release clearly shows up in *Table 7.2.*

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

Gg CO_2	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001** [3)]
Carbon uptake increment [1)]	3302	3340	3217	3516	3569	3402	3574	3522	3600	3410	3593	3593
Carbon release [2)]	-1880	-1812	-1730	-1710	-1640	-2170	-2176	-2342	-2220	-2174	-2180	-2180
Net CO_2 removals	**1422**	**1528**	**1487**	**1806**	**1929**	**1232**	**1398**	**1180**	**1380**	**1236**	**1423**	**1423**

[1)] Forest and non-forest trees.
[2)] Biomass consumption from stocks.
[3)] Same estimate as for 2000.

The uncertainty in the resulting sink estimates has not yet been assessed. However, the changes over time as apparent from the CRF files and the summary data in Table 7.2 are an indication of the accuracy of the estimate within the constraints of the definition of the source category considered here, i.e. only for 5A2. Apparently, the interannual changes can be as large as 0.5 Mton (see 1994/1995 change) for an average sink of about 1.5 Mton.

According to the dataset used in the 1990-2000 period the total forest area expanded by 5% (from 314 kha to 360 kha); in particular broadleaved forest areas increased (by 8%). These figures are excluding non-forest trees. The Netherlands therefore recently revised its quantitative forest policy into the more general objective of expanding the total forested area (LNV, 2001).

7.2.4 Planned improvements

As discussed above, for 2001 and subsequent years no comparable data are available because of the discontinuation of the old monitoring network and transition to a new monitoring network, in Dutch called '*Meetnet Functievervulling'*. This new sampling network will provide data on forest area, standing volume and annual volume increment, subdivided into tree species. However, new data on harvest will not be available before the completion of the second four years sampling cycle (at the earliest in 2008).

Secondly, a group of consultants is performing a study comparing the present situation with regard to sinks monitoring with the requirements for the national system under the *Kyoto Protocol*. This includes the subcategories of sources/sinks which are not yet reported: LUCF subcategories 5B-5E and 5A4 and CO_2 from agricultural soils (category 4D). Literature has been reviewed for quantitative data on carbon stocks and CO_2 emissions form agricultural soils, forest soils and other nature soils in the Netherlands (Kuikman *et al*., 2003). To estimate and improve the calculation of the CO_2 emissions from soils due to change of carbon stocks, the use of a computer model was recommended, that parameterises five arable crops, together comprising 84% of the area use for arable farming, and grass). For agricultural soils the data in the study are based on the main crops in the Netherlands, i.e. grassland and cropland with maize, potato, beets and grains. A special item was the organic soils in low areas that have been drained. Three databases and approaches are options to assess soil carbon stocks:

- based on the topographic soil map coupled with the soils information system;
- based on the Netherlands' soil monitoring program;
- based on the monitoring soils in forest and nature ecosystem.

For LUCF subcategories 5B-5E also new datasets are being compiled, of which some information is presented below. However, the results are still under discussion.

Results of this study, which are scheduled for April 2003, will give guidance in further improvements with regard to monitoring and reporting of sinks. Later in 2003, these results and alternative options for assessing the annual changes in forests will be evaluated in the *WEB Project Group on Sinks* as part of the development of the National System (see *Section 10.4*). A decision will be made to what extent data can and will be used for reporting on the Source/Sink category in future editions of the Netherlands' greenhouse gas inventory for reporting under the *UN Framework Convention on Climate Change* (UNFCCC) and under the *Kyoto Protocol*.

8. WASTE [CRF sector 6]

8.1 Overview of sector

The waste sector comprises four source categories:

- solid waste disposal (i.e. landfills) (6A);
- wastewater handling (6B);
- waste incineration (6C);
- other waste (6D).

The trends in greenhouse gas emissions from the waste sector are summarised in Table *8.1*. It clearly shows that methane emissions from solid waste disposal sites (landfills) are the largest source category within this sector; in fact these emissions rank among the top-5 key level and key trend sources (see *Annex 1*). 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. Therefore their emissions are reported under category 1A1a (to comply with IPCC reporting guidelines). However, in *Section 8.4* methodological issues of this source category are briefly discussed. It can also be observed from this table that the CO_2 emissions from 'other waste' (6D) vary substantially over time. This is discussed in more detail in *Section 8.5.*

From *Box 8.1*, in which the key and non-key sources of the waste sector are presented based on level, trend or both, we can conclude that both methane emissions from landfills and from wastewater handling are (trend) key sources. Methane from landfills is also a large *level* key source.

Table 8.1. Trend in greenhouse gas emissions from waste handling (category 6) (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
6A. Solid waste disposal	0	0	0	0	0	0	0	0	0	0	0	0
6C. Waste Incineration [1)]	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
6D. Other	0.9	0	0	0	0	0.9	1.1	1.2	0.5	1.0	0.4	0.4
CH_4												
6A. Solid waste disposal	562	556	540	522	505	480	476	463	445	428	404	390
6B. Wastewater handling	6.6	6.0	2.4	6.3	5.1	1.5	1.3	0.8	3.6	2.1	0.8	0.8
6C. Waste Incineration [1)]	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
6D. Other	0	0	0	0	0	0	10	0	0	0	0	0
N_2O												
6B. Wastewater handling	0.4	0.4	0.4	0.5	0.0	0.5	0.5	0.6	0.5	0.6	0.6	0.6
6C. Waste Incineration [1)]	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
6D. Other	0	0	0	0	0	0	0	0	0	0	0	0

[1)] Since most waste incineration facilities also produce electricity or heat used for energetic purposes these are reported under category 1A1a (to comply with IPCC reporting guidelines).

Box 8.1. Key source identification in the waste sector using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

6D	CO_2	Misc. CO_2, of which 1/3 in category 6D	Non-Key
6A	**CH_4**	**CH_4 emissions from solid waste disposal sites**	**Key (L,T)**
6B	**CH_4**	**Emissions from wastewater handling**	**Key (T1)**
6B	N_2O	Emissions from wastewater handling	Non-key
6C	all	Emissions from waste incineration	Included in 1A1

8.2 Solid waste disposal on land (6A)

8.2.1 Source category description

As mentioned above, methane from landfills is a major key source, both in terms of level and trend. Its share of CH_4 emissions in the national greenhouse gas total is presently 4% (and 6% in the base year 1990). In the Netherlands the policy aims to reduce landfilling. This means all efforts must be undertaken to enhance prevention and recycling of waste, followed by incineration. Already in the early 1990's the government introduced bans for the landfilling of certain categories of waste, like the organic fraction of household waste. Another method to reduce landfilling was raising the landfill tariff so that they comply with the incineration of waste. Depending on the capacity of incineration, the government can grant exemptions from these 'obligations'. *Figure 8.1* shows the landfilled waste categories in the Netherlands in 2000.

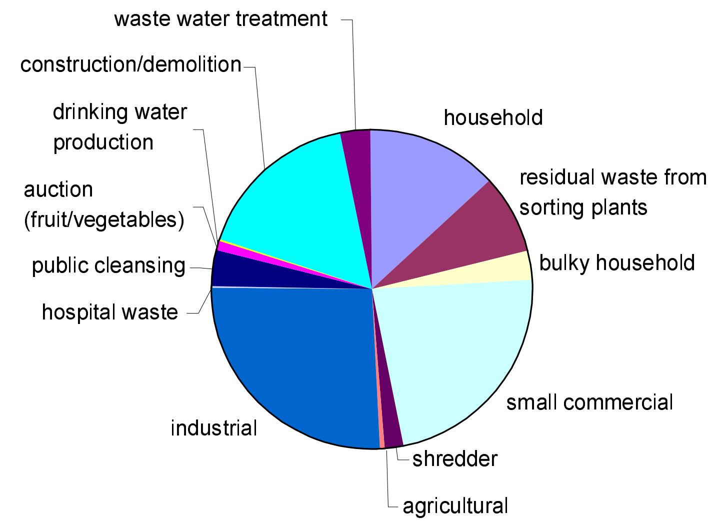

Figure 8.1. Landfilled waste categories in the Netherlands (2000)

In 2001 there were some 35 operating landfill sites. In addition, there are a few thousand old sites, which still are reactive. At 47 sites methane recovery takes place. As a result of anaerobic degradation of the organic material within the landfill body, all these landfills produce methane and carbon dioxide. Landfill gas contains about 60%(vol) methane and 40%(vol) carbon dioxide. Due to a light overpressure the landfill gas migrates into the atmosphere. On several landfill sites the gas is extracted before it reaches the atmosphere. In these cases the methane will be used as an energy source or the gas is flared off; in both cases the methane in the extracted gas will not come into the atmosphere. When the landfill gas passes the cover of the landfill, the methane can more or less be degraded (oxidised) by bacteria resulting in a lower methane concentration.

The anaerobic degradation of the organic matter in a landfill is a time dependent process, which can take many decades. Some influencing factors are known, some not. Every landfill site has its own unique characteristics: concentration and type of organic matter, moisture, temperature etc. Major determining factors for the decrease in net CH_4 emissions were lower quantities of organic carbon deposited into landfills (organic carbon content * total amount of landfilled waste) and higher methane recovery rates from landfills (see *Section 8.2.2. and 8.2.3*).

8.2.2 Methodological issues

In order to calculate the methane 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, which started in 1945 (although, as stated above, characteristics of individual sites vary substantially). Methane emissions from this national landfill are then calculated using a first order decomposition model (first order decay function) with annual input of the total amounts deposited and characteristics of the landfilled waste and the amount of landfill gas extracted. This is equivalent to an IPCC Tier 2 methodology. Since the methane emissions from landfills are a key source (see *Box 8.1*), the present methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000). Parameter values used in the landfill emissions model are:

- total amount of landfilled waste;
- fraction of Degradable Organic Carbon (DOC) (see *Table 8.2* for a detailed time series);
- methane 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 year, respectively (see *Table 8.2* for a detailed time series);
- methane oxidation factor: 10%;
- fraction methane in landfill gas: 60%;
- fraction of DOC actually dissimilated (DOC_F): 0.58;
- methane conversion factor (IPCC parameter): 1.0.

Table 8.2. Parameters used in the IPCC Tier 2 method that change over time (additional information on solid waste handling, part 1)

Parameter	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Waste generation rate (kg/cap/day)	8.90	8.87	8.87	8.65	8.63	8.99	9.14	9.14	9.73	9.75	10.17	9.92
Fraction MSW disposed to SWDS	0.29	0.24	0.24	0.23	0.19	0.16	0.13	0.11	0.10	0.10	0.08	0.08
Fraction DOC in MSW	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12
Fraction of waste incinerated	0.08	0.08	0.08	0.08	0.09	0.09	0.11	0.12	0.12	0.13	0.12	0.13
Fraction of waste recycled	0.63	0.67	0.68	0.69	0.72	0.75	0.76	0.77	0.78	0.78	0.79	0.79
CH_4 generation rate constant (k)	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Number of SWDS recovering CH_4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	47
Waste incineration (Tg)	3.9	4.1	4.0	3.8	4.4	4.7	5.6	6.7	6.8	7.1	7.2	7.5

Notes: ND = No Data. Waste generation rate refers to total waste, including MSW.

Table 8.3. Composition of landfilled waste (%) (additional information on solid waste handling, part 2)

Waste type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Paper and paperboard	ND	ND	ND	ND	ND	16.6	ND	ND	13.5	12.6	13.1	ND
Food and garden waste	ND	ND	ND	ND	ND	21.6	ND	ND	22.3	22.9	24.7	ND
Plastics	ND	ND	ND	ND	ND	6.9	ND	ND	7.1	6.5	9.4	ND
Glass	ND	ND	ND	ND	ND	2.1	ND	ND	2.0	1.9	1.8	ND
Textiles	ND	ND	ND	ND	ND	1.0	ND	ND	1.1	1.0	1.3	ND
Other:												
- Metals	*ND*	*ND*	*ND*	*ND*	*ND*	*2.5*	*ND*	*ND*	*1.9*	*1.7*	*3.6*	*ND*
- Building wastes and ashes	*ND*	*ND*	*ND*	*ND*	*ND*	*32.5*	*ND*	*ND*	*39.4*	*42.4*	*32.5*	*ND*
- Wood	*ND*	*ND*	*ND*	*ND*	*ND*	*6.5*	*ND*	*ND*	*6.6*	*6.2*	*5.3*	*ND*
- Other	*ND*	*ND*	*ND*	*ND*	*ND*	*10.0*	*ND*	*ND*	*6.1*	*4.9*	*8.2*	*ND*

ND = No Data

A special effort was made to include background data for category 6A *'Solid waste disposal'* in the CRF files. Trend information on IPCC Tier 2 method parameters that change over time are provided in *Table 8.2* and additional information on the composition of landfilled waste for selected years is provided in *Table 8.3*. The change in DOC values is amongst others due to the prohibition of landfilling combustible wastes, whereas the change in k values is caused by a strong increase of the recycling of vegetable, fruit and garden waste in the early 1990s. The integration time for the emission calculation is for all years the period from 1945 to the year for which the calculation is made.

The following primary data sources are used for the annual activity data used in the emission calculations:

- waste production and handling: Working Group on Waste Registration (WAR), CBS, RIVM;
- methane recovery from landfills: VVAV (until 1998); RIVM estimates from 1999.

8.2.3 Uncertainty and time-series consistency

The uncertainty in CH_4 emissions of solid waste disposal sites is estimated to be about 35% in annual emissions (see *Section 1.7* for more details).

The CH_4 emission trend for landfills is summarised in *Table 8.4*. In this table is also shown that the amount of CH_4 has been recovered (mostly for energy use). In the period 1990-2001 the emissions of CH_4 have decreased from 562 to 390 Gg per year (-30%). This decrease is due to the threefold increase of the amount of CH_4 recovered from about 5% in 1990 to 18% in 2001 (*Table 8.4*), but also due to the decrease of the amount of methane produced in solid waste disposal sites. The main factors that influence the quantity of CH_4 produced are the *amount* of waste disposed of on land (see *Table 8.4*) and the *concentration* of C (carbon) in that waste (see *Table 8.3*).

Table 8.4. Net methane emissions and methane recovered from solid waste disposal sites 1990-2001(unit: Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CH_4 emissions (net)	562	556	540	522	505	479	477	464	445	428	404	390
CH_4 recovered/flared	27	37	47	58	68	78	73	73	76	76	86	86
% of gross emissions	5%	6%	8%	10%	12%	14%	13%	14%	15%	15%	18%	18%

Note: Recent data suggest that in the last five years the amount of CH_4 recovered and the net emissions are lower than the figures presented here (about 20 Gg in 2001).

Table 8.5. Waste disposal (excluding discharge into surface water)(Tg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Incinerated	3.9	4.1	4.0	3.8	4.4	4.7	5.6	6.7	6.8	7.1	7.2	7.5
Reused/recycled	30.6	32.6	33.4	33.1	34.9	37.7	39.4	42	43.3	43.5	43.4	45.7
Landfilled	13.9	11.9	11.6	11.2	9.0	8.2	6.7	5.8	5.5	5.5	4.8	4.8

Since 1990, the amounts of waste disposed in landfills as well as the concentration of carbon (C) have decreased, resulting in a smaller production of CH_4. These decreases are the result of environmental policy in the Netherlands to minimise the disposal of waste in landfills and to increase recycling and incineration of waste. *Table 8.5* shows the trend in waste handling in the Netherlands for the period 1990-2001. It clearly shows that the amount of waste disposed in landfills decreased substantially. However, preliminary data for 2001 indicate that this steady decrease has now levelled off.

8.2.4 Source-specific planned improvement

Recently a refined data analysis and improved emission calculation was made, which suggests that gross annual emissions and in the last five years the amount of CH_4 recovered are lower than the figures presented in *Table 8.5*. This would result in net methane emissions that may be about 10 Gg lower in 1990 and about 20 Gg less in 2001. The results of this analysis will be reported in the NIR 2004 submission.

8.3 Wastewater handling (6B)

8.3.1 Source category description

CH_4 emission from wastewater handling (category 6B) is identified as key source (trend) in *Box 8.1*. Its present share of CH_4 emissions in the national total was 0.2% (0.5% in 1990). N_2O emissions from wastewater treatment or considered to be no key source; they have at present a share of 1% in total emissions (0.7% in 1990).

8.3.2 Methodological issues

For CH_4 and N_2O emissions from wastewater handling country-specific methodologies are used, which are both equivalent to the IPCC Tier 2 methods. A full description of the methodology is provided in Spakman *et al.* (2003). Since the CH_4 emissions from wastewater handling are a key source (see *Box 6.1*), the present Tier 2 methodology does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

8.3.3 Uncertainties and time-series consistency

In *Table 8.6* an overview of the trend in greenhouse gas emissions from wastewater handling is given. Since 1990, CH_4 emissions from wastewater treatment plants decreased due to the introduction of a new sludge stabilisation system in one of the largest wastewater treatment plants in 1990, of which the operation took a few years to get optimised. This caused larger venting emissions in the introductory period than during normal operation conditions. From *Table 8.7* it can be concluded that 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 8.6. Wastewater handling emissions of methane (in Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Net CH_4 emissions	6.6	6.0	2.4	6.3	5.1	1.5	1.3	0.8	3.6	2.1	0.8	0.8
CH_4 recovered and/or flared	27.6	32.6	33.3	32.7	NE	37.8	37.3	39.5	34.3	37.9	40.2	40.2
Recovery/flared (% of gross emiss.)	81%	84%	93%	84%	NA	96%	97%	98%	90%	95%	98%	98%

Table 8.7. Wastewater handling: composition (unit: Gg DOC/yr [1])

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Wastewater	933	940	948	960	970	921	921	916	930	915	921	921
Sludge	254	263	248	246	251	269	283	270	279	282	281	281
Total	**1187**	**1203**	**1196**	**1206**	**1221**	**1190**	**1204**	**1186**	**1209**	**1197**	**1202**	**1202**

[1] DOC: Degradable Organic Component.

8.4 Waste incineration (6C)

8.4.1 Source category description

The source category waste incineration is included in source category 1A1 '*Energy industries*', since most waste incineration facilities also produce electricity or heat used for energetic purposes and according to the *IPCC Guidelines* (IPCC, 1997) these should be reported under category 1A1a.

8.4.2 Methodological issues

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 which are included in the ER-I dataset. The fossil-based CO_2 emissions from *waste incineration* (e.g. plastics) are calculated from the total amount of waste that has been incinerated, split into 8 waste types, each with a specific carbon content and fraction of fossil C in total C, based on an analysis by De Jager and Blok (1993).

The CH_4 and N_2O emissions from these sources are also included in the ER-I dataset. For N_2O an emission factor of 20 g/ton waste is applied. A more detailed description of the methodology is provided in Spakman *et al.* (2003).

8.4.3 Uncertainties and time-series consistency

The source category waste incineration is included in category 1A1 (Energy industries) as a part of the subsource '*Public Electricity and Heat Production*', see *Section 3.2.1*. The emissions of this source are not specified separately.

8.5 Other waste handling (6D)

8.5.1 Source category description

This source category consists of emissions from ambiguous subsources, mostly CO_2 emissions of about 0.5-1 Tg and incidentally some CH_4 emissions (in 1996) (see *Table 8.1*). This source category is not considered as a key source.

8.5.2 Methodological issues

For this source category country-specific methodologies are used. The estimations are based on environmental reports from individual companies. As the set of individual companies is different for all years, it may happen that for some year a very plant-specific emission is reported that does not occur in the emissions dataset of other years. Since this source is not considered as a key source (see *Box 8.1*), the present methodology level does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

8.5.3 Uncertainties and time-series consistency

In the Dutch PER the waste sector uses ambiguous source descriptions and these change over time. Therefore the allocation of these sources is subject to interpretation. In the NIR 2003 the allocations for the years 1990 and 1995-2001 are based on the source descriptions for 2000. In doing so the trend in 6D remains unsatisfactory, but given the current dataset in the PER we conclude that it is not possible to improve the trend until a revised dataset has been calculated by the Task Force ENINA.

8.5.4 Source-specific recalculations

All data sets for 1990 and for 1995-2001 were checked for possible false allocations of (biomass) fuels. This action led to a change in the CO_2 emissions from biomass in several years. In addition also the other data for the waste sector were analysed. These actions changed the CO_2 emissions in category 6D as shown in *Table 8.8*. However, further study into the (biomass) data in waste combustion (reported under 1A and 6D) is necessary to finalise the organic CO_2 from biomass data and the non-organic CO_2 from waste handling activities.

Table 8.8. Effect of recalculation of CO_2 (Tg) emissions from 'Other waste' (category 6D)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NIR2003	0.9	0.0	0.0	0.0	0.0	0.9	1.1	1.2	0.5	1.0	0.4
NIR2002	0.5	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.6	0.5	0.5
Difference	***0.4***	***0.0***	***0.0***	***0.0***	***0.0***	***0.8***	***1.1***	***1.1***	***-0.1***	***0.6***	***-0.1***

9. OTHER [CRF sector 7]

9.1 Overview of sector

The Netherlands uses this source category to report all sources that cannot be properly allocated to one of the subcategories of the standard IPCC source sectors 1 to 6, either because of the definition of the source does not match with the IPCC classification or because the CRF (following IPCC recommendations) erroneously does not permit to report emissions of specific gases under these sectors. *Table 9.1* lists both the sources reported here as well as their emission trends. It shows that the N_2O emissions reported under this category are assumed to remain constant over time.

Table 9.1. Trend in emissions from the other sector (category 7) (CO_2 in Tg; others in Gg)

Gas/subsource	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2												
a. Solvents and other product use	0.2	0.0	0.0	0.0	0.0	0.4	0.4	0.5	0.5	0.6	0.4	0.4
CH_4												
a. Solvents and other product use	0.1	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
b. Degassing drinking water [1)]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.8
N_2O												
c. Polluted surface water	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8

[1)] From ground water.

From *Box 9.1*, in which the key and non-key sources of this sector are presented based on level, trend or both, we can conclude that N_2O from polluted surface water is a (level) key source.

Box 9.1. Key source identification in the 'Other' source sector 7 using the IPCC Tier 1 and 2 approach (L = Level, T = Trend)

7	CH_4	Misc. CH_4	Non-key
7	CO_2	Misc. CO_2	Non-key
7	N_2O	Misc. N_2O	Non-key
7	**N_2O**	**Polluted surface water**	**Key (L)**

9.1.1 Source category description

Miscellaneous non-industrial CO_2 sources

The small CO_2 emissions labelled in *Table 9.1* as '*Solvents and other product use'* consist of emissions from fireworks. These emissions are reported here for historical reasons.

Miscellaneous non-industrial CH_4 sources

Some minor sources of CH_4 emissions from non-industrial, non-combustion sources have been included in the Netherlands' inventory, but these are reported in category 7 '*Other*' instead of in category 3, since the CRF table for that category erroneously do not allow for methane to be reported. These sources are:

- emissions from fireworks (also a negligible source of N_2O);
- emissions from paints and lacquers and from food storage/warehouses;
- degassing of drinking water;
- burning of candles.

The latter is a new source introduced in the Dutch Emission inventory in 2002. Activity data were based on an amount of candle burning of 2.2 kg per person per year (Van Harmelen *et al.,* 2002).

CH_4 emissions from (agricultural) soils decreased in last 40 years due to drainage and lowering of water tables and are estimated on the basis of the methane background document (Van Amstel *et al*., 1993). Since the IPCC methodology only considers CO_2 sinks, these reduced CH_4 emissions have been included in the natural total, although they act as a methane sink. Therefore, they are not reported as anthropogenic emissions under IPCC category 7.

Miscellaneous N_2O sources

In addition, one source of N_2O is reported under this source sector 7: '*Polluted surface water'*. This comprises the indirect N_2O emissions from leaching and run-off, which are calculated as a fixed value that comprises leaching and run-off from agricultural activities (3/4) and from other nitrogen sources (1/4), including human sewage. More details on this source can be found in Spakman *et al.* (2003) and Kroeze (1994). Since this figure includes more than only agriculture related emissions we do not report these under 4.D but as a separate source in category '7' (see also *Section 6.4*). Total N_2O emissions from leaching and run off are 3.8 Gg N_2O. The N_2O emissions stemming from agriculture are thus 3/4 * 3.8 = 2.85 Gg N_2O; the other part stems from NO_x emissions from transport and stationary combustion sources.

9.1.2 Methodological issues

Nitrous oxide emissions from polluted surface water, comprising indirect N_2O emissions from leaching and run-off, is identified as a (level) key source and the methodological aspects are addressed in *Sections 9.1.1* and *6.4*. The Netherlands does not use the IPCC method to estimate these indirect N_2O emissions from leaching and run-off; N_2O emissions from atmospheric deposition emissions are not estimated. Since the emissions are a key source (see *Box 9.1*), the present methodology does not fully comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

For other sources reported here also country-specific methodologies are used. The estimations are based on statistics from suppliers of products. Methane from food storage/warehouses is also reported in annual environmental reports from individual companies. Since these emissions are not considered to be key sources (see *Section 1.5*), the present methodology level does comply with the *IPCC Good Practice Guidance* (IPCC, 2000).

9.1.3 Uncertainties and time-series consistency

The uncertainty of N_2O emissions from polluted surface water is estimated to be 200% in annual emissions (see *Section 1.7* for more details). The uncertainty of N_2O is expected to be rather large due to inherent uncertainty in the emission factors, and because of the correlation with the N_2O emissions from other sources. The uncertainty of the other sources is estimated to be in the range 25-50% (*Section 1.7*).

It is expected that the N_2O emissions from polluted surface water will, in practice, vary from year by year, but because no detailed data are available the emissions from this source are kept constant (see *Table 9.1*). It can be observed in *Table 9.1* that CO_2 and CH_4 emissions from the solvent use subcategory can vary substantially over time. This may be attributed partly to changes in the groups of individual firms reporting in every year.

9.1.4 Source-specific planned improvements

The present methodology used to estimate indirect N_2O emissions from agricultural soils, here reported as *N_2O from polluted surface water*, does not fully comply with *IPCC Good Practice Guidance* (IPCC, 2000). For this reason actions are taken to revise and expand calculations to be in accordance with *IPCC Good Practice Guidance*.

10. RECALCULATIONS AND IMPROVEMENTS

In this chapter we outline the key differences compared with the previous submission reported by Olivier *et al.* (2002). Because most changes are only minor and, since recalculations have not been performed for all the years prior to 1998 but mostly only to 1990 and 1995, emission figures have, in general, remained unchanged for the years 1991-1994 compared to the previous submission. The minor alterations that have been made are explained in the following sections. The emission data presented in this report are identical to those officially published for 1990, 1995 and 1999-2001 in the *Emission Monitor 2002* (Koch *et al*., 2002) and used in RIVM (2002a), except for a revision of CO_2 from waste incineration (reported under source category 1A1 *'Energy sector'*) for the years 1990 and 1995-2001. The last mentioned action led to a decrease in CO_2 emissions compared to those reported by Koch *et al*. (2002) of about a half Mton (see *Section 10.1.3* for details).

10.1 Explanation and justification for recalculations

This section will elaborate the relevant changes in emission figures compared to the last NIR. A distinction is made between:

- *Methodological changes:* new data based on revised or new estimation methods; improved emission factors are also included under methodological changes;
- *Allocation:* changes in allocation of emissions to the different sectors (only affect the totals per sector);
- *Error corrections:* repair of incorrect data transfer from the PER to the CRF.

In 2002, recalculations or methodological changes were made for the years 1990, 1995, 1999, 2000 and (new) 2001. This means that for 1991-1994 and 1996-1998 no recalculations have been made, except in the cases explicitly mentioned below.

10.1.1 Methodological changes

The following methodological changes were made for greenhouse gases:

- Recalculation of N_2O emissions from nitric acid production (1991-1994; 1996-1998) based on the method for 1990, 1995 and 1999-2001 (years that were recalculated prior to the previous submission);
- Recalculation of CH_4 and N_2O emissions from wastewater handling (1990-2001);
- Revision of HFC emissions for the years 1994-2001 based on improved analysis of data;
- Revision of SF_6 emissions for the years 1994-2001 based on improved analysis of data.

For precursor gases the following changes were made:

- Recalculation of the NO_x emissions from inland navigation based on improved emission factors (1990-2001);
- Recalculation of NO_x emissions from small stationary combustion sources (less than 20 MW) for the years 1990, 1995, 2000 and 2001 based on new emission factors.

10.1.2 Source allocation

In this submission the source allocation was improved in the following cases:

- *Waste*: The Dutch PER uses ambiguous source descriptions for the waste sector and these have changed over time. Therefore the allocation of these sources is subject to interpretation. In the NIR 2003 an allocation was selected based on the source descriptions for 2000. In doing so the trend in 6D remains unsatisfactory, but given the current dataset in the PER we conclude that we can not improve the trend until a revised dataset has been calculated by the Task Force ENINA.
- *Other fuels in fuel combustion*: In the NIR 2002 the combustion emissions with no or incomplete activity data were allocated to the category *'Other fuels'*. The allocation of emissions of derived

fuels and LPG to the categories liquid, solid and gaseous fossil fuels was done manually. We discovered some flaws in the allocation of LPG last year; not all LPG was allocated under liquid fuels. Therefore, the fuel split was improved in this NIR 2003, using a standard query in the database. In this way we established a uniform fuel split (using the same rules) for all years, an action that led to shifts in the fuel allocation, especially for liquids (due to LPG) and solids (due to derived gases) compared to last submission (see also *Section 10.4*).
- *Industrial processes:* The emissions from industrial processes for the years 1996 and 1997 were for NIR 2003 provided with the newest source codes (as used for the years 1990, 1995, 1998-2001). Therefore the allocation of the emission to sector 2 for these years is now in fully consistent with the allocation for the years 1990 and 1995, and 1998 to 2001. The use of the new reporting codes also influenced the emissions in 6D, since process emissions from waste recycling industries were erroneously allocated (manually) to 1A in the previous submission.

10.1.3 Error corrections

While reallocating the emissions we detected a few errors due to the previous data transfer from the PER to the CRF. Furthermore, the Task Forces detected some errors. After removing the errors, all emissions were allocated to the appropriate CRF (sub)categories. These actions also led to changes in emissions per category and in national total emissions. The most obvious error corrections were:
- Removal of double counting for CO_2 in category 2G *'Industrial processes'* (desulphurisation of flue gas) (1990);
- CO_2 emissions from Fuel combustion in (1A2f) (1990, 1995,1998 and 1999 to 2000);
- CO_2 emissions in Energy industries (1A1) (1999);
- Corrected data in the CRF Feedstock Table 1Ad for 1994, and 1999 to 2001, related to different definitions of non-energetic use of coal and cokes in the iron and steel sector;
- All data sets for 1990, 1995 to 2001 were checked for possible incorrect attribution of CO_2 from combustion of biomass fuels to emissions included in the national total;
- N_2O from agricultural soils (1990 and 2000).

The last action on CO_2 emissions from biomass combustion sources led to a change in the CO_2 emissions from biomass for several years as presented in *Table 10.1*. The CO_2 emissions included in the national total were modified by an equal but opposite amount.

Table 10.1. Comparison of CO_2 emissions from biomass in the NIR 2002 and NIR 2003 (in Tg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NIR 2003	3.4	2.7	2.6	3.3	3.5	3.6	5.2	6.0	5.4	5.0	5.2
NIR 2002	3.5	2.7	2.6	3.3	3.5	3.5	4.5	5.3	4.9	4.9	5.0
Difference	***-0.2***	***0.0***	***0.0***	***0.0***	***0.0***	***0.1***	***0.7***	***0.7***	***0.5***	***0.1***	***0.2***

Note: The CO_2 emissions included in the national total were modified by an equal but opposite amount.

The last mentioned action had an effect on the CO_2 emissions in 1A4 and 1A1, and 6D and also led to a decrease in CO_2 emissions compared to those reported by Koch *et al, 2002*. The differences amount to about a half Mton: 0.3 Tg for 1990, 0.5 Tg for 1995, 0.5 Tg for 1999, 0.7 Tg for 2000 and 0.6 Tg for 2001. We conclude that further study into the (biomass) data in waste combustion (reported under 1A) is necessary to finalise the CO_2 from biomass data.

From 1999 onwards the iron and steel industry reported cokes and coal use partly as final non-energetic use and partly as input for transformations. For the years prior to 1999, a larger portion of the fuel use was reported as final energetic use. Detailed analysis of the 1994 data led to the conclusion that this 'new' definition for the energy use/non-energy use split was accidentally also used in 1994. To achieve a consistent time series we reinterpreted the coal and cokes figures from the national energy statistics according to the old definition. The consequences of these changes for the non-energy use of energy (feedstocks) in table 1Ad compared to the previous NIR are illustrated in *Table 10.2*.

Table 10.2. Comparison of non-energy use (feedstock) used in the NIR 2002 and NIR 2003 (in PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
NIR 2003												
Coal	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.5	0.1
Coke	5.4	3.9	3.9	3.5	3.6	3.5	4.0	3.7	3.6	4.0	4.1	4.1
Total	**334**	**423**	**400**	**350**	**358**	**359**	**333**	**369**	**358**	**385**	**419**	**426**
NIR 2002												
Coal	0.2	0.2	0.2	0.1	4.2	0.2	0.3	0.4	0.4	NE	NE	
Coke	5.4	3.9	3.9	3.5	13.4	3.5	4.0	3.7	3.6	NE	NE	
Total	**334**	**423**	**400**	**350**	**372**	**359**	**333**	**369**	**358**	**381**	**415**	
Differences												
Coal	*0%*	*0%*	*0%*	*0%*	*3736%*	*0%*	*0%*	*0%*	*0%*			
Coke	*0%*	*0%*	*0%*	*0%*	*270%*	*0%*	*0%*	*0%*	*0%*			
Total	***0%***	***0%***	***0%***	***0%***	***-3.9%***	***0%***	***0%***	***0%***	***0%***	***1.1%***	***1.1%***	

Note: Only fuels for which recalculations have been performed are reported.

10.2 Implications for emission levels

This section outlines the implications of the different improvements, as described in *Section 10.1,* for the emission levels over time. *Table 10.3* elaborates the differences between the submissions from last year and the current NIR on level of the different greenhouse gases. More detailed explanations are elaborated in the sectoral *Chapters 3 to 9*.

Table 10.3. Differences between NIR 2002 and NIR 2003 for 1990-2000 due to recalculations

Gas	Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 [Tg]	NIR 2002	**158.2**	166.0	164.2	166.1	166.8	171.4	178.3	167.8	173.7	170.8	172.1
Incl. LUCF	NIR 2003	**157.8**	166.0	164.2	166.1	166.8	171.2	178.9	167.5	172.4	169.5	172.4
	Difference	***-0.2%***	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*-0.1%*	*0.3%*	*-0.2%*	*-0.7%*	*-0.8%*	*0.2%*
CO_2 [Tg]	NIR 2002	**159.6**	167.5	165.7	167.9	168.8	172.7	179.7	169.0	175.1	172.1	173.5
Excl. LUCF	NIR 2003	**159.3**	167.5	165.7	167.9	168.8	172.4	180.3	168.7	173.8	170.7	173.8
	Difference	***-0.2%***	***0.0%***	***0.0%***	***0.0%***	***0.0%***	***-0.1%***	***0.3%***	***-0.2%***	***-0.7%***	***-0.8%***	***0.2%***
CH_4 [Gg]	NIR 2002	**1293**	1309	1257	1226	1203	1170	1173	1101	1065	1038	983
	NIR 2003	**1292**	1309	1253	1226	1203	1170	1174	1100	1065	1037	983
	Difference	***0.0%***	*0.0%*	*-0.3%*	*0.0%*	*0.0%*	*0.0%*	*0.2%*	*-0.2%*	*0.0%*	*0.0%*	*0.0%*
N_2O [Gg]	NIR 2002	**53.3**	61.9	63.4	63.5	65.2	58.6	65.3	68.1	57.5	56.0	54.8
	NIR 2003	**53.4**	54.2	57.9	60.2	59.1	58.6	57.9	57.4	56.9	56.0	53.7
	Difference	***0.1%***	*-12.4%*	*-8.7%*	*-5.2%*	*-9.4%*	*0.0%*	*-11.4%*	*-15.7%*	*-1.1%*	*0.0%*	*-1.9%*
PFCs [Mg]	NIR 2002	353	354	304	307	273	**269**	295	312	246	203	214
	NIR 2003	353	354	304	307	273	**269**	295	312	246	203	214
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***0.0%***	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
HFCs [Mg]	NIR 2002	379	412	388	433	604	**653**	931	1424	1489	1133	1071
	NIR 2003	379	295	406	474	680	**700**	1113	1496	1585	1196	1053
	Difference	*0.0%*	*-28.4%*	*4.6%*	*9.4%*	*12.7%*	***7.2%***	*19.5%*	*5.0%*	*6.4%*	*5.6%*	*-1.7%*
SF_6 [Mg]	NIR 2002	7.8	4.2	4.5	4.6	6.2	**15.1**	15.3	16.1	15.4	14.1	13.7
	NIR 2003	7.8	4.2	4.5	4.6	6.2	**11.5**	11.9	13.0	12.3	11.1	11.2
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***-23.7%***	*-21.9%*	*-19.2%*	*-20.2%*	*-21.2%*	*-17.8%*
Total	NIR 2002	208.9	220.0	217.0	218.9	220.7	222.4	232.8	222.8	225.2	216.6	215.5
[Tg CO_2-eq.]	NIR 2003	208.6	216.3	215.2	217.8	218.9	222.1	231.5	219.1	223.8	215.2	215.4
Incl. LUCF	*Difference*	*-0.2%*	*-1.7%*	*-0.9%*	*-0.5%*	*-0.8%*	*-0.1%*	*-0.55%*	*-1.64%*	*-0.62%*	*-0.6%*	*0.0%*
Total.	NIR 2002	210.3	221.5	218.5	220.7	222.6	223.6	234.2	224.0	226.5	217.8	216.9
[Tg CO_2-eq]	NIR 2003	210.0	217.8	216.7	219.6	220.9	223.3	232.9	220.3	225.2	216.4	216.8
Excl. LUCF	*Difference*	*-0.2%*	*-1.7%*	*-0.9%*	*-0.5%*	*-0.8%*	*-0.1%*	*-0.6%*	*-1.6%*	*-0.6%*	*-0.6%*	*0.0%*

Note: base year values are indicated in bold.

10.2.1 Recalculation of base year and (now final) year 2000

Base year (1990 for CO_2, CH_4 and N_2O and 1995 for F-gases)

The total CO_2-eq. emissions in the base year 1990 decreased by 0.3 Tg CO_2-eq or 0.2% compared to last submission. This decrease can be explained by the following most relevant changes (all in CO_2 equivalent):

- For CO_2: -0.6 Tg in the category *Energy* (1A) mainly due to error correction in 1A4 and reallocation to *Waste* (6); +0.4 Tg in *Waste* (6D) on the basis of improved allocation of fuel related emissions; and -0.1 Tg in *Industrial processes* (2G) due to removal of double counting;
- For other gases the changes are very small: -0.004 Tg for CH_4 in *Energy* (1A) and *Waste* (6) and +0.03 Tg for N_2O in *Agricultural Soils* (4B) due to error corrections;

The changes for F-gases in 1995 (the base year for the F-gas emissions) due to recalculations are very minor (rounded 0.0 Tg CO_2-eq.): +0.04 Tg for HFCs and -0.086 Tg for SF_6 emissions. Improved data and changes in source allocation can explain the remainder of the differences in emissions.

Year 2000: now final data

The data for 2000 are now 'final'; in the previous submission they were partly based on preliminary statistics. The increase in the total CO_2-eq. emissions for 2000 was 0.1 Tg CO_2-eq or 0.04 % compared to last submission. For the finalisation of the 2000 figures a different estimation method is used which implicitly leads to changes in emission data.
The main changes are (all in CO_2 equivalent):

- For CO_2 *:* +0.5 Tg in *Energy* (1A) due to the use of final energy statistics; -0.1 Tg in *Industry* (2) due to reallocation to *Energy* (1A); and -0.1 Tg in *Waste* (6) due to reallocation to *Energy* (1A);
- For CH_4 : +0.02 Tg in *Energy* (1) mainly due finalisation of 1B2; -0.03 Tg in *Industry* (2); +0.06 Tg in *Agriculture* (4A Enteric fermentation) based on final agricultural statistics; -0.04 Tg in *Waste* (6), mainly based on final figures for *Wastewater handling* (6B) and *Waste disposal* (6A);
- For N_2O: - 0.3 Tg mainly due the finalisation of the agricultural soil emissions (4D);
- For HFCs and SF_6: -0.04 Tg and -0.06 Tg, respectively, due to recalculations

10.2.2 Recalculation of other years/gases

Years 1991-1994

The decrease in the total CO_2-eq. emissions in 1991 to 1994 compared to the last submission amounts to 3.8, 1.9, 1.1 and 1.7 Tg CO_2-eq or 1.7, 0.9, 0.5 and 0.8%, respectively. As can be concluded from *Table 10.2,* the gases N_2O and HFCs almost completely account for these changes. For these years, the emissions from *nitric acid production* (2B2) were recalculated according the method used previously for the other years. The HFCs emissions were recalculated with improved consumption data per application. For 1992 the recalculation of the CH_4 emission from *wastewater handling* (6B) also contributed to the decrease in total emissions.

Year 1995

The decrease in the total CO_2-eq. emissions in 1995 was 0.3 Tg CO_2-eq or 0.1%, compared to the last submission: CO_2 emissions decreased by 0.3 Tg due to error correction in *Energy* (1A2). CH_4 and N_2O emissions did not change.

Years 1996-1999

The decrease in the total CO_2-eq. emissions in 1996 to 1999 compared to last submission amounts to 1.3, 3.7 , 1.4 and 1.4 Tg CO_2-eq or 0.5%, 1.6%, 0.6% and 0.6%, respectively. The main changes are (all in CO_2 equivalent):

- CO_2 emissions changed due to reallocation of emissions thanks to improved fuel type identification and the use of the newest reporting codes (mostly from 1A1 to 6D) and error corrections from the previous submission (such as in 1A2f in 1998 and 1999 (-0.7 Tg) and 1A2g for 1999 (-0.8 Tg));
- CH_4 emissions changed in 1996 and 1997 due to recalculations in *Wastewater handling* (6B) and an error correction in 1A4 in 1996. For 1999 a minor error was corrected;
- N_2O emissions from *Nitric acid production* [2B2] were recalculated for the years 1996 to 1998 according the method used for the other years. For 1999 a minor error was corrected;
- HFCs and SF_6 emissions that were also recalculated according to the method used for the other years.

10.3 Implications for emission trends, including time-series consistency

The recalculations, in general, account for an improvement in the overall emission trend. Data for all greenhouse gases for the years 1990, and 1995 to 2001 are now consistent in methodology and allocation. The differences in national total emissions per compound are presented in *Table 10.3* for each year in the period 1990 to 2000. The change in the 1990-2000 trend for the greenhouse gas emissions compared to the previous submission is presented in *Table 10.4*. From this table it can be concluded that due to recalculations the trend in the total national emissions increased by 0.1% compared to the NIR 2002. The largest relative changes in emission trends are observed for N_2O, HFCs and SF_6.

Table 10.4. Differences between NIR 2002 and NIR 2003 for the emission trends 1990-2000

Compound [unit]	**Trend (absolute change)**			**Trend (%)**		
	NIR 2002	NIR 2003	*Difference*	NIR 2002	NIR 2003	*Difference*
CO_2 [Gg] [1)]	13,897	14,570	*673*	8.7%	9.1%	*0.4%*
CH_4 [Gg]	-310	-309	*1*	-24.0%	-23.9%	*0.0%*
N_2O [Gg]	1.5	0.4	*-1.1*	2.8%	0.7%	*-2.1%*
HFCs [Mg]	692	674	*-18*	182.7%	177.9%	*-4.8%*
PFCs [Mg]	-139	-139	*0*	-39.3%	-39.3%	*0.0%*
SF_6 [Mg]	5.9	3.4	*-2.4*	74.9%	43.7%	*-31.2%*
CO_2-eq. [Gg] [1)]	6,568	6,812	*244*	3.1%	3.2%	*0.1%*

[1)] Excluding LUCF.

The trends for all gases for all years on a more detailed level can be found in the CRF file for 2001 (CRF Tables 10), which are also reproduced in *Annex 7.3*. Furthermore, additional information on the trends is given in the sectoral sections. Although the allocation of sources is uniform due to the ambiguous source descriptions and differences in data quality, the trends on the (sub)sector level may show more fluctuations. The years 1991-1994 were not recalculated completely (i.e. either not or only partially for 1A1, 1A2 and 1A5; 2A, 2D, 2G; 3; and 6B and 6D); especially the CO_2 emissions do not match the overall trend.

10.4 Recalculations, response to the review process and planned improvements

10.4.1 Revised source allocations

For domestic purposes, emissions in the Netherlands are grouped by the so-called Target Sectors on which environmental policy is focused. The definition of these sectors is provided in Olivier *et al.* (1999). An updated correspondence table for emissions from Target sectors and IPCC source categories is provided in *Table 1.1*. As a further step towards uniform reporting at the more detailed source category level of the Common Reporting Format (CRF), all subcategories at the lowest aggregation level currently used for reporting for domestic purposes (so-called reporting codes (in Dutch: 'rap-codes') have received an additional attribute 'IPCC subsector'. In the year 2001 the reporting codes used in past years, were revised in order to improve the link between Netherlands' emissions sources and IPCC subsectors. Based on these new reporting codes, improvements of the related reporting code have been made to the IPCC sector correspondence table. This was done to achieve the best possible compliance with source category definitions in the *Revised 1996 IPCC Guidelines* within the constraints of lowest subsource categories currently identified (reporting codes) in the Netherlands' *Pollutant Emission Register* (Coenen and Olivier, 2002).

All emission data in this submission for the years 1990, 1995, 1999, 2000 and 2001 were submitted to the Netherlands' Emission Registration system using the updated source codes, resulting in a totally comparable source allocation in the CRF for these years. Especially for CO_2 (and related combustion emissions), this resulted in reallocations between and within categories 1, 2 and 6, mainly due to improved identification of combustion, process and biomass emissions in the inventory data (see also *Section 10.1*).

For the years 1996 and 1997, the process emissions in industry were submitted using the updated rapcodes, resulting in a change in allocation within these categories and error corrections in the related combustion emissions in the energy sector.

The historic inventory datasets used for reporting data for the 1991-1994 period were only partly revised and thus, the overall source allocation did not change for these years. Nevertheless, a detailed fuel allocation for CO_2 was made for the subsectors within category *Other sectors* (1A4) for the years 1991-1994.

10.4.2 Completeness of sources

The Netherlands greenhouse gas emission inventory includes all sources identified by the *Revised IPCC Guidelines* **except** for the following:

- Indirect N_2O emissions from *atmospheric deposition* (category 4D) are not estimated/reported;
- CO_2 emissions from *agricultural soils* (category 4D) are not estimated/reported;
- In addition, it has been observed that *CH_4 and N_2O from manure of horses* (category 4B) is missing due to the fact that until now no manure production estimates from horses are being made and no emission factors for this source category have been defined;
- CH_4 emissions from soils deceased in the last 40 years due to drainage and lowering of water tables; these emissions have been included in the natural total; so there are no net (positive) anthropogenic emissions;
- CH_4, N_2O and other non-CO_2 emissions from *international bunkers* have not yet been estimated/reported. The results of a study in 2002 into these emissions will be implemented in the next NIR.

Two new sources were introduced in the Dutch Emission inventory in 2002; burning of candles and smoking of cigars. Emissions of NMVOC and methane emissions are included for these sources in the CRF for all years. For details on sources reported elsewhere, see the Completeness Table for 1990 listed in *Annex 5* (and in the documentation boxes in the CRF files).

A survey made to check for possibly unidentified sources of non-CO_2 emissions in the Netherlands showed that some minor sources are not included in the present greenhouse gas inventory (DHV, 2000):

- CH_4: notably large-scale compost production from organic waste and wastewater treatment; to be included when monitored regularly.
- N_2O: notably large-scale compost production from organic waste and wastewater treatment; to be included when monitored regularly.
- PFCs and SF_6: some minor sources; to be included when monitored regularly.

These sources may be included at a later stage, when it has been decided to monitor them regularly.

10.4.3 Changes in CRF files compared to the previous submission

The tables included in the *Annex 7* represent the *printed summary version* of the 2003 Netherlands' annual submission of the CRF files of its greenhouse gas emission inventory in accordance with the UNFCCC and the European Union's *Greenhouse Gas Monitoring Mechanism.* These include:

- IPCC Summary Tables 7A for the base years 1990 and 1995, and for the last two years (2000 and preliminary 2001) (CRF Summaries 1);
- Trend Tables 10 for each gas individually and for all gases and source in CO_2-eq. (is included in the file *Netherlands - submission 2003 v 2.0 - 2001.xls*);
- Trend Tables 10 for precursor gases (in file *Netherlands - submission 2003 v 2.0 - 2001.xls*);
- Recalculation Tables and Explanation Table 8.a and 8.b for base years 1990-2000.

Completeness Table 9 for 1990 has been included in *Annex 5*. The largest changes are (see copy of recalculation checklist below):

- Data for 1999 and 2000 were updated (2000 data were preliminary in the previous submission);
- Data for 2001 have been added (all figures for 2001 are preliminary data);
- Data for 1990-1998 were updated according to the latest data and methodology. See also *Sections 10.1* to *10.4*), including changes announced in the previous three inventory reports;
- More detailed data have also been added to the set of CRF files that accompany this report:
  - For *fuel combustion* (IPCC category 1A) in particular, the split of the emission data per sector by fuel type was uniformed in the years 1990, 1995 to 1999 and improved for the fossil-fuel types solid, liquid and gaseous fuels. For the years 1999 to 2001 this could not be done to a large extent due to limited detail in the reports of the individual companies that make up the largest part of the source categories 1A1 and 1A2;
  - The fuel split and related emissions in *Other sectors* (1A4) are included for the years 1991 to 1994;
  - Corrected data in the CRF Feedstock Table 1.A.d. for 1994 and 1999 to 2001 due to non-uniform definitions of non-energetic use of coal;
  - Revised data (including additional information) for Wastewater handling (6B) for the total time series;
  - Additional information on *Waste disposal* (6A and 6C).
- For LUCF subcategories (5D) we introduced the amounts of limestone and dolomite, but the corresponding emission estimates for CO_2 are not yet available;
- The CRF data were transposed into the new CRF file format and, doing so, the use of notation keys was updated and completed.

In the files for 1991 to 1994, only data for HFCs and N_2O from nitric acid production and wastewater treatment have been changed due to the earlier mentioned improvements.

Status reports on recalculations

We have summarised the CRF status reports on recalculations below for your information.

Recalculations for 1991-1994:

Recalculation:	Energy	Ind.Processes	Solvent Use	LUCF	Agriculture	Waste
CO_2	☑	☐	☐	☐	☐	☐
CH_4	☑	☐	☐	☐	☐	☐
N_2O	☑	☐	☐	☐	☐	☐
HFCs, PFCs, SF_6		☑				
Explanations:	☑	☑	☐	☐	☐	☐
Recalculation tables for all recalculated years:			☑			
Full CRF for the recalculated base year:			☑			

Recalculations for 1990, 1995-1999: recalculations based on more detailed data

Recalculation:	Energy	Ind.Processes	Solvent Use	LUCF	Agriculture	Waste
CO_2	☑	☑	☐	☐	☐	☑
CH_4	☑	☐	☐	☐	☐	☑
N_2O	☑	☐	☑	☐	☑	☑
HFCs, PFCs, SF_6		☐				
Explanations:	☑	☑	☐	☐	☑	☑
Recalculation tables for all recalculated years:			☑			
Full CRF for the recalculated base year:			☑			

Recalculations for 2000: full recalculation, since previous statistics data had a 'preliminary' status, which is now changed to 'final'.

Recalculation:	Energy	Ind.Processes	Solvent Use	LUCF	Agriculture	Waste
CO_2	☑	☑	☑	☐	☐	☑
CH_4	☑	☑	☑	☐	☑	☑
N_2O	☑	☑	☑	☐	☑	☑
HFCs, PFCs, SF_6		☑				
Explanations:	☑	☑	☑	☐	☑	☑
Recalculation tables for all recalculated years:			☑			
Full CRF for the recalculated base year:			☑			

10.4.4 Completeness of the CRF files

As mentioned above, the CRF files for 1990 and 1995-2001 now also include sectoral background data for *1A1 Fuel combustion,* including *1A1: Energy industries* and *1A2: Manufacturing industries,* i.e., to the extent that emissions were reported in the various industry sectors in the national Emission Registration system per fuel type (solid, liquid and gaseous fossil fuels).

Derived gases (coke oven gas, blast furnace gas etc.) were included under 'Solid fuels'. Emissions from LPG (except for Transport) were included in 'Liquid fuels'. The emissions not reported by fuel type are summed and reported under 'Other fuels', as is total fuel consumption associated with these unspecified emissions. This fraction increases from about 11% of fossil-fuel related emissions in 1990 to 15% in 1996-1997, and to 34% in 2000; i.e. this percentage of CO_2 emissions could not be allocated to a specific fuel type. In addition, a special effort was made to include background data for category 6B *Wastewater handling.*

In general, completeness of the CRF tables is limited by the present level of detail of ER-I data storage, in particular, for IPCC categories 1A1, 1A2 and 2 (see *Table 10.5*). These are the sectors that are largely reported by individual firms for which the level of detail, completeness and quality varies considerably (see *Section 1.6* on Quality Assurance). For example, in cases where point sources are reported differently, inconsistent fuel consumption figures are associated with emissions of CO_2, CH_4 and N_2O, respectively. In those cases it was decided to use the fuel data for CO_2 in the CRF tables, since CO_2 is, by far, the most important gas of the three. As a consequence, however, the implied emission factors for CH_4 and N_2O in these cases will show another value than could be calculated from the original reported activity data.

Currently, for PFCs and SF_6 no potential emissions (= total consumption data) are reported. This is due to the limited number of companies for which currently individual consumption figures are available and which are now used for estimating actual emissions (so-called Confidential Business Information). This replaces the use of aggregated figures from the annual report by KPMG on consumption of CFCs, halons, HCFCs, HFCs, PFCs and SF_6. Some of these entries are therefore labelled 'C', but please note that as a result of the CRF structure, most of the summed figures for potential emissions of PFCs and SF_6 show '0.0'. Please also note that the Netherlands introduced the species 'HFC unspecified' and 'PFC unspecified' in the F-gas tables, accompanied by an average GWP value. One should pay attention to this when extracting CRF data for other calculation.

Table 10.5 provides a summary of the completeness of the CRF files per IPCC source category. Where 'IEF' is included, both emissions and activity data were provided in the sectoral background tables. In some cases confidentiality ('C') prohibited this. Compared to the previous submission, completeness of sectoral background tables has improved substantially, as was noted above. The still limited completeness for the years 1991-1994 in subcategories 1A (although a fuel split for category 1.A.4 was established) and 1B is mainly due to fact that (recalculated and updated) data for these sectors are not yet available in the required format.

10.4.5 Response to the issues raised in external reviews

Although the contents of the PER as a whole has not been subjected to regular external reviews, in recent years a number a reviews have been conducted on the greenhouse gas emission data and the PER as National System for compiling the national greenhouse gas inventory. For example:

- In 1999 Utrecht University on request of RIVM reviewed the quality of annual carbon dioxide emissions of the PER and trend assessments made by RIVM for its annual evaluation of emission trends within the framework of the *Environmental Balance* (Turkenburg and Van der Sluijs, 1999). As a result of these reviews of analyses made for the *Environmental Balance*, it was concluded that more attention should be given to: a) documentation of methodologies; b) documentation of data quality including uncertainty estimates and c) a wider consultation of experts to analyse the uncertainty in the data.
- On request of the UNFCCC secretariat, a consultant described and evaluated the quality of the Netherlands' present National System for compiling the National Greenhouse Gas Emission Inventory (Mareckova, 2000).

In addition, this year, for the first time, organisations and individuals could make comments to the draft NIR. This process was organised by Novem and RIVM, using the site www.greenhousegases.nl, developed to improve the transparency of the National System (see *Section 1.6.2*). More than 20 persons provided comments; some in detail, some on special subjects and some provided more general comments. Although comments were received on almost all chapters, the majority was related to energy. Only a few comments were received from people living outside the Netherlands. All comments were evaluated whether (a) they should result in modifications of the draft report, (b) be listed for further discussion or (c) be rejected. The comments did contribute to elimination of errors and further clarification of descriptions and explanations.

Table 10.5.a. Summary of completeness of the Common Reporting Format files 1990-2001

GREENHOUSE GAS CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy												
A. Fuel Combustion												
1. Energy Industries	IEF [1]	EM	EM	EM	EM	IEF [1]	IEF [1]	IEF [1]	IEF [1]	IEF [1]	IEF [1]	IEF [1]
2. Manufacturing Industries and Construction	IEF [1]	EM	EM	EM	EM	IEF [1]	IEF [1]	IEF [1]	IEF [1]	IEF [1]	IEF [1]	IEF [1]
3. Transport	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
4. Other Sectors	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
5. Other	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
B. Fugitive Emissions from Fuels												
1. Solid Fuels	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2. Oil and Natural Gas	IEF [2]	EM	EM	EM	EM	IEF [2]	IEF [2]	IEF [2]	IEF [2]	IEF [2]	IEF [2]	IEF [2]
2. Industrial Processes												
A. Mineral Products												
1. Cement Production	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
3. Limestone and Dolomite Use	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Chemical Industry												
2. Nitric Acid Production	C	C	C	C	C	C	C	C	C	C	C	C
C. Metal Production												
1. Iron and Steel Production	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE
3. Aluminium Production	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]	IEF [3]
D. Other Production	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
E. Production of Halocarbons and SF_6												
1. By-product Emissions HCFC-22 production	C	C	C	C	C	C	C	C	C	C	C	C
F. Consumption of Halocarbons and SF_6												
1 Refrigeration	C	C	C	C	C	C	C	C	C	C	C	C
2 Foam Blowing	C	C	C	C	C	C	C	C	C	C	C	C
8 Other	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]	EM [4]
G. Other	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
3. Solvent and Other Product Use	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
4. Agriculture												
A. Enteric Fermentation	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
B. Manure Management	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]	IEF [5]
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils												
Synthetic Fertilizers	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
Animal Wastes Applied to Soils	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
N-fixing Crops	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
Crop Residue	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Cultivation of Histosols	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]
Animal Production	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
Atmospheric Deposition	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Nitrogen Leaching and Run-off	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]	IE [6]
Background agricultural soils	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
E. Prescribed Burning of Savannas	NO	NO	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	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry												
A. Changes in Forest and Other Woody Biomass Stocks	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
B. Forest and Grassland Conversion	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]
C. Abandonment of Managed Lands	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]
D. CO_2 Emissions and Removals from Soil	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]
E. Other	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]	NE [7]
6. Waste												
A. Solid Waste Disposal on Land	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
B. Wastewater Handling												
Wastewater/Sludge	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
N_2O from human sewage	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]	IE [8]
C. Waste Incineration	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE
D. Other	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
7. Other												
Solvents and other product use	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
Polluted surface water	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
International Bunkers												
Aviation	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]
Marine	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]	IEF [9]
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

For notes see next page.

Table 10.5b. Summary of completeness of Common Reporting Format files 1990-2001:Iindustrial processes.

SPECIFICATION OF INDUSTRIAL PROCESSES:	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2. Industrial Processes												
A. Mineral Products												
1. Cement Production	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF	IEF
3. Limestone and Dolomite Use	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
4. Soda Ash	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Glass Production	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Chemical Industry												
1. Ammonia Production (3)	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2. Nitric Acid Production	C	C	C	C	C	C	C	C	C	C	C	C
3. Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Carbide Production	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
5. Other *(please specify)*	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
C. Metal Production												
1. Iron and Steel Production	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE	AD/IE
3. Aluminium Production	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)	IEF 3)
D. Other Production												
1. Pulp and Paper	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2. Food and Drink	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
E. Production of Halocarbons and SF_6												
1. By-product Emissions HCFC-22 production	C	C	C	C	C	C	C	C	C	C	C	C
F. Consumption of Halocarbons and SF_6												
1 Refrigeration	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM
2 Foam Blowing	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM
3 Fire Extinguishers 10)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4 Aerosols 10)	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
5 Solvents 10)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6 Semiconductors 10)	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE
7 Electric Equipment 10)	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE	C/IE
8 Other *(please specify)*	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM	AD/EM
G. Other	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM

Abbreviations:

IEF = Implied Emission Factor; EM = Emissions (no IEF)
EM = Emissions, no activity data, though not confidential
NO = Not Occurring; NE = Not Estimated; IE = Included Elsewhere
C = Confidential Business Information (only emissions)

Notes:

1) Implied emission factors of CO_2 for solid, liquid and gaseous fossil fuel use are now in line with underlying fuel consumption due to allocation under 'other fuels' where CO_2 and related fuel consumption did not properly match. However, this approach did not simultaneously improve the IEFs for CH_4 and N_2O. Due to limited data quality and completeness of point-source data, about 10 to 35% of fossil fuel consumption is not reported as gas, oil or coal, but is included under 'other fuels'.
2) Only IEFs for CH_4; Not for flaring/venting separately.
3) IEFs for PFCs; other process emissions are included elsewhere.
4) Activity data are included when not considered confidential.
5) No split of amount of manure per type for animal waste management system.
6) Included under 'Background agricultural soils'.
7) Not yet estimated. See *Section 2.5* for improvement activities.
8) Included under categories *Wastewater/Sludge treatment* (6B) and *7 Polluted surface water* (7)
9) Only for CO_2 (CH_4 and N_2O not estimated).
10) IE refers to category 2F8 (others). Notation keys filled in CRF Table 2(II)Fs2.

N.B. N_2O from crop residues (4D3) are included in 'Background from agricultural soils' (4D). In the CRF files, and thus in this table which is copied from the CRF, accidentally the wrong notation key 'NE' has been used.

10.4.6 Response to the issues raised in UNFCCC reviews

The Netherlands greenhouse gas inventory is subject to the following reviews by the Climate Secretariat: (a) Desk Review and Centralised Review of the NIR 2000 and (b) Country section of Synthesis & Assessment report on the NIR 2001 and the NIR 2002. In general the findings of the different UNFCCC reviews are well observed and described. The Netherlands response to the general remarks is as recorded below.

- *Inconsistency in time series*
  Some of the apparent inconsistencies in time series are due to (a) limited recalculations (only for 1990, 1995 and the last three years) because of the limitation in the annual PER project of the years considered in the update; and (b) to different source allocations used for different years (in particular 1991-1994) because of a different national source coding system for these years. Therefore, with the current PER practices, consistency over the complete time period can not be guaranteed for all sources. However, as explained in *Section 10.4.7*, this aspect is part of the improvement programme.
- *Missing notation keys and other documentation in CRF tables*
  While transferring all data to the new CRF format, the use of notation keys could be improved; however, due to the redundancy in the various tables and files, it is not an easy task. We have included all notation keys now in the SBT and have documented where 'IE' keys refer to (IE = 'Included Elsewhere').
- *Incompleteness of CRF and NIR*
  A lot of comments referred to incompleteness of the CRF, which was due to limited capacity in the Netherlands and limited data availability in the proper format. However, some tables are also, in fact, redundant in the CRF, e.g. the Trend Tables for the greenhouse gases are identical in all files and can be linked to other tables in the CRF. Instructions are not always clear as to what extent documentation should be provided in the CRF and which part should be explained in the NIR. In the NIR 2003, all the items have been included which were observed as missing in the NIR 2002 submission (as far as they are available at the moment).
- *Additional info in NIR*
  The review reports make recommendations on the inclusion in the NIR of information provided in other Dutch reports cited. In general, this raises the question on how extensive the explanations in the NIR should be, given that the report needs to be submitted annually. In this report we have added an annex with references to other reports 'that should be considered as part of the NIR', which are also publicly available through the internet, as are the NIR and the corresponding CRF files.
- *Comparison of activity data with international statistics*
  In comparing Netherlands' activity data with international data, we stress that, in general, statistical data published by international organisations like UN, IEA and FAO, though essentially officially submitted national data, are ultimately the responsibility of these organisations. Any discrepancies found could be due to various reasons, e.g. (a) apparent errors in one of the national submissions; (b) errors in data processing by the international statistical agency; (c) errors arising from data conversions prior or after submission; (d) differences in activity definitions; (e) differences in datasets compared due to revisions in subsequent editions; and (f) modifications or estimates made by the international statistical agency, when inconsistencies or omissions were found in the dataset and national agencies did not conclusively respond to requests for clarifications. However, it is still important to check discrepancies found to see if errors have been made in the emission compilation or reporting process.

In the NIR/CRF 2003 the following specific changes were made in the CRF tables (see also *Section 10.4.3*) partly in response to the reviews and partly as a result of the national improvement programme:

- CRF tables improved by replacing 0 by notation keys NE, NO, IE, C, where appropriate;
- CRF tables improved in cases of 'IE' by adding the source allocation used to the completeness table and other documentation boxes;

- Many data gaps in sectoral background tables have been filled: activity data and emissions (exceptions for 1991-1994 data in categories 1A1, 1A2, category 2 excluding cement clinker and steel and aluminium production and all data for categories 5B-E);
- Correction of typing/unit errors as observed;
- Implied Emission Factors (IEF) for CO_2 from fuel combustion have been improved substantially by moving all data with inconsistent – i.e. incomplete – fuel/emission data to the subcategory ‘Other fuels’. In the 2003 submission the fuel split was made uniform for the years 1990, 1995 to 2001.

10.4.7 Planned improvements

The UNFCCC Guidelines for reporting the emissions and the Guidelines for National Systems for annual emission monitoring under the Kyoto Protocol have added additional requirements to the present *Pollutant Emission Register* (PER) of the Netherlands. In 2000 a programme was started to adapt the monitoring procedures of greenhouse gases in the Netherlands to meet these requirements. Similar requirements were imposed by the European Union, which is also a Party to the Convention and the Protocol, which require that the EU Member States’ National Systems to be operational by 1 January 2005.

The national system improvement programme is being implemented under the responsibility of the Netherlands Ministry of Spatial Planning, Housing and the Environment (VROM), who delegated the practical co-ordination to Novem. An interdepartmental committee, the *Working Group on Emission Monitoring of Greenhouse Gases* (WEB) was created to direct the actions. Several institutes and ministries are involved in these activities. The programme has been set up as a temporary special assignment. Ultimately, all improvements and arrangements will become an integral part of the larger system of annual emission monitoring (PER). The WEB has three subgroups: the Project Groups on CO_2, on Non-CO_2 and on Sinks. The subgroup on Non-CO_2 is formed by the Steering Committee of the Netherlands’ *Reduction Programme on Other Greenhouse Gases* (ROB). In this section we will summarise the three main elements of this programme and the results of actions so far.

Monitoring improvement programme

In 1999 two workshops were held on the quality of methodology and data used for calculation of greenhouse gas emissions in the Netherlands. This workshop was attended both by experts involved in the ER project as well as by other Dutch experts on greenhouse gas emission estimation from universities and other research institutes (Van Amstel *et al*., 2000a,b). The workshop assessed the situation, and the possible and required improvements. A long-list of possible actions was elaborated. Subsequently, the aforementioned working group, WEB, was installed to prioritise the actions and the improvement programme was started. To focus the work further, the WEB initiated three Expert Project Groups focussing on CO_2, non-CO_2 and Sinks, respectively. Both WEB and the Project Groups are composed of persons from the relevant ministries and institutes, who are usually also involved in the Emission Registration project. This ensures inclusion of the appropriate expertise and promotes optimal communication with the parties of the ER project. In this way synergy is created between the improvements initiated by the greenhouse monitoring requirements and other improvements in the annual Dutch PER on the basis of (inter)national agreements as decided by the CCDM (WEM, CCDM 2003).

A series of activities have been concluded the last few years, for example:

- *Uncertainty assessment:* the completion of an initial comparison of Tier 1 and Tier 2 uncertainty analyses of the Netherlands greenhouse gas inventory. This study encountered some problems with regard to disaggregation of data on uncertainties in some categories and had to use some preliminary calculations. The study concluded that (with a reservation for the preliminary calculations):
  - the Tier 2 and Tier 1 uncertainty analyses resulted in similar magnitudes of overall uncertainty estimates;
  - the model for emission estimates had been thoroughly assessed, indicating some areas of improvement;

- with regard to data in various sectors, the quality of uncertainty data still depends to a large extent on expert estimates.

The on-going monitoring improvement programme will deal with the most important 'weaker' spots. The planning is to update the Tier 2 uncertainty analysis with better data, as early as 2003.

- *Emission factors for fuels:* A study to evaluate the documentation and validity of the present set of country-specific CO_2 emission factors for fuels was finalised. This study showed that for some sources, national CO_2 emission factors should be changed, but also, that for some fuels, data for establishing country-specific national emission factors are lacking (Van Harmelen and Koch, 2002). A recommendation was made to draw up a set of guidelines on the proper application of the set of national emission factors agreed on and to communicate those broadly, e.g. to the companies that report their emissions through the MJV. This has been planned for the PER 2004, as for the MJV will change to an IT-based data collecting structure then.
- *Feedstocks:* The study dealing with CO_2 emissions related to non-energetic use of energy carriers (notably as chemical feedstock) will be finalised in 2003. Accounting tables are being developed in the EU project on *Non-energy use and CO_2 emissions* (Patel *et al*., 2000*)*. These are used to evaluate the present methods to define the non-energy use and to estimate the related CO_2 emissions. The results for the 1993-1999 period were obtained with (partly confidential) data provided by Statistics Netherlands (2002). It can be concluded that a material flow analysis like the NEAT model may result in valuable estimations of non-energy use CO_2 emissions and can produce reliable estimations for country-specific storage fractions for use in the *IPCC Reference Approach* for CO_2. Furthermore, this approach can be used as an important check for reported values on non-energy use in energy statistics. The considerable data requirement for the NEAT model remains a major drawback. At the moment, the discussion on the model output is about to be finalised, including a quantitative comparison of the storage fractions, as reported in the *IPCC Reference Approach* and *IPCC Sectoral Approach* (= *National Approach*), on one hand, and the model outputs on the other. One chance is that the value of non-energy use in the Netherlands' National Communication now holds an underestimation.
- *Unknown sources:* As follow-up to a study to identify the sources of non-CO_2 greenhouse gases that are as yet not well known.
- *Sinks:* The updating of data for forest biomass stocks and stocks of carbon in soils, and emissions of CO_2 from agricultural soils in the Netherlands was discussed. It was decided not to update this data. A common understanding on the present and future monitoring systems should be realised first. A group of consultants is working on this subject: in a study comparing the present situation on to sinks monitoring with the requirements from a national system point of view. The results of this study, expected in April 2003, will give guidance in further improvements with regard to sinks monitoring and reporting.

Protocols and process descriptions

In 2001 a project was started to develop specific monitoring protocols for the greenhouse gas emissions in the Netherlands. As part of the National System, all relevant methodologies, procedures, tasks, responsibilities and such are being described in a transparent way in these protocols. In this project, under co-ordination of Novem, discussions were initiated with key firms, organisations involved in the PER process and other research institutes. In this process the methodologies and procedures for estimating greenhouse gas emission in the Netherlands were (re)assessed and compared with UNFCCC and IPCC requirements and, where relevant, adapted. Discussions include the feasibility and willingness to provide additional (sometimes confidential) data and, where relevant, the feasibility and costs of changing methodologies.

The project started with the non-CO_2 greenhouse gases, since some of these were not traditionally part of the PER. For four (key) sources the first phase finished in 2001 with four draft protocols. In 2002 most other key sources, including the CO_2 sources, were described in draft protocols. At present this set of draft protocols is being discussed within the ER project (Task Forces and *Co-ordinating Committee on Target Group Monitoring,* CCDM) in order to incorporate these protocols in the PER process. These discussions focus mainly on cost and other feasibility aspects. Parallel discussions are ongoing, with and within the Ministry of VROM, on the required adaptations in legal and organisational bases. The protocols are expected to enter their pilot phase as of the end of 2003. It should be noted that some of the improvements agreed upon are (or have been) implemented earlier.

Elaboration and implementation of a QA/QC system as part of the National System

In 2001 a three-phase project was started to develop (or rather adapt) the QA/QC system for the Netherlands GHG monitoring and NIR/CRF process:

1. The first phase was finished in late 2001 and early 2002; it included an assessment of the present situation as compared to the UNFCCC/IPCCC requirements.
2. The second phase of the project involves the elaboration and description of relevant processes and procedures, including, where necessary, adaptation of the present situation. This is being done through a project group with involvement from the Ministry of VROM and the PER and co-ordination by Novem. This phase is planned for completion in 2003, running to a large extent parallel to the elaboration of the protocols. This phase also includes making practical arrangements for the implementation of the procedures, e.g. through workshops with involved staff and through supporting documentation and tools (where feasible and relevant).
3. The third phase comprises the formal and legal arrangements needed for the structural embedding of the QA/QC procedures. This will be done in 2003/2004, together with the legal embedding of the protocols.

Improvement proposals resulting from compiling the NIR/CRF 2003 submission

During the compilation and checks of the data for the CRF files it was concluded that the data for the *waste sector* (category 6) were not satisfactory. Actions should be taken to standardise source descriptions, and new calculations of the related emissions may be necessary.

Furthermore, it has been concluded that the combustion emissions for 1997 in the *Manufacturing industries* (category 1A2) do not fit well in the expected trend. This especially holds for the chemical industry and the food industry. Amongst others this may contribute to the difference between the reference approach and the national approach which is for 1997 the highest of all years and not yet fully understood (see *Section 3.2.6* and *Annex 4*). Also the level of the combustion emissions for 2000 in the chemical industry compared to the 1999 figures is not yet fully explained. Improvement envisaged for the current dataset should be verified, although this might be difficult because of the poor quality of fuel (and emission) data from individual firms. These issues will be brought to the attention of the *Co-ordinating Committee on Target Group Monitoring* (CCDM).

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