National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Greenhouse Gas Emission in the Netherlands 1990-2010

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National Inventory Report 2012

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This report has been compiled by order and for the account of the Directorate-General for the Environment, of the Dutch Ministry of Infrastructure and the Environment, within the framework of the project Emission Registration M/500080/NIR, 'Netherlands Pollutant Release & Transfer Register'.
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 2010).

This investigation has been performed by order and for the account of IenM, within the framework of M/680355/10/NI.

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Rapport in het kort

De Nederlandse uitstoot van broeikasgassen 1990-2010

In 2010 is de Nederlandse uitstoot van broeikasgassen, waaronder CO_2, methaan en lachgas met ongeveer 6 procent gestegen ten opzichte van de emissie in 2009. Deze stijging komt vooral door een hoger brandstofverbruik in de industrie en energiesector als gevolg van de destijds herstellende economie. Daarnaast is vanwege het winterweer gedurende de eerste en laatste maanden van 2010 meer brandstof gebruikt voor verwarming. De totale uitstoot van broeikasgas wordt uitgedrukt in CO_2-equivalenten en bedroeg 210,1 Teragram (Megaton of miljard kilogram) in 2010. Dit is een afname van ongeveer 1,5 procent in vergelijking met de uitstoot van 213,3 Tg CO_2-equivalenten in het Kyoto-basisjaar. Dit basisjaar, dat afhankelijk van het broeikas 1990 of 1995 is, dient als referentie voor de uitstoot van broeikasgassen volgens het Kyoto Protocol uit 1997. De geleverde cijfers zijn exclusief de emissies die afkomstig zijn uit het soort landgebruik en de verandering daarin, zoals natuurontwikkeling of ontbossing (land use, land use change and forestry, LULUCF). De getallen inclusief deze bijdrage vertonen dezelfde trend.

Nationale rapportageverplichting

Dit blijkt uit de jaarlijkse inventarisatie van broeikasgasemissies die het RIVM op verzoek van het ministerie van Infrastructuur en Milieu (I&M) heeft opgesteld. Met deze inventarisatie voldoet Nederland aan de nationale rapportageverplichtingen voor 2012 van het Klimaatverdrag van de Verenigde Naties (UNFCCC), van het Kyoto Protocol en van het Bewakingsmechanisme Broeikasgassen van de Europese Unie.

Overige onderdelen inventarisatie

De inventarisatie bevat verder trendanalyses om ontwikkelingen in de uitstoot van broeikasgassen tussen 1990 en 2010 te verklaren, en een analyse van de onzekerheid in de emissiesgetallen. Daarnaast staat aangegeven welke (sleutel)bronnen het meest aan deze onzekerheid bijdragen. Ook biedt de inventarisatie documentatie van de gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren. Ten slotte bevat het een overzicht van de onderdelen van het kwaliteitssysteem en de wijze waarop de Nederlandse Emissieregistratie de emissiecijfers heeft gevalideerd.

Trefwoorden: broeikasgassen, emissies, trends, methodiek, klimaat

Abstract

The total greenhouse gas emission from the Netherlands in 2010 increased by approximately 6% compared to the emission in 2009. This increase is mainly the result of increased fuel combustion in the energy sector and space heating.
In 2010, total direct greenhouse gas emissions (excluding emissions from LULUCF – land use, land use change and forestry) in the Netherlands amounted to 210.1 Tg CO_2 eq. This is approximately 1.5% below the emissions in the base year (213.3 Tg CO_2 eq).

This report documents the 2012 Netherlands' annual submission of its greenhouse gas emission inventory in accordance with the guidelines provided by the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism.

The report comprises explanations of observed trends in emissions; a description of an assessment of key sources and their uncertainty; documentation of methods, data sources and emission factors applied; and a description of the quality assurance system and the verification activities performed on the data.

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

Contents

Samenvatting

Het National Inventory Report (NIR) 2012 bevat de rapportage van broeikasgasemissies (CO_2, N_2O, CH_4 en de F-gassen) over de periode 1990 tot en met 2010. De emissiecijfers in de NIR 2012 zijn berekend volgens de protocollen behorend bij het 'National System' dat is voorgeschreven in het Kyoto Protocol. In de protocollen zijn de methoden vastgelegd voor zowel het basisjaar (1990 voor CO_2, CH_4 en N_2O en 1995 voor de F-gassen) als voor de emissies in de periode tot en met 2012. De protocollen staan op de website www.agentschapnl.nl/nie.

National Inventory Report (NIR)

Dit rapport over de Nederlandse inventarisatie van broeikasgasemissies is op verzoek van het ministerie van Infrastructuur en Milieu (IenM) opgesteld om te voldoen aan de nationale rapportageverplichtingen in 2012 van het Klimaatverdrag van de Verenigde Naties (UNFCCC), het Kyoto protocol en het Bewakingsmechanisme Broeikasgassen van de Europese Unie. Dit rapport bevat de volgende informatie:

- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2010;
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van de IPCC Good Practice Guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- een overzicht van het kwaliteitssysteem en de validatie van de emissiecijfers voor de Nederlandse Emissieregistratie;
- de wijzigingen die in de methoden voor het berekenen van broeikasgasemissies zijn aangebracht na de review van het Nationaal Systeem broeikasgassen vanuit het Klimaatverdrag. Op basis van de methoden die in de NIR en de Nederlandse protocollen broeikasgassen zijn vastgelegd, is de basisjaaremissie bepaald en de hoeveelheid broeikasgassen die Nederland in de periode 2008 t/m 2012 (volgens het Kyoto Protocol) mag uitstoten.

De NIR bevat ook de informatie die voorgeschreven is volgens artikel 7 van het Kyoto protocol (deel 2 van dit rapport). Hiermee voldoet Nederland aan alle rapportagerichtlijnen van de UNFCCC.

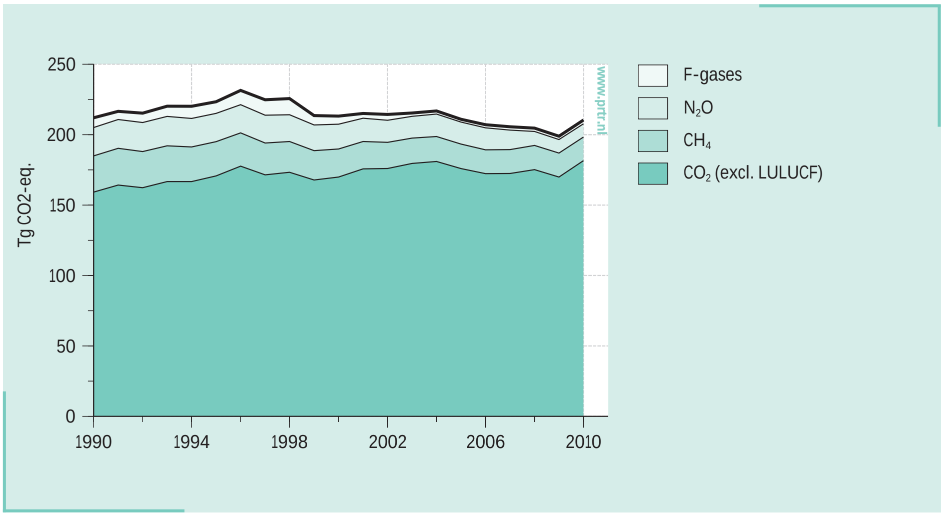
Een losse annex bij dit rapport bevat elektronische data over emissies en activiteitsdata in het zogenaamde Common Reporting Format (CRF), waar door het secretariaat van het VN-Klimaatverdrag om wordt verzocht. In de bijlagen bij dit rapport is ondermeer een overzicht van sleutelbronnen en onzekerheden in de emissie opgenomen.

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 Balans van de Leefomgeving (opgesteld door het Planbureau voor de Leefomgeving, PBL) en de vijfde Nationale Communicatie onder het Klimaatverdrag, die eind 2009 is verschenen.

Ontwikkeling van de broeikasgasemissies

De emissieontwikkeling in Nederland wordt beschreven en toegelicht in dit National Inventory Report (NIR 2012). Figuur ES.1 geeft het emissieverloop over de periode 1990-2010 weer. De totale emissies bedroegen in 2010

Figure ES.1 Broeikasgassen: emissieniveaus en emissietrends (exclusief LULUCF), 1990-2010.



circa 210,1 Tg (Mton ofwel miljard kg) CO_2 equivalenten en zijn daarmee circa 1,5% afgenomen in vergelijking met de emissies in het basisjaar (213,3 Tg CO_2 eq). De hier gepresenteerde emissies zijn exclusief de emissies van landgebruik en bossen (LULUCF); deze emissies tellen mee vanaf het emissiejaar 2008 onder het Kyoto Protocol. De emissie van CO_2 is sinds 1990 met circa 14% toegenomen, terwijl de emissies van de andere broeikasgassen met circa 47% zijn afgenomen ten opzichte van het basisjaar. In 2010 steeg de CO_2 emissie met circa 7% ten gevolge van een gestegen brandstofgebruik in de energiesector en ten behoeve van ruimteverwarming. De emissies van CH_4 en N_2O daalden in 2010 licht ten opzichte van 2009, beide ongeveer 2%. De emissies van F-gassen steeg in 2010 met 12,5 % ten opzichte van 2009. De totale emissie van broeikasgassen in 2010 ligt 6% hoger dan het niveau in 2009.

Box ES.1 Onzekerheden

De emissies van broeikasgassen kunnen niet exact worden gemeten of berekend. Onzekerheden zijn daarom onvermijdelijk. Het RIVM schat de onzekerheid in de jaarlijkse totale broeikasgasemissies op circa 3%. Dit is geschat op basis van informatie van emissie-experts in een eenvoudige analyse van de onzekerheid (volgens IPCC Tier 1). De totale uitstoot van broeikasgassen ligt daarmee met 95% betrouwbaarheid tussen de 204 en 217 Tg (Mton). De onzekerheid in de emissietrend tussen het basisjaar (1990/1995) en 2010 is geschat op circa 3%; dat wil zeggen dat de emissietrend in die periode met 95% betrouwbaarheid ligt tussen de +2 tot -4%.

Methoden

De methoden die Nederland hanteert voor de berekening van de broeikasgasemissies zijn vastgelegd in protocollen voor de vaststelling van de emissies, te vinden op www.agentschapnl.nl/nie. De protocollen zijn opgesteld door Agentschap NL, in nauwe samenwerking met deskundigen van de EmissieRegistratie (voor wat betreft de beschrijving en documentatie van de berekeningsmethoden). Na vaststelling van deze protocollen in de Stuurgroep EmissieRegistratie (december 2005), zijn de protocollen vastgelegd in een wettelijke regeling door het ministerie van IenM. De methoden maken onderdeel uit van het Nationaal Systeem (artikel 5.1 van het Kyoto Protocol) en zijn bedoeld voor de vaststelling van de emissies in zowel het basisjaar als in de jaren in de budgetperiode. Naar aanleiding van de reviews vanaf het zogenaamde 'Initial Report' zijn de methoden en protocollen aangepast. Deze zijn daarmee in overeenstemming met de IPCC Good Practice Guidance and Uncertainty Management, dat als belangrijkste voorwaarde is gesteld aan de te hanteren methoden voor de berekening van broeikasgassen. Deze methoden zullen de komende jaren (tot 2014) worden gehanteerd; tenzij er grote veranderingen plaatsvinden in bijvoorbeeld de beschikbaarheid van basisdata of de implementatie van beleidsmaatregelen aanleiding geeft de methoden aan te passen. In deze submissie zijn een aantal methodewijziging doorgevoerd als follow up van de review van de NIR 2011. Deze methodewijzigingen hebben geleid tot een completere inventarisatie maar hebben slechts zeer beperkt invloed op de gerapporteerde emissies.

Executive Summary

ES1 Background information on greenhouse gas inventories and climate change

This report documents the 2012 Netherlands' annual submission of its greenhouse gas emission inventory in accordance with the guidelines provided by the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism. These guidelines, which also refer to Revised 1996 IPCC Guidelines and IPCC Good Practice Guidance and Uncertainty Management reports, provide a format for the definition of source categories and for calculation, documentation and reporting of emissions. The guidelines aim at facilitating verification, technical assessment and expert review of the inventory information by independent Expert Review Teams of the UNFCCC. Therefore, the inventories should be transparent, consistent, comparable, complete and accurate, as elaborated in the UNFCCC Guidelines for reporting and be prepared using good practice as described in the IPCC Good Practice Guidance. This National Inventory Report (NIR) 2012, therefore, provides explanations of the trends in greenhouse gas emissions, activity data and (implied) emission factors for the period 1990-2010. It also summarises descriptions of methods and data sources of Tier 1 assessments of the uncertainty in annual emissions and in emission trends; it presents an assessment of key sources following the Tier 1 and Tier 2 approaches of the IPCC Good Practice Guidance; and describes Quality Assurance and Quality Control activities. This report provides no specific information on the effectiveness of government policies for reducing greenhouse gas emissions. This information can be found in the Environmental Balance (two-yearly edition; in Dutch: 'Balans van de leefomgeving') prepared by the Netherlands Environmental Assessment Agency (PBL) and the 5th National Communication (NC5) prepared by the Government of the Netherlands.

The Common Reporting Format (CRF) spreadsheet files, containing data on emissions, activity data and implied emission factors, accompany this report. The complete set of CRF files as well as the NIR in PDF format can be found at the website www.nlagency.nl/nie.

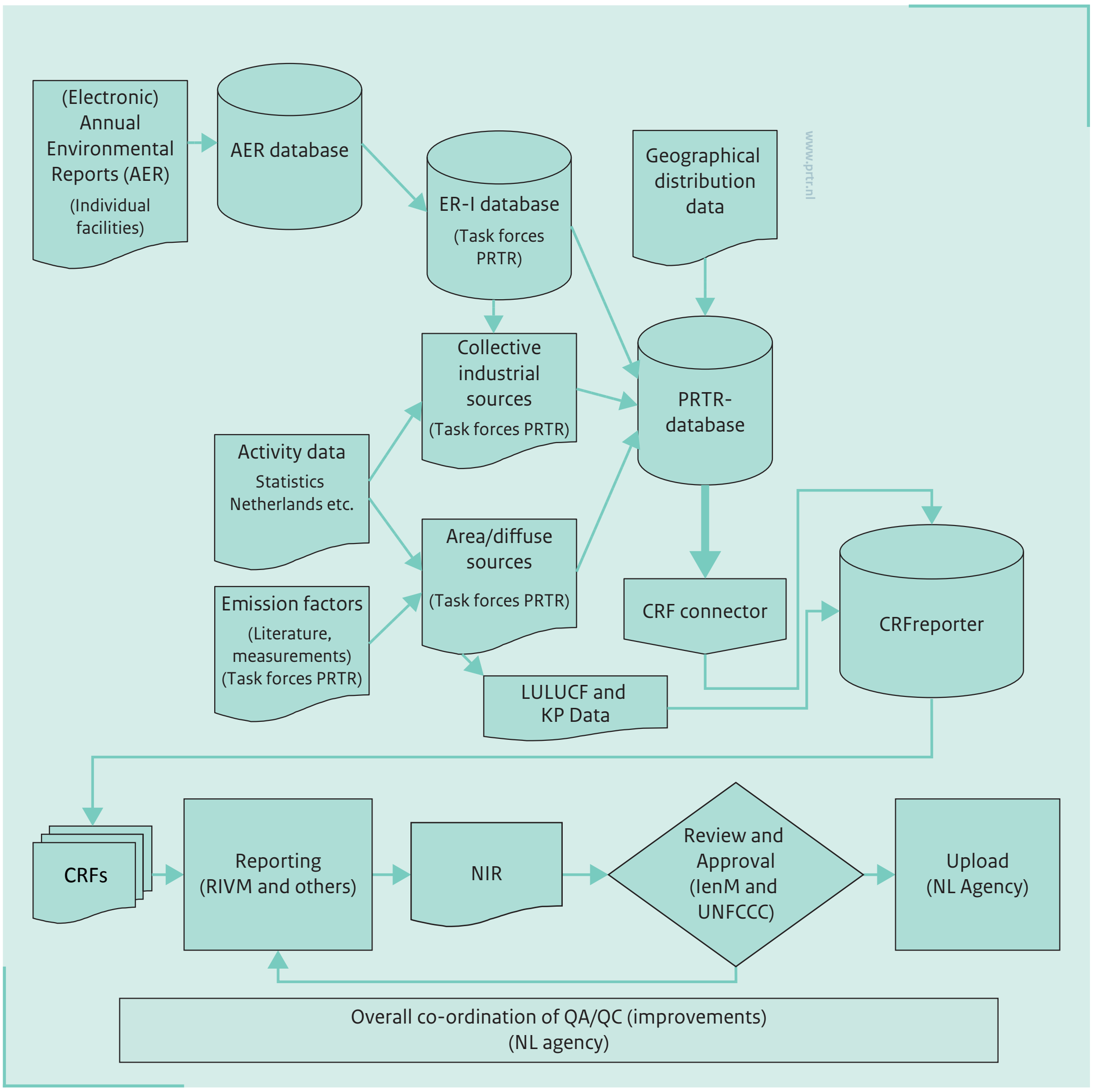
Climate Convention and Kyoto Protocol
This NIR is prepared as a commitment under the UNFCCC and under the Kyoto Protocol. The NIR also contains a part 2 that focuses on supplementary information under article 7 of the Kyoto protocol. One of the commitments is the development of a National System for greenhouse gas emissions (art. 5.1 of the Protocol). This National System developed in the period 2000-2005 was reviewed by an Expert Review Team of the UNFCCC in April 2007 and found to be in compliance with the requirements. Figure ES.2 Main elements in the greenhouse gas inventory compilation process.

Key categories
For identification of the 'key categories' according to the IPCC Good Practice approach, national emissions are allocated according to the IPCC potential key category list wherever possible. The IPCC Tier 1 method consists of ranking this list of source category-gas combinations for the contribution to both the national total annual emissions and the national total trend. The results of these listings are presented in Annex 1: the largest sources, the total of which ads up to 95% of the national total, are 33 sources for annual level assessment and 32 sources for the trend assessment from a total of 72 sources. Both lists can be combined to give an overview of sources, which meet either of these two criteria. Next, the IPCC Tier 2 method for identification of key sources is used, which requires incorporating the uncertainty to each of these sources before ordering the list of shares. The result is a list of 42 source categories from a total of 72 that could be identified as 'key sources' according to the definition of the IPCC Good Practice Guidance report. Finally, four key categories are found in the LULUCF sector (Sector 5), after inclusion of 9 LULUCF subcategories in the key category analysis.

Institutional arrangements for inventory preparation
The greenhouse gas inventory of the Netherlands is based on the national Pollutant Release & Transfer Register (PRTR). The general process of inventory preparation has existed for many years and is organised as a project with an annual cycle. In 2000, an improvement programme was initiated under the lead of SenterNovem (now NL Agency) to transform the general process of the greenhouse gas inventory of the PRTR into a National System, according to the requirements under article 5.1 of the Kyoto Protocol. The National Institute for Public Health and the Environment (RIVM) has been contracted by the Ministry of Infrastructure and the Environment (IenM) to compile and maintain the PRTR and to co-ordinate the preparation of the NIR and filling the CRF (see Figure ES.2). NL Agency is designated by law as the National Inventory Entity (NIE) and co-ordinates the overall QA/QC activities and the support/response to the UNFCCC review process.

Monitoring protocols
As part of the improvement programme, the methodologies for calculating greenhouse gas emission in the Netherlands were reassessed and compared with UNFCCC and IPCC requirements. For the key sources and for sinks, the methodologies and processes are elaborated, re-assessed and revised where required.

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



The final revision was done after review of the National System (including the protocols). The present CRF/NIR is based on methodologies approved during/after the review of the National System and the calculation of the Assigned Amount of the Netherlands. Monitoring protocols describing methodologies, data sources and the rationale for their selection are available at www.nlagency.nl/nie.

Organisation of the report

This report is in line with the prescribed NIR format, starting with an introductory chapter 1, containing background information on the Netherlands' process of inventory preparation and reporting; key categories and their uncertainties; a description of methods, data sources and emission factors and a description of the quality assurance system, along with verification activities applied to the data. Chapter 2 provides a summary of trends for aggregated greenhouse gas emissions by gas and by main source. Chapters 3 to 9 present detailed explanations for emissions in different sectors. Chapter 10 presents information on recalculations, improvements and response to issues raised in external reviews on the NIR 2011 and on the draft of the NIR 2012. In addition, the report provides detailed information on key categories, methodologies and other relevant reports in 10 Annexes. In Part II of this report the Supplementary information required under Article 7, Paragraph 1 of the Kyoto Protocol is reported.

ES2 Summary of national emission and removal related trends

In 2010, total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands were

Figure ES.3 An overview of the emission trends for greenhouse gas emissions (excl. LULUCF) 1990-2010.

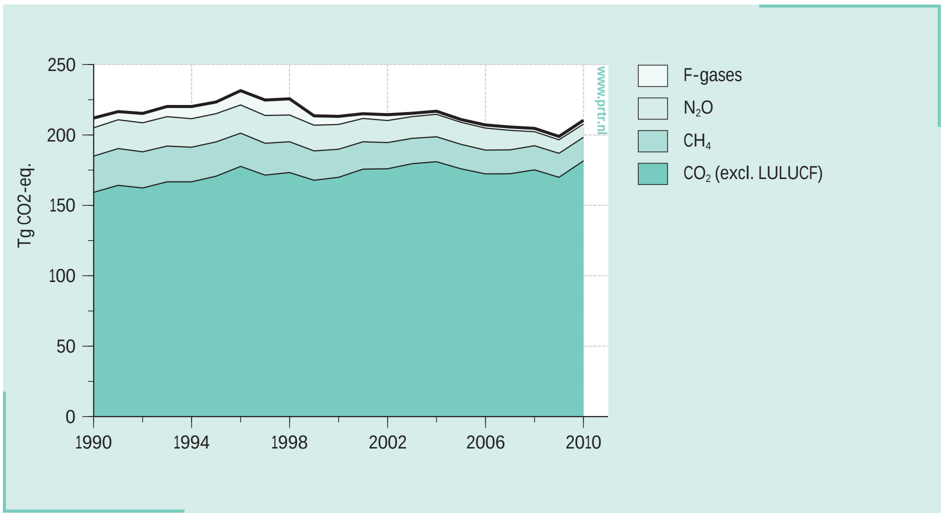


Table ES.1 Summary of emission trend per gas (unit: Tg CO_2 equivalents).

	CO_2 incl. LULUCF	CO_2 excl. LULUCF	CH_4	N_2O	HFCs	PFCs	SF_6	Total (incl. LULUCF)	Total (excl. LULUCF)
Base year	**162.2**	**159.2**	**25.7**	**20.2**	**6.0**	**1.9**	**0.3**	**216.1**	**213.3**
1990	162.2	159.2	25.7	20.2	4.4	2.3	0.2	214.7	212.0
1991	166.9	164.3	26.1	20.4	3.5	2.2	0.1	218.9	216.6
1992	165.3	162.3	25.7	20.7	4.4	2.0	0.1	217.9	215.3
1993	169.5	166.7	25.4	20.9	5.0	2.1	0.1	222.7	220.2
1994	169.4	166.7	24.6	20.2	6.5	2.0	0.2	222.6	220.2
1995	173.6	170.7	24.3	20.1	6.0	1.9	0.3	225.9	223.4
1996	180.3	177.6	23.6	20.0	7.7	2.2	0.3	233.8	231.4
1997	174.4	171.5	22.6	19.7	8.3	2.3	0.3	227.5	224.8
1998	176.2	173.3	21.9	19.0	9.3	1.8	0.3	228.2	225.7
1999	170.7	167.8	20.8	18.3	4.9	1.5	0.3	216.2	213.6
2000	172.9	169.9	19.9	17.6	3.9	1.6	0.3	215.8	213.2
2001	178.3	175.7	19.4	16.5	1.6	1.5	0.3	217.3	215.1
2002	178.6	176.0	18.6	15.7	1.7	2.2	0.3	216.6	214.4
2003	182.5	179.6	18.0	15.5	1.5	0.6	0.2	218.0	215.4
2004	183.9	181.0	17.7	15.9	1.7	0.3	0.3	219.5	216.8
2005	179.0	175.9	17.4	15.6	1.5	0.3	0.2	213.8	211.0
2006	175.4	172.3	17.0	15.6	1.7	0.3	0.2	209.9	207.0
2007	175.3	172.4	17.0	13.8	1.8	0.3	0.2	208.3	205.5
2008	178.2	175.2	17.2	10.0	1.9	0.3	0.2	207.5	204.6
2009	172.8	169.9	17.1	9.6	2.0	0.2	0.2	201.6	198.9
2010	184.2	181.2	16.8	9.4	2.3	0.2	0.2	213.1	210.1

estimated at 210.1 Tg CO_2 equivalents (CO_2 eq). This is about 1.5% below the emissions in the base year (213.3 Tg CO_2 eq). In the Netherlands, the base year emissions are 1990 for CO_2, CH_4 and N_2O and 1995 for fluorinated gases. CO_2 emissions (excluding LULUCF) increased by about 14% from 1990 to 2010, mainly due to the increase in the emissions in the 1A1a Public Electricity sector and 1A3 Transport sector. CH_4 emissions decreased by 35% in 2010 compared to the 1990 level, mainly due to decrease in the waste sector, the Agricultural sector and fugitive emissions in the Energy sector. N_2O emissions decreased by 53% in 2010 compared to 1990, mainly due to a decrease in emissions from Agriculture and from Industrial Processes, which partly compensated N_2O emission increases from fossil fuel combustion (mainly from transport). The emissions of all fluorinated greenhouse gases (HFCs, PFCs

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

	1. Energy	2. Ind. Proc.	3. Solvents	4. Agriculture	5. LULUCF	6. Waste	7. Other	Total (incl. LULUCF)	Total (excl. LULUCF)
Base year	**154.0**	**23.5**	**0.5**	**22.5**	**3.0**	**12.8**	**NA**	**216.3**	**213.3**
1990	154.0	22.2	0.5	22.5	3.0	12.8	NA	215.0	212.0
1991	159.1	21.2	0.5	23.0	2.6	12.9	NA	219.2	216.6
1992	157.8	21.5	0.4	22.9	2.9	12.7	NA	218.2	215.3
1993	162.5	22.3	0.4	22.6	2.7	12.4	NA	222.9	220.2
1994	161.8	24.3	0.4	21.7	2.7	11.9	NA	222.9	220.2
1995	165.9	23.5	0.4	22.2	2.9	11.3	NA	226.2	223.4
1996	173.6	24.8	0.4	21.7	2.7	10.9	NA	234.1	231.4
1997	166.4	26.0	0.3	21.4	3.0	10.6	NA	227.8	224.8
1998	168.3	26.4	0.4	20.4	2.9	10.2	NA	228.5	225.7
1999	162.6	21.2	0.4	20.0	2.9	9.4	NA	216.5	213.6
2000	164.9	20.3	0.3	18.8	2.9	8.9	NA	216.1	213.2
2001	171.2	16.7	0.3	18.5	2.6	8.4	NA	217.6	215.1
2002	171.5	17.1	0.2	17.5	2.6	8.0	NA	216.9	214.4
2003	175.0	15.5	0.2	17.1	2.9	7.5	NA	218.3	215.4
2004	176.3	16.0	0.2	17.1	2.9	7.3	NA	219.7	216.8
2005	171.2	15.8	0.2	16.9	3.0	6.8	NA	214.0	211.0
2006	168.0	15.5	0.3	16.9	3.0	6.4	NA	210.0	207.1
2007	167.8	14.8	0.3	16.7	2.9	6.1	NA	208.4	205.6
2008	171.7	10.2	0.3	16.8	3.0	5.7	NA	207.6	204.7
2009	166.8	9.9	0.2	16.7	2.9	5.3	NA	201.8	198.9
2010	177.8	10.4	0.2	16.6	3.0	5.0	NA	213.1	210.1

and SF_6) decreased in the period 1995 (chosen as the base year) to 2010 with respectively, 62%, 89% and 36%. Total emissions of all F gases decreased by about 68% compared to the 1995 level.

Between 2009 and 2010, CO_2 emissions increased (excluding LULUCF) by 11.3 Tg. The emissions of CH_4 and N_2O showed a decrease of respectively 0.3 and 0.2 Tg CO_2 eq between the year 2009 and 2010. All the fluorinated greenhouse gases showed a small increase between 2009 and 2010, about 0.2 for HFCs, 0.04 for PFCs and 0.014 Tg CO_2 eq for SF_6.

Overall, total greenhouse gas emissions increased by about 6% compared to 2009.

ES3 Overview of source and sink category emission estimates and trends

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

Sectors showing the largest growth in CO_2 equivalent emissions since 1990 are Transport (1A3) and Energy industries (1A1) (+33% and +27%, respectively). Half the marked increase in the public electricity sector of almost 30% between 1990 and 1998 is caused by a shift of cogeneration plants from manufacturing industries to the public electricity and heat production sector due to a change of ownership (joint ventures), simultaneously causing a 15% decrease in industry emissions in the early 1990s (1A2).

ES4 Other information

General uncertainty evaluation

The results of the uncertainty estimation according to the IPCC Tier 1 uncertainty approach are summarised in Annex 1 of this report. The Tier 1 estimation of annual uncertainty in CO_2 eq emissions results in an overall uncertainty of 3%, based on calculated uncertainties of 2%, 16%, 43% and 35% for CO_2 (excluding LULUCF), CH_4, N_2O and F-gases, respectively.

However, these figures do not include the correlation between source categories (e.g., cattle numbers for enteric fermentation and animal manure production), or a correction for not-reported sources. Therefore, the actual uncertainty of total annual emissions per compound and of the total will be somewhat higher; it is currently estimated by RIVM at:

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

Annex 1 summarises the estimate of the trend uncertainty 1990-2010 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in the total CO_2 eq emissions (including LULUCF) for 1990-2010 (1995 for F-gases) of ±3% points. This means that the trend in total CO_2 eq emissions between 1990 and 2010 (including LULUCF), which is calculated to be a 2% decrease, will be between 5% decrease and 1% increase. 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%, ±8%, ±8% and ±11%, respectively. More details on the level and trend uncertainty assessment can be found in Annex 7.

Completeness of the national inventory

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

- CO_2 from asphalt roofing (2A5), due to missing activity data;
- CO_2 from road paving (2A6), due to missing activity data;
- CH_4 from enteric fermentation of poultry (4A9), due to missing emission factors;
- N_2O from industrial waste water (6B1), due to negligible amounts;
- part of CH_4 from industrial waste water (6B1b Sludge), due to negligible amounts;
- Precursor emissions (carbon monoxide (CO), nitrogen oxide (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2) from Memo item 'International bunkers' (international transport) have not been included.

For more information on this issue, see Annex 5.

Methodological changes, recalculations and improvements

This NIR 2012 is based on the envisaged National System of the Netherlands under article 5.1 of the Kyoto Protocol, as developed in the last decade and finalised by December 2005. In past years the results of various improvement actions have been implemented in the methodologies and processes of the preparation of the greenhouse gas inventory of the Netherlands. Compared to the NIR/CRF 2011 and based on the results of the review of the National System by an Expert Review Team of the UNFCCC, some recalculations were undertaken in the last year. The recalculations did not significantly change the emission data. The ratio behind the recalculations is documented in the sectoral chapters 3-8 and chapter 10.

Table ES.3 provides the results of recalculations in the NIR 2012 compared to the NIR 2011 and the resubmitted data from November 2011.

Improving the QA/QC system

The QA/QC programme (quality assurance/quality control) is up to date and all procedures and processes have been established to meet the National System requirements (as part of the annual activity programme of the Netherlands PRTR). QA/QC activities to be undertaken as part of the National System are described in chapter 1.

Emission trends for indirect greenhouse gases and SO_2

Compared to 1990, CO and NMVOC emissions were reduced in 2010 by 54% and 69%, respectively. For SO_2 this is 83% and for NO_x, the 2010 emissions are 53% lower than the 1990 level. Table ES.4 provides trend data. In contrast to the direct greenhouse gases, emissions of precursors from road transport have not been corrected for fuel sales according to the national energy statistics but are directly related to transport statistics on vehicle-km, which differs to some extent from the IPCC approach. Recalculations (due to changes in methodologies and or allocation) have only been performed for 1990, 1995, 2000 and 2005 to 2010 for all sources.

Table ES.3 Differences between NIR 2011 and NIR 2012 due to recalculations and the resubmitted data from November 2011 (Unit: Tg CO_2 eq, F-gases: Gg CO_2 eq).

Gas	Source	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Tg)	NIR 2012	**162.2**	173.6	172.9	179.0	175.4	175.3	178.2	172.8
Incl. LULUCF	NIR 2011	**162.0**	173.3	172.5	178.7	175.0	174.9	177.9	172.4
	Difference	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
CO_2 (Tg)	NIR 2012	**159.3**	170.7	169.9	175.9	172.3	172.4	175.2	169.9
Excl. LULUCF	NIR 2011	**159.3**	170.8	170.0	176.0	172.3	172.4	175.2	169.9
	Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CH_4 (Tg)	NIR 2012	**25.7**	24.3	19.9	17.4	17.0	17.0	17.2	17.1
	NIR 2011	**25.7**	24.3	19.9	17.3	16.9	17.0	17.2	17.1
	Difference	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
N_2O (Tg)	NIR 2012	**20.2**	20.1	17.6	15.6	15.5	13.8	9.9	9.6
	NIR 2011	**20.1**	20.1	17.7	15.7	15.6	13.8	9.9	9.7
	Difference	0.1%	0.0%	-0.5%	-0.5%	-0.5%	-0.6%	-0.9%	-1.4%
PFCs (Gg)	NIR 2012	2,264	**1,938**	1,582	266	257	323	251	168
	NIR 2011	2,264	**1,938**	1,582	266	257	323	251	168
	Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HFCs (Gg)	NIR 2012	4,432	**6,019**	3,892	1,515	1,727	1,843	1,922	2,040
	NIR 2011	4,432	**6,018**	3,886	1,494	1,704	1,820	1,889	2,061
	Difference	0.0%	0.0%	0.1%	1.9%	1.4%	1.3%	1.7%	-1.0%
SF_6 (Gg)	NIR 2012	218	**287**	297	240	199	188	184	170
	NIR 2011	217	**301**	315	239	198	192	186	175
	Difference	0.4%	-4.8%	-5.9%	0.5%	0.3%	-2.3%	-1.1%	-2.7%
Total	NIR 2012	215.0	226.2	216.1	214.0	210.0	208.4	207.6	201.8
(Tg CO_2 eq.)	NIR 2011	214.7	225.9	215.9	213.7	209.7	208.1	207.3	201.5
Incl. LULUCF	*Difference*	0.2%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%
Total	NIR 2012	212.0	223.4	213.2	211.0	207.0	205.5	204.6	198.9
[Tg CO_2 eq.]	NIR 2011	212.0	223.4	213.3	211.0	207.0	205.6	204.7	199.1
Excl. LULUCF	*Difference*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%

Note: Base year values are indicated in bold.

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Total NO_x	558	464	391	333	324	300	292	268	261
Total CO	1,238	943	829	662	654	632	630	578	573
Total NMVOC	475	337	237	175	165	162	160	150	149
Total SO_2	198	139	79	70	81	59	50	38	34

Part 1
Annual Inventory Report

1 Introduction

1.1 Background information on greenhouse gas inventories and climate change

1.1.1 Background information on climate change

The United Nations Framework Convention on Climate Change (UNFCCC) was ratified by the Netherlands in 1994 and entered into force in March of 1994.
One of the commitments made by the ratifying Parties under the Convention is to develop, publish and regularly update national emission inventories of greenhouse gases. This national inventory report, together with the CRF, represents the 2011 national emission inventory of greenhouse gases under the UNFCCC (part 1 of this report) and under its Kyoto Protocol (part 2 of this report).

Geographical coverage
The reported emissions include those that have to be allocated to the legal territory of the Netherlands. This includes a 12-mile zone from the coastline and also inland water bodies. It excludes Aruba, Curaçao and Sint Maarten that are constituent countries within the Royal Kingdom of the Netherlands. It also excludes the isles Bonaire, Saba and Sint Eustatius that are since 10 October 2010 public bodies (openbare lichamen) with their own legislation that is not applicable to the European part of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included.

1.1.2 Background information on greenhouse gas inventory

As indicated, this national inventory report documents the 2010 Greenhouse Gas Emission Inventory for the Netherlands under the UNFCCC and under the Kyoto Protocol. The estimates provided in the report are consistent with the Intergovernmental Panel on Climate Change (IPCC) 1996 Guidelines for National Greenhouse Gas Inventories (IPCC, 1997) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2001) and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (LULUCF). The methodologies applied for the Netherlands' inventory are also consistent with the guidelines under the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism.

For detailed assessments of the extent to which changes in emissions are due to the implementation of policy measures, see the Environmental Balance (PBL, 2009; in Dutch), the Fourth and the Fifth Netherlands National Communication under the United Nations Framework Convention on Climate Change (VROM, 2005 resp. VROM, 2009) and the Netherlands Report on Demonstrable

Progress under Article 3.2 of the Kyoto Protocol (VROM, 2006b).

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

The National Inventory Report (NIR) covers the six direct greenhouse gases included in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) (the F-gases). Emissions of the following indirect greenhouse gases are also reported: nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC), as well as sulphur oxides (SO_x).
This report provides explanations of the trends in greenhouse gas emissions per gas and per sector for the 1990–2010 period and summarises descriptions of methods and data sources for: (a) Tier 1 assessments of the uncertainty in annual emissions and in emission trends; (b) key source assessments following the Tier 1 and Tier 2 approaches of the IPCC Good Practice Guidance (IPCC, 2001); (c) quality assurance and quality control (QA/QC) activities.

Under the National System under Article 5.1 of the Kyoto Protocol, methodologies were established (and documented) in monitoring protocols. These protocols are annually re-assessed and revised, if needed, for example, based on recommendations of UN reviews. The monitoring protocols and the general description of the National System are available on the website www.nlagency.nl/nie. The emissions reported in the NIR 2012 are based on these methodologies, which have been incorporated in the National System for greenhouse gases. The emissions are, with a delay of some months, also available on the website www.prtr.nl.

In 2007, the UN performed an in-country initial review under the Kyoto Protocol. The review concluded that the Netherlands National System has been established in accordance with the guidelines and that it meets the requirements. This was also confirmed by later reviews such as the in-country review of the NIR 2011. The National System has remained unchanged with the exception of an organisational change per 1 January 2010. At that date, co-ordination of the above mentioned PRTR project (emissions registration project) shifted from PBL (Netherlands Environmental Assessment Agency) to RIVM (National Institute for Public Health and the Environment). In 2010 arrangements were made to ensure the quality of the products of the PRTR project in the new setting.

The structure of this report complies with the format required by the UNFCCC (FCCC/SBSTA/2004/8 and the latest annotated outline of the National Inventory report including reporting elements under the Kyoto protocol). It also includes supplementary information under Article 7 of the Kyoto Protocol. Part 2 gives an overview of this information.

Greenhouse gas emissions presented in this report are given in gigagrammes (Gg) and teragrammes (Tg). Global warming potential (GWP) weighed emissions of the greenhouse gases are also provided (in CO_2 equivalents), using the GWP values in accordance with the Kyoto Protocol and using the IPCC GWP for a time horizon of 100 years. The GWP of each individual greenhouse gas is provided individually in Annex 9.

The Common Reporting Format (CRF) spreadsheet files accompany this report as electronic annexes (the CRF files are included in the zip file for this submission: NETHERLANDS-2012-v1.1.zip). The CRF files contain detailed information on greenhouse gas emissions, activity data and (implied) emission factors specified by sector, source category and greenhouse gas. The complete set of CRF files as well as this report comprise the National Inventory Report (NIR) and are published on the website www.nlagency.nl/nie.
Other information, such as protocols of the methods used to estimate emissions, is also available on this website. Section 10 provides details on the extent to which the CRF data files for 1990–2010 have been completed and on improvements made since the last submission.

1.1.3 Background information on supplementary information under Article 7 of the Kyoto Protocol

Part 2 of this report provides the supplementary information (under Article 7) of the Kyoto Protocol. As the Netherlands has not elected any activities to include under Article 3, paragraph 4 of the Kyoto Protocol, the supplementary information on KP LULUCF deals with activities under Article 3, paragraph 3. Information on the accounting of Kyoto units is also provided in the SEF file SEF_NL_2012_1_16-20-3 4-1-2012.xls and in the SIAR report file SIAR Reports 2011-NL v1.0.xls.

1.2 Institutional arrangements for inventory preparation

1.2.1 Overview of institutional arrangements for the inventory preparation

The Ministry of Infrastructure and Environment (IenM) has overall responsibility for climate change policy issues including the preparation of the inventory.

In August 2004, IenM assigned SenterNovem (now NL Agency) executive tasks bearing on the National Inventory Entity (NIE), the single national entity required under the Kyoto Protocol. In December 2005, NL Agency was designated by law as the NIE. In addition to co-ordinating the establishment and maintenance of a National System, the tasks of NL Agency include overall co-ordination of improved QA/QC activities as part of the National System and co-ordination of the support/ response to the UNFCCC review process. The National System is described in more detail in the Fourth and Fifth National Communication (VROM 2006b, 2009).

Since 1 January 2010, RIVM has been assigned by IenM as co-ordinating institute for compiling and maintaining the pollutants emission register/inventory (PRTR system), containing about 350 pollutants including the greenhouse gases. The PRTR project system is used as basis for the NIR and for filling the CRF. After the general elections in the Netherlands in 2010, the responsibilities of the former VROM moved to the restructured Ministry of Infrastructure and Environment (IenM).

1.2.2 Overview of inventory planning

The Dutch PRTR has been in operation in the Netherlands since 1974. This system encompasses data collection, data processing and registering and reporting emission data for about 350 policy-relevant compounds and compound groups that are present in air, water and soil. The emission data is produced in an annual (project) cycle (RIVM, 2010). This system is also the basis for the national greenhouse gas inventory. The overall co-ordination of the PRTR is outsourced by the ministry (IenM) to the RIVM.
The main objective of the PRTR is to produce an annual set of unequivocal emission data that is up-to-date, complete, transparent, comparable, consistent and accurate. In addition to RIVM, various external agencies contribute to the PRTR by performing calculations or submitting activity data. These include: CBS (Statistics Netherlands), PBL (Netherlands Environmental Assessment Agency), TNO (Netherlands Organisation for Applied Scientific Research), NL Agency, Centre for Water Management, Deltares and several institutes related to the Wageningen University and Research Centre (WUR).

Responsibility for reporting
The NIR part 1 is prepared by RIVM as part of the PRTR project. Most institutes involved in the PRTR also contribute to the NIR (including CBS and TNO). In addition, NL Agency is involved in its role as NIE. NL Agency also prepares the NIR part 2 and takes care of integration and submission to the UNFCCC in its role as NIE. Submission to the UNFCCC only takes place after approval by IenM.

1.2.3 Overview of the inventory preparation and management under Article 7 of the Kyoto Protocol

Following the annotated outline, the supplementary information under Article 2 of the Kyoto Protocol is reported together in the NIR part 2. This information is prepared by NL Agency, using information from various other involved organisations, such as the NEa (Dutch Emissions Authority), the WUR and the ministry (IenM).

1.3 Inventory preparation

1.3.1 GHG and KP-LULUCF inventory

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

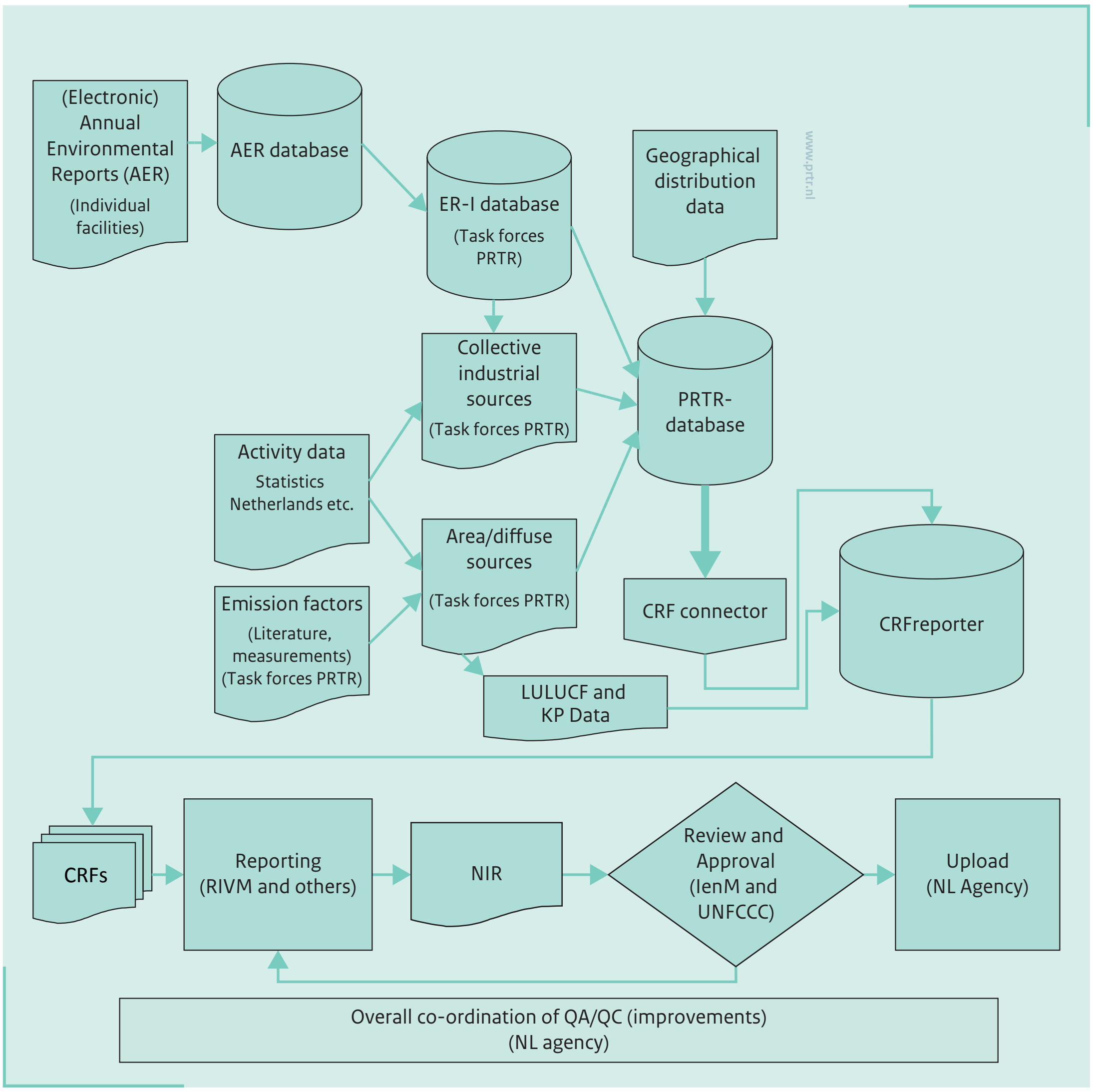
For the KP-LULUCF inventory, the inventory preparation is combined with the work for reporting LULUCF by the unit Wettelijke Onderzoekstaken Natuur & Milieu, part of Wageningen UR. The project team LULUCF (which is part of the Taskforce Agriculture) oversees data management, the preparation of the reports for land-use, land-use change and forestry and the QA/QC activities and decides on further improvements.

1.3.2 Data collection processing and storage

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

Statistical data
Statistical data are provided under various (not specifically greenhouse-gas related) obligations and legal arrangements. These include national statistics from Statistics Netherlands (CBS) and a number of other sources of data on sinks, water and waste. The provision

Figure 1.1 Main elements **in the greenhouse gas inventory process.**



of relevant data for greenhouse gases is guaranteed through covenants and an Order in Decree, the latter of which is under preparation by IenM. For greenhouse gases, relevant agreements with respect to waste management are in place with CBS and NL Agency. An agreement with the Ministry of Agriculture, Nature and Food Quality (LNV, now EL&I) and related institutions was established in 2005.

Data from individual companies

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

N_2O, HFC-23 and PFCs released as by-products) are mainly based on information from these AER, as are the calculated emissions from precursor gases (CO, NO_x, NMVOC) and SO_2. As reported in previous NIRs, only those AER with high-quality and transparent data are used as a basis for calculating total source emissions in the Netherlands.

Additional greenhouse-gas-related data

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

Processing and storage

Data processing and storage are co-ordinated by RIVM; these processes consist most notably of the elaboration of emission estimates and data preparation in the PRTR database. The emission data are stored in a central database, thereby satisfying – in an efficient and effective manner – national and international criteria on emission reporting. Using a custom made programme (CRF Connector) all relevant emission and activity data are extracted from the PRTR database and included in the CRF Reporter thus ensuring highest level of consistency. Data from the CRF Reporter are used in the compilation of the NIR.

The actual emission calculations and estimates that are made using the input data are implemented in five task forces (shown in Figure 1.2), each dealing with specific sectors:

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

The task forces consist of experts from several institutes. In 2011, in addition to the RIVM, these included PBL, TNO, CBS, Centre for Water Management, Deltares, FO-I (the Facilitating Organisation for Industry, which co-ordinates annual environmental reporting by companies), NL Agency (Waste Management division) and two agricultural research institutes: Alterra (sinks) and LEI. The task forces are responsible for assessing emission estimates based on the input data and emission factors provided. RIVM commissioned TNO to assist in the compilation of the CRFs.

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

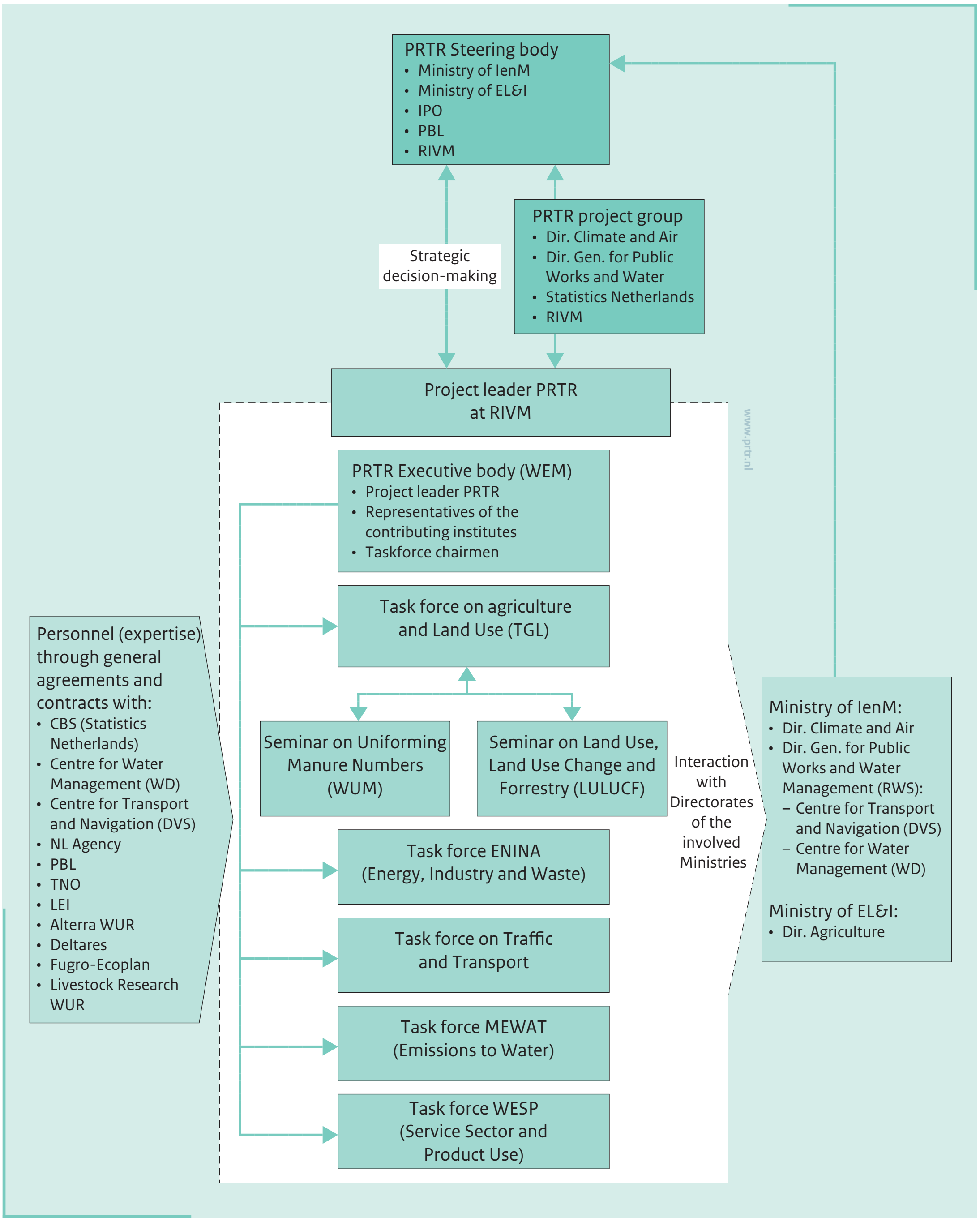
The NIR is prepared by RIVM with input from experts in the relevant PRTR task forces and from NL Agency. This step includes documentation and archiving. IenM formally approves the NIR before it is submitted; in some cases approval follows consultation with other ministries. NL Agency is responsible for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

For KP-LULUCF, consistency with the values submitted for the Convention is assured by using the same base data and calculation structure. The data, as required in the KP-LULUCF CRF, tables are derived from these base data using specific calculations. The data and calculations were thus subject to the same QA/QC procedures (Van den Wyngaert et al., 2009).
The calculated values were entered in the LULUCF reporting system at Alterra, and checked by the LULUCF sectoral expert. They were then exported as an XML file and sent to the Dutch inventory, which imported the data in the CRF database for all sectors and again checked. Any unexpected or incomplete values were reported to the LULUCF sectoral expert, checked and if necessary corrected.

Verification with other international statistics was performed only with FAO. The area of forest is systematically lower for FAO. This may be due to a different methodology. For discussion on different outcomes of different estimates of forest cover in the Netherlands, see Nabuurs et al., 2005. The net increase in forest area in the FAO statistics is higher that reported for KP-LULUCF, and this may indicate that the 1990 estimate may be low in the FAO statistics. These values indicate a conservative estimate of the net forest increase in the Netherlands.

The mean C stock in Dutch forests (used as an emission factor for deforestation under the KP) is slightly higher in the UNFCCC estimates than in the FAO estimates. Considering that different conversion factors were used, the estimates are close, while the difference has the tendency to increase. If this continues for the 2010 FAO

Figure 1.2 Organisational arrangements **PRTR-project.**



estimate, this will be reason for investigation. These values indicate a conservative estimate of C emissions from deforestation.

No values from FAO are available on young forests. FAO statistics also provide no information on fires or disturbances for the Kyoto period, since at the national level these statistics are no longer kept. The same accounts for EFFIS, the European Forest Fires Information System.

1.4 Brief description of methodologies and data sources used

1.4.1 GHG inventory

Methodologies
Table 1.1 provides an overview of the methods used to estimate greenhouse gas emissions. Monitoring

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

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

	HFCs		PFCs		SF_6	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
2. Industrial Processes	**CS,T1,T2**	**CS,PS**	**T2**	**PS**	**CS,T2,T3**	**D,PS**
A. Mineral Products						
B. Chemical Industry	NA	NA	NA	NA	NA	NA
C. Metal Production	NA	NA	T2	PS	NA	NA
D. Other Production						
E. Production of Halocarbons and SF_6	T1,T2	PS	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6	CS,T2	CS			CS,T2,T3	D,PS
G. Other	NA	NA	NA	NA	NA	NA

protocols, documenting the methodologies and data sources used in the greenhouse gas inventory of the Netherlands as well as other key documents are listed in Annex 6. The protocols were elaborated, together with relevant experts and institutes, as part of the monitoring improvement programme.
Explanation of notation keys used:

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

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

Data sources

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

- fossil fuel data: (1) national energy statistics from CBS (National Energy Statistics; Energy Monitor); (2) natural gas and diesel consumption in the agricultural sector (Agricultural Economics Institute, LEI).
- (residential) bio fuel data: (1) national renewable energy statistics from CBS (National Energy Statistics; Renewable Energy).
- transport statistics: (1) monthly statistics for traffic and transportation; (2) national renewable energy statistics from CBS (National Energy Statistics; Renewable Energy).
- industrial production statistics: (1) annual inventory reports from individual companies; (2) national statistics.
- consumption of HFCs: annual reports from the accountancy firm PriceWaterhouseCoopers (only HFC data are used due to inconsistencies for PFCs and SF_6 with emissions reported elsewhere).
- consumption/emissions of PFCs and SF_6: reported by individual firms.
- anaesthetic gas: data provided by the three suppliers of this gas in the Netherlands; Linde gas (former HoekLoos), NTG (SOL group) and Air Liquide.
- spray cans containing N_2O: the Dutch Association of Aerosol Producers (Nederlandse Aerosol Vereniging, NAV).
- animal numbers: from the CBS/LEI agricultural database, plus data from the annual agricultural census.
- manure production and handling: from the CBS/LEI national statistics
- fertiliser statistics: from the LEI agricultural statistics.
- forest and wood statistics: (1) harvest data: FAO harvest statistics;
- (2) stem-volume, annual growth and fellings: Dirkse et al. (2003)
- (3) carbon balance: National Forestry Inventory data based on two inventories: HOSP (1988-1992) and MFV (2001-2005).
- land use and land use change: based on digitised and digital topographical maps of 1990 and 2004 (Kramer et al. 2009).
- area of organic soils: De Vries (2004).
- soil maps: De Groot et al. (2005).
- waste production and handling: Working Group on Waste Registration (WAR), NL Agency and CBS.
- CH_4 recovery from landfills: Association of Waste Handling Companies (VVAV).

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

1.4.2 KP-LULUCF inventory

Methodologies

The methods used to estimate data on sinks and sources as well as the units of land subject to Article 3.3 afforestation, reforestation and deforestation are additional to the methods used for LULUCF. The methodology of the Netherlands to assess the emission from LULUCF is based on a wall-to-wall approach for the estimation of area per category of land use. For the wall-to-wall map overlay approach were used harmonised and validated digital topographical maps of 1990, 2004 and 2009 (Kramer et al., 2009; Van den Wyngeart et al., 2012). The result was a national scale land use and land use change matrix.
To distinguish between mineral soils and peat soils, an overlay was made between two Basic Nature maps and the Dutch Soil Map (De Vries et al., 2004). The result is a map with national coverage that identifies for each pixel whether it was subject to RA or D between 1990 and 2004 and whether it is located on a mineral or on an organic soil and if on a mineral soil, which is the aggregated soil type.

Data sources

The changes in land use are based on comparing detailed maps that best represent land use in 1990, 2004 and 2009. All three datasets on land use were especially developed to support the temporal and spatial development in land use and especially designed to support policy in the field of nature conservation. Changes after 2009 have been obtained by linear extrapolation.

1.5 A brief description of the key categories

1.5.1 GHG inventory

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

Guidance. A detailed description of the key source analysis is provided in Annex 1 of this report. Per sector, the key sources are also listed in the first section of each of chapters 3 to 8.

Compared to the key source analysis for the NIR 2011, two new key categories are identified:
- 2B5 Caprolactam production
- 5E2 Land converted to settlements

This is due to the use of new emission data (2010).

1.5.2 KP-LULUCF inventory

With -451 Gg CO_2 the annual contribution of re/afforestation under the KP is below the smallest key category (Tier 1 level analysis including LULUCF). Deforestation under the KP in 2010 causes an emission of 790 Gg CO_2, which is more than the smallest key category (Tier 1 level analysis including LULUCF).

1.6 Information on the QA/QC plan

As one of the results of a comprehensive inventory improvement programme, a National System fully in line with the Kyoto requirements was finalised and established at the end of 2005. As part of this system, an Act on the Monitoring of Greenhouse Gases also became effective in December 2005. This Act determines the establishment of the National System for monitoring of greenhouse gases and empowers the Minister for Infrastructure and Environment (IenM) to appoint an authority responsible for the National System and the National Inventory. The Act also determines that the National Inventory be based on methodologies and processes as laid down in the monitoring protocols. In a subsequent regulation the Minister has appointed NL Agency as NIE (National Inventory Entity, the single national entity under the Kyoto Protocol) and published a list of the protocols. Adjustments to the protocols will require official publication of the new protocols and announcement of publication in the official Government Gazette (Staatscourant).

As part of its National System, the Netherlands has developed and implemented a QA/QC programme. This programme is assessed annually and updated, if needed. The key elements of the current programme (NL Agency, 2011) are briefly summarised in this chapter, notably those related to the current NIR.

1.6.1 QA/QC procedures for the CRF/NIR 2012

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

- Various QC issues:
  - Inconsistencies in the key category analysis between CRF and NIR were analysed and removed. The key category analysis is updated in the NIR (Annex 1) as well as the CRF files.
  - The Expert Review Team (ERT) recommended providing more information in the NIR report and protocols, which was until now only included in background information. The Netherlands has updated the protocols; for various sectors this implies that more information is included in the protocols, as requested by the ERT.
  - The ERT recommended providing more specific information on sector specific QC activities. In 2009 and early 2010, a project was performed to re-assess and update both the information on uncertainties and on sector specific QC activities (Ecofys, 2010). The PRTR task forces continue to work on the implementation of the recommendations from this report in 2012.
  - The Netherlands continues its efforts to include the correct notation keys in the CRF files.
- For the NIR 2012, changes were incorporated in and references were updated to the National System website (www.nlagency.nl/nie), providing additional information on the protocols and relevant background documents.

General QC checks were performed. To facilitate these general QC checks, a checklist was developed and implemented. A number of general QC checks have been introduced as part of the annual work plan of the PRTR and are also mentioned in the monitoring protocols. The QC checks included in the work plan aim at covering issues such as consistency, completeness and correctness of the CRF data. The general QC for the present inventory was largely performed in the institutes involved as an integrated part of their PRTR work (Wever, 2011). The PRTR task forces fill in a standard-format database with emission data for 1990–2010 (with the exception of LULUCF). After a first check of the emission files by RIVM and TNO for completeness, the (corrected) data are available to the specific task force for checking consistency checks and trend analysis (comparability, accuracy). The task forces have access to information about the relevant emissions in the database. Several

weeks before the dataset was fixed, a trend verification workshop was organised by RIVM (December, 2011) see Box 1.1. The result of this workshop including actions for the task forces to resolve the identified clarification issues are documented at RIVM. Required changes to the database are then made by the task forces.
Basic LULUCF data (e.g., Forest Inventories, Forests statistics and land use maps) have a different routing compared to the other basic data (see Figure 1.1).
QA/QC for these data are described in the description of QA/QC of the outside agencies (Wever, 2011).

Quality Assurance for the current NIR includes the following activities:
- A peer and public review, on the basis of the draft NIR in January/February 2012. Results of this review are summarised in chapter 10 and have been dealt with as far as possible in the present NIR.
- In preparing this NIR, the results of former UNFCCC reviews, including the preliminary results of the 2011 in-country review (see chapter 10.4 for an overview).

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

The QA/QC system should operate within the available means (capacity, finance). Within those boundaries, the main focal points of the QA/QC activities are:
- The *QA/QC programme* (NL Agency, 2011) that has been developed and implemented as part of the National System. This programme includes quality objectives for the National System, the QA/QC plan and a time schedule for implementation of the activities. It is updated annually as part of an 'evaluation and improvement cycle' for the inventory and National System and held available for review.
- The adaptation of the PRTR-project to the quality system of RIVM (ISO 9001:2008 system) was completed in 2011.
- The annual *project plan* of the RIVM (RIVM 2011). The work plan describes the tasks and responsibilities of the parties involved in the PRTR process, such as products, time schedules (planning) and emission estimation methods (including the monitoring protocols for the greenhouse gases), as well as those of the members of several task forces. The annual work plan also describes the general QC activities to be performed by the task forces before the annual database is fixed (see section 1.6.2).
- The responsibility for the quality of data in *annual environmental reports* (AER) lies with the companies themselves, while validation of the data is the responsibility of the competent authorities. It is the responsibility of the institutes involved in the PRTR to judge whether or not to use the validated data of individual companies to assess the national total emissions. (CO_2 emissions, however, are based on energy statistics and standard emission factors and only qualified specific emission factors from environmental reports are used).
- *Agreements/covenants* between RIVM and other institutes involved in the annual PRTR process. The general agreement is that by accepting the annual work plan, the institutes involved commit themselves to deliver capacity for the products specified in that work plan. The role and responsibility of each institute have been described (and agreed upon) within the framework of the PRTR work plan.
- Specific procedures that have been established to fulfil the QA/QC requirements as prescribed by the UNFCCC and Kyoto Protocol. General agreements on these procedures are described in the QA/QC programme as part of the National System. The following specific procedures and agreements have been set out and described in the QA/QC plan and the annual PRTR work plan:
  - QC on data input and data processing, as part of the annual process towards trend analysis and fixation of the database following approval of the involved institutions.
  - Documentation of consistency, completeness and correctness of the CRF data (see also section 1.6.2). Documentation is required for changes in the historical data set and for the emission trend that exceeds 5% at the sector level and 0.5% at the national total level.
  - Peer reviews of CRF and NIR by NL Agency and institutions not fundamentally involved in the PRTR process.
  - Public review of the draft NIR: NL Agency organises every year a public review (by means of the Internet). Relevant comments are incorporated in the final NIR.
  - Audits: in the context of the annual work plan, it has been agreed that the involved institutions of the PRTR inform RIVM concerning possible internal audits. Furthermore, NL Agency is assigned the task of organising audits, if needed, of relevant processes or organisational issues within the National System. In February 2012, such an audit was performed for the confidential data of industrial process emissions.
  - Archiving and documentation: internal procedures are agreed (amongst others in the PRTR annual activity programme) for general data collection and the storage of fixed datasets in the RIVM database, including the documentation/archiving of QC checks. The RIVM database holds, as of this submission, storage space where the task forces can store the crucial data for their emission calculations. The use of this feature is voluntary.

Table 1.2 Key items of the verification actions CRF/NIR 2012.

Item	Date	Who	Result	Documentation
Comparison sheets to check for accidentally changed historical data	30-11-2011	RIVM	Input for trend analyses	historische reeksen vergeleken LUCHT v 28 november 2011.xls
Draft CRF	07-12-2011	NIC/TNO	Explanation of recalculations	Recalculations1.xls
Comparison sheets dataset years 2009-2010	06-12-2011	RIVM	Input for trend analysis	Verschiltabel definitieve emissiecijfers 6 december 2011 LUCHT IPCC.xls
List of required actions (action list)	02-12-2011	RIVM	Input for trend analysis	Actiepunten trendanalyse definitieve emissiecijfers 2010 v 5 dec.xls
Trend analysis	08-12-2011	Task Forces	Updated Action list	Actiepunten trendanalyse 2010 definitief v 10 dec 2011.xls
Resolving the issues of the Action list	Until 15-12-2011	Task Forces	Final data set	Actiepunten trendanalyse 2010 definitief v 15 dec 2011.xls
Comparison data in CRF and EPRTR database	Until 12-01-2012	NIC/TNO	Final CRF sent to the EU	NLD-2012-v1.1.xml
Writing and Checks of NIR	Until 13-01-2012	Task forces/ NIC/TNO/NIE	Draft texts	S:\ \NI National Inventory Report\NIR 2011\NIR2011-werkversie
Generate tables for NIR from CRF	Until 13-01-2012	NIC/TNO	Final text and tables NIR	Tabellen Hoofdstuk 3 NIR2012.xls NIR2012 Tables and Figures (version 1.6).xls

  - The improved monitoring protocols have been documented and will be published on the website www.nlagency.nl/nie. To improve transparency, the implemented checklists for QC checks have been documented and archived. As part of the QA/QC plan the documentation and archiving system has been further upgraded. NL Agency (NIE) maintains the National System website and a central archive of relevant National System documents.
  - Each institution is responsible for QA/QC aspects related to reports based on the annually fixed database.
- Evaluation and improvement: those persons involved in the annual inventory tasks are invited once a year to evaluate the process. In this evaluation, the results of any internal and external review and evaluation are taken into account. The results are used for the annual update of the QA/QC programme and the annual work plan.
- Source-specific QC: comparison of emissions with independent data sources was one of the study topics in the inventory improvement programme. Because it did not seem possible to considerably reduce uncertainties through independent verification (measurements) – at least not on a national scale – this issue has received less priority. However, the theme is taken up in two projects. Following the UN review recommendations, NL Agency carried out a project together with Ecofys (Ecofys, 2010) and the PRTR project to re-assess and update the description of uncertainties and the sector specific QC activities. Based on this report, further action on this issue will be undertaken in 2012.
- In 2011, a quantitative assessment was made of the possible (in)consistencies in CO_2 emissions between data from ETS, NIR and National Energy Statistics. The figures that were analysed concerned about 40% of the CO_2 emissions in the Netherlands in 2010. The differences could reasonably be explained (e.g., different scope) within the given time available for this action (De Ligt, 2011).

1.6.2 Verification activities for the CRF/NIR 2012

Two weeks in advance of a trend analysis meeting, a snapshot from the database is made available by RIVM in a web-based application (Emission Explorer, EmEx) for checks by the institutes and experts involved (PRTR task forces). This allows the task forces to check for level errors and consistency in the algorithm/method used for calculations throughout the time-series. The task forces perform checks such as for CO_2, CH_4 and N_2O emissions from all sectors. The totals for the sectors are then compared with the previous year's data set. Where significant differences are found, the task forces evaluate the emission data in more detail. The results of these checks are then subject to discussion at the trend analysis workshop and subsequently documented. Furthermore, the task forces were provided with the CRF Reporter software to check the time-series of emissions per substance. The task forces examine these time-series. During the trend analysis, the greenhouse gas emissions for all years between 1990 and 2010 were checked in two ways:

(1) emissions from 1990 – 2009 should (with some exceptions) be identical to those reported last year;

(2) the data for 2010 were compared with the trend development for each gas since 1990. Checks of outliers were carried out at a more detailed level for the sub-sources of all sector background tables:
- annual changes in emissions of all greenhouse gases
- annual changes in activity data
- annual changes in implied emission factors
- level values of implied emission factors

Exceptional trend changes and observed outliers are noted and discussed at the trend analysis workshop, resulting in an action list. Items on this list must either be processed within two weeks or be dealt with in next years' inventory.

The trend verification workshop held on 8 December 2011, showed the following results:
Issues per source category:
- Error correction of fuel consumption of non-road vehicles based on new fuel consumption data from the agricultural sector. This also affected the emission data for Fisheries.
- Based on new data from Netherlands Statistics the bunker emissions changed and therefore the AD and Emissions from this topic.
- Because detailed data became available in 2011, the historic emissions of F-gases changed.
- Changes in emissions in category. 4. Agriculture (whole time-series) should be explained in chapter 6.
- Changes in activity data and emissions for LULUCF and KP-LULUCF, due to the implementation of a 3rd land use map.

All above-mentioned checks are planned in the annual project plan for 2012 (RIVM, 2011). Furthermore, data checks (also for non-greenhouse gases) are performed and a trend verification workshop is held. To facilitate the data checks and the trend verification workshop, three types of data sheet were prepared from the PRTR emission database:
- Based on the PRTR emission database, a table with a comparison of the emission years 2009 and 2010. In this table, differences >5% at the sector level were marked for documenting trends;
- Based on the PRTR emission database, to check if no historical data have been accidentally changed, a table with a comparison of the complete inventories of 2011 versus 2012;
- To check that no errors occur during transfer of data from the PRTR emission database to the CRF, a table with the comparison of data from both data sources.

The data checks are performed by the sector experts and others involved in preparing the emission database and the inventory. Communications (e-mail) between the participants in the data checks is centrally collected and analysed. This resulted in a checklist of actions to be taken. This checklist is used as input for the trend verification workshop and completed with the actions agreed in this workshop. Furthermore, in the trend verification workshop trends >5% on sector level are explained. Table 1.2 shows the key items of the verification actions for the CRF/NIR 2012.

Completion of an action is reported on the checklist. Based on the completed checklist and the documentation of trends, the dataset is formally agreed by the two most involved inst'itutes: RIVM and Statistics Netherlands (CBS). The acceptance of the dataset is, furthermore, a subject in the PRTR Executive body (WEM).

All documentation (e-mails, data sheets and checklist) are stored electronically on a server at RIVM.

1.6.3 Treatment of confidentiality issues

Some of the data used in the compilation of the inventory are confidential and cannot be published in print or electronic format. That is the reason the Netherlands has to use the notation key 'C' in the CRF. Although this does impair the transparency of the inventory, all confidential data can be made available to the official review process of the UNFCCC.

1.7 Evaluating general uncertainty

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

1.7.1 GHG inventory

The following information sources were used for estimating the uncertainty in activity data and emission factors (Olivier et al., 2009):
- Estimates used for reporting uncertainty in greenhouse gas emissions in the Netherlands that were discussed at a national workshop in 1999 (Van Amstel et al., 2000a).
- Default uncertainty estimates provided in the IPCC Good Practice Guidance report (IPCC, 2001).
- RIVM fact sheets on calculation methodology and data uncertainty (RIVM, 1999).
- Other recent information on the quality of data (Boonekamp et al., 2001).

Table 1.3 Uncertainty of total annual emissions (excl. LULUCF).

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

Table 1.4 Top ten sources contributing most to total annual uncertainty in 2010.

IPCC category	Category	Gas	Combined uncertainty as a percentage of total national emissions in 2010
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1.5%
1A4a	Stationary combustion: Other Sectors, Commercial/Institutional, gases	CO_2	1.2%
4D1	Direct N_2O emissions from agricultural soils	N_2O	1.0%
4B1	Emissions from manure management: cattle	CH_4	0.8%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	0.7%
4D2	Animal production on agricultural soils	N_2O	0.6%
1A3b	Mobile combustion: road vehicles, diesel oil	CO_2	0.5%
4B8	Emissions from manure management: swine	CH_4	0.5%
1A1b	Stationary combustion, petroleum refining, liquids	CO_2	0.5%
1A4b	Stationary combustion: Other Sectors, Residential, gases	HFC	0.5%

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

These data sources were supplemented with expert judgments from RIVM/PBL and CBS emission experts (also for new key sources). This was followed by an estimation of the uncertainty in the emissions in 1990 and 2010 according to the IPCC Tier 1 methodology – for both the annual emissions and the emission trend for the Netherlands. All uncertainty figures should be interpreted as corresponding to a confidence interval of two standard deviations (2σ), or 95%. In cases where asymmetric uncertainty ranges were assumed, the largest percentage was used in the calculation.

The results of the uncertainty calculation according to the IPCC Tier 1 uncertainty approach are summarised in Annex 7 of this report. The Tier 1 calculation of annual uncertainty in CO_2 equivalent emissions results in an overall uncertainty of about 3% in 2010, based on calculated uncertainties of 2%, 16%, 43% and 35% for CO_2 (excluding LULUCF), CH_4, N_2O and F-gases, respectively. The uncertainty in CO_2 equivalent emissions including emissions from LULUCF is calculated to be 3%.
However, these figures do not include the correlation between source categories (e.g., cattle numbers for enteric fermentation and animal manure production) or a correction for not-reported sources. Therefore, the Tier 2 uncertainty of *total annual emissions* per compound and of the total will be somewhat higher; see Table 1.3 for the currently estimated values.

Table 1.4 shows the top ten sources (excluding LULUCF) contributing most to total annual uncertainty in 2010, after ranking the sources according to their calculated contribution to the uncertainty in total national emissions (using the column 'Combined uncertainty as a percentage of total national emissions in 2010' in Table A7.1).

Compared to NIR 2011 1A4b (residential, gases) has replaced 2F (substitutes for ozone depleting substances). This as a result of using the new 2010 emission data. Table A7.1 of Annex 7 summarises the estimate of the trend uncertainty 1990–2010 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in the total CO_2 equivalent emissions (excluding LULUCF) for 1990–2010 (1995 for F-gases) of ±3%. This means that the trend in total CO_2 eq emissions between 1990 and 2010, which is calculated to −2% (decrease) will be between −5% and 1% (increase).
Per individual gas, the trend uncertainty in total emissions of CO_2, CH_4, N_2O and the total group of F-gases has been calculated to be ±3%, ±8%, ±8% and ±11%, respectively. More details on the level and trend

Table 1.5 Top ten sources contributing most to trend uncertainty in the national total.

IPCC category	Category	Gas	Uncertainty introduced into the trend in total national emissions
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1.8%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	1.2%
4D2	Animal production on agricultural soils	N_2O	0.9%
4B1	Emissions from manure management: cattle	CH_4	0.6%
1A4a	Stationary combustion: Other Sectors Commercial/Institutional, gases	CO_2	0.5%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	0.4%
2E	HFC-23 emission from HCFC-22 manufacture	HFC	0.4%
1A	Emissions from stationary combustion non-CO_2	CH_4	0.3%
4D1	Direct N_2O emissions from agricultural soils	N_2O	0.2%
2B2	Nitric acid production	N_2O	0.2%

uncertainty assessment can be found in Annex 7.
Table 1.5 shows the top ten sources (excluding LULUCF) contributing most to trend uncertainty (calculated) in the national total.
Six of these key sources are included in both the list presented above and the list of the largest contributors to annual uncertainty.

The propagation of uncertainty in the emission calculations was assessed using the IPCC Tier 1 approach. In this method, uncertainty ranges are combined for all sectors or gases using the standard equations for error propagation. If sources are added, total error is the root of the sum of squares of the error in the underlying sources. Strictly speaking, this is only valid if the uncertainties meet the following conditions: (a) standard normal distribution ('Gaussian'); (b) 2s smaller than 60%; (c) independent (not-correlated) sector-to-sector and substance-to-substance. It is clear, however, for some sources that activity data or emission factors are correlated, which may change the overall uncertainty of the sum to an unknown extent. It is also known for some sources that the uncertainty is not distributed normally; in particular, when uncertainties are very high (of an order of 100%), it is clear that the distribution will be positively skewed.
Even more important is the fact that although the uncertainty estimates have been based on the documented uncertainties mentioned above, uncertainty estimates are unavoidably – and ultimately – based on the judgment of the expert. On occasion, there is only limited reference to actual data for the Netherlands possible as support for these estimates. By focusing on the order of magnitude of the individual uncertainty estimates, it is expected that this data set provides a reasonable first assessment of the uncertainty of key source categories.

Furthermore, in 2006 a Tier 2 uncertainty assessment was carried out (Ramírez-Ramírez et al., 2006). This study used the same uncertainty assumption as the Tier 1 study but accounted for correlations and non-Gaussian distributions. Results reveal that the Tier 2 uncertainty in total Netherlands CO_2 equivalent emissions is on the same order of magnitude as that in the Tier 1 results, although a higher trend uncertainty is found (see Tables 1.6 and 1.7).
Furthermore, the Tier 2 uncertainty for 1990 emissions is slightly higher (about 1.5%) than the uncertainty for the 2004 emissions. Finally, the resulting distribution for total Netherlands CO_2 equivalent emissions turns out to be clearly positively skewed.

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

Table 1.6 Effects of simplifying Tier 1 assumptions on the uncertainties of 2004 emissions (without LULUCF).

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

Table 1.7 Effects of simplifying Tier 1 assumptions on the uncertainty in the emission trend for 1990–2004 (without LULUCF).

Greenhouse gas	Emission trend 1990-2004	Tier 1 trend uncertainty	Tier 2 trend uncertainty
Carbon dioxide	+13%	2.7%	2.1%
Methane	-32%	11%	15%
Nitrous oxide	-16%	15%	28%
F-gases	-75%	7.0%	9.1%
Total	+1.6%	3.2%	4.5%

view of the state of knowledge on the processes that lead to N_2O emission. Another finding is that correlations (covariance and dependencies in the emission calculation) seem somewhat under-addressed in most present-day European Tier 2 studies and may require more systematic attention in future.
In the assessments made above, only random errors have been estimated, assuming that the methodology used for the calculation does not include systematic errors. It is well known that in practice, this may well be the case. Therefore, a more independent verification of the emission level and emission trends using, for example, comparisons with atmospheric concentration measurements is encouraged by the IPCC Good Practice Guidance. In the Netherlands, these approaches have been studied for several years, funded by the National Research Programme on Global Air Pollution and Climate Change (NOP-MLK) or by the Dutch Reduction Programme on Other Greenhouse Gases (ROB). The results of these studies can be found in Berdowski et al. (2001), Roemer and Tarasova (2002) and Roemer et al. (2003). In 2006, the research programme 'Climate changes spatial planning' started to strengthen knowledge on the relationship between greenhouse gas emissions and land-use and spatial planning.

1.7.2 KP-LULUCF inventory

The analysis combines uncertainty estimates of the forest statistics, land use and land use change data (topographical data) and the method used to calculate the yearly growth in carbon increase and removals (Olivier et al., 2009). The uncertainty analysis is performed for Forests according to the Kyoto definition and is based on the same data and calculations as used for KP article 3.3 categories. Thus, the uncertainty for total net emissions from units of land under article 3.3 afforestation/reforestation are estimated at 63%, equal to the uncertainty in Land converted to Forest Land. Similarly, the uncertainty for total net emissions from units of land under article 3.3, deforestation is estimated at 66%, equal to the uncertainty in Land converted to Grassland (which includes for the sake of the uncertainty analysis all Forest land converted to any other type of land use.

1.8 General assessment of the completeness

1.8.1 GHG inventory

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

1.8.2 KP-LULUCF inventory

As good data to relate carbon accumulation in litter and dead wood since the time of re/afforestation are lacking for the Netherlands, this carbon sink is conservatively estimated as zero.

Forest fertilisation does not occur in the Netherlands and therefore fertilisation in re/afforested areas are reported as not occurring.

Greenhouse gas emissions (CO_2, CH_4 and N_2O) related to biomass burning are not estimated because biomass burning has not been monitored since 1996. Wildfire statistics indicate that forest fires rarely occurred in the two decades before 1996.

2

Trends in greenhouse gas emissions

2.1 Emission trends for aggregated greenhouse gas emissions

Chapter 2 summarises the trends in greenhouse gas emissions during the period 1990–2010, by greenhouse gas and by sector. Detailed explanations of these trends are provided in chapters 3–8. In 2010, total direct greenhouse gas emissions (excluding emissions from Land Use, Land Use Change and Forestry, LULUCF) in the Netherlands are estimated at 210.1 Tg CO_2 eq. This is 1.5% lower than the 213.3 Tg CO_2 eq reported in the base year (1990; 1995 is the base year for fluorinated gases).

Figure 2.1 shows the trends and relative contributions of the different gases to the aggregated national greenhouse gas emissions. In the period 1990–2010, emissions of carbon dioxide (CO_2) increased by 14% (excluding LULUCF), while emissions of non-CO_2 greenhouse gases decreased by 47% compared with base year emissions. Of the non CO_2 greenhouse gases, methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (F-gases) decreased by 35%, 53% and 78%, respectively.

Emissions of LULUCF related sources increased by about 7% in 2010 compared to 2009. In 2010, total greenhouse gas emissions (including LULUCF) increased by 11.2 Tg CO_2 eq compared to 2009 (213.1 Tg CO_2 eq in 2010).

2.2 Emission trends by gas

2.2.1 Carbon dioxide

Figure 2.2 presents the contribution of the most important sectors, as defined by the Intergovernmental Panel on Climate Change (IPCC) to the trend in total national CO_2 emissions (excluding LULUCF). In the period 1990–2010, the national CO_2 emissions increased by 7% (from 159.2 to 181.2 Tg). The Energy sector is by far the largest contributor to CO_2 emissions in the Netherlands (96%), with the categories 1A1 'Energy industries' (37%), 1A4 'Other sectors' (24%) and 1A3 'Transport' (19%) as largest contributors in 2010.

The relatively high level of CO_2 emissions in 1996 is mainly explained by a very cold winter, which increased energy use for space heating in the residential sector. The resulting emissions are included in the category 1A4 'Other sectors'. The relatively low level of CO_2 emissions in the category 1A1 'Energy industries' in 1999 is explained by the marked increase in imported electricity and a shift from the use of coal to residual chemical gas and natural gas in 1999; the share of imported electricity almost doubled. However, this increased import of electricity led to only a temporary decrease in the CO_2 emissions. In the period 2000-2004, the pre-1999 annual increase in CO_2 emissions from this category – about 1–2% – was observed again. In 2008, import of electricity decreased.

Figure 2.1 Greenhouse gases: trend and emission levels (excl. LULUCF), 1990–2010.

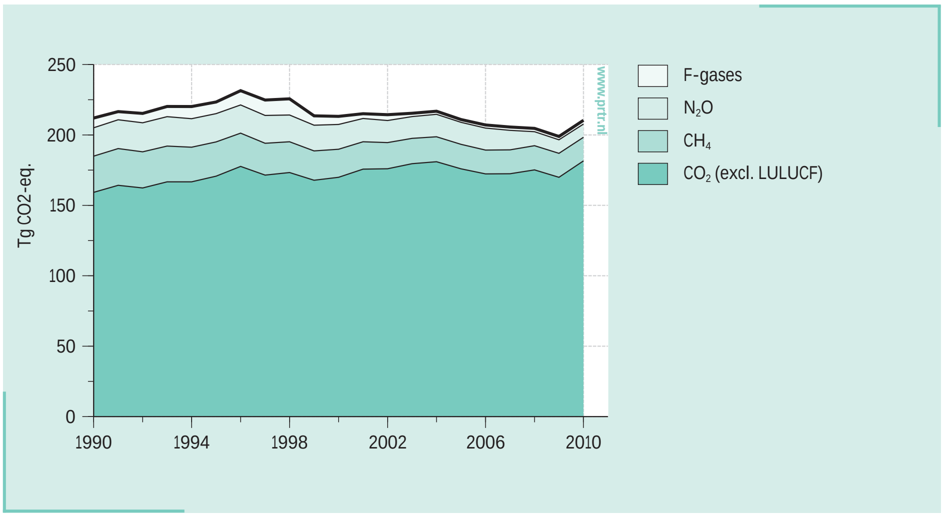
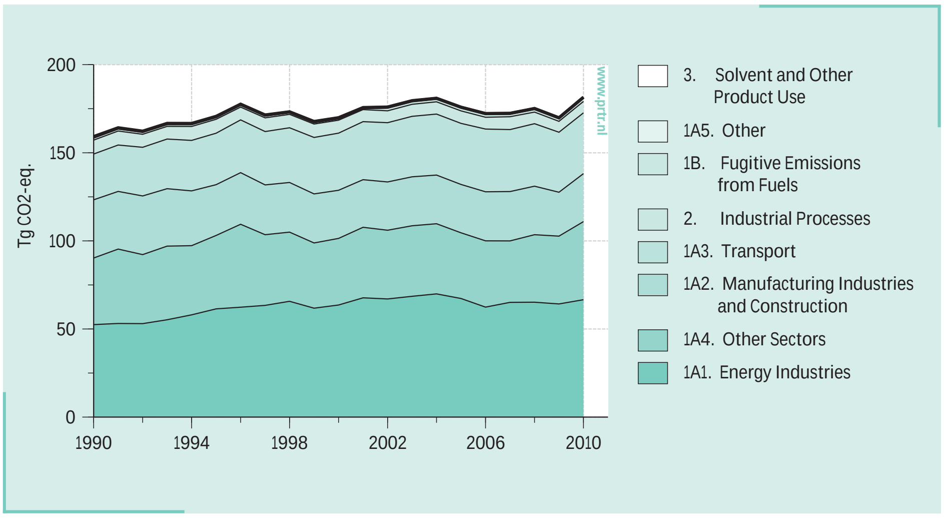


Figure 2.2 CO_2: trend and emission levels of sectors (excl. LULUCF), 1990–2010.



In 2010, CO_2 emissions increased by 7% compared to 2009 mainly due to increased fuel combustion in the sector energy.

2.2.2 Methane

Figure 2.3 presents the contribution of the most important IPCC sectors to the trend in total CH_4 emissions. The national CH_4 emissions decreased by 35%, from 1.22 Tg in 1990 to 0.80 Tg in 2010 (25.7 to 16.8 Tg CO_2 eq). The Agriculture and Waste sector (57% and 27%) were the largest contributors in 2010.
Compared to 2009, national CH_4 emissions decreased by about 2% in 2010 (0.3 Tg CO_2 eq), due to the decrease of CH_4 emissions mainly in the categories 6A Solid Waste Disposal on Land.

2.2.3 Nitrous oxide

Figure 2.4 presents the contribution of the most important IPCC sectors to the trend in national total N_2O emissions. The total national inventory of N_2O emissions decreased by about 53%, from 65.0 Gg in 1990 to 30.3 Gg in 2010 (20.2 to 9.4 Tg CO_2 eq). The sector contributing the most to this decrease in N_2O emissions is 'Industrial Processes' (for which the emissions decreased by more than 85% compared to the base year).

Compared to 2009, total N_2O emissions decreased by 2.1% in 2010 (–0.20 Tg CO_2 eq) mainly due to decreased emissions from agricultural soils.

Figure 2.3 CH_4: trend and emission levels of sectors, 1990-2010.

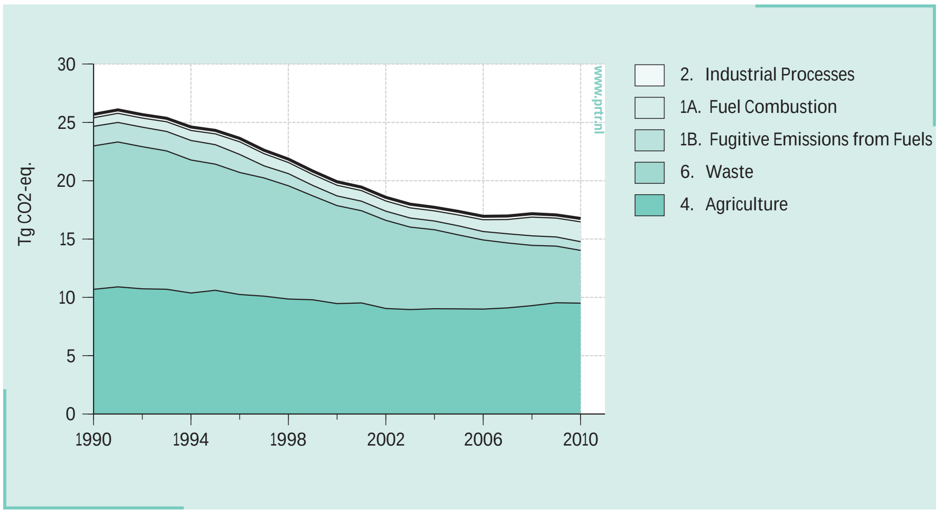
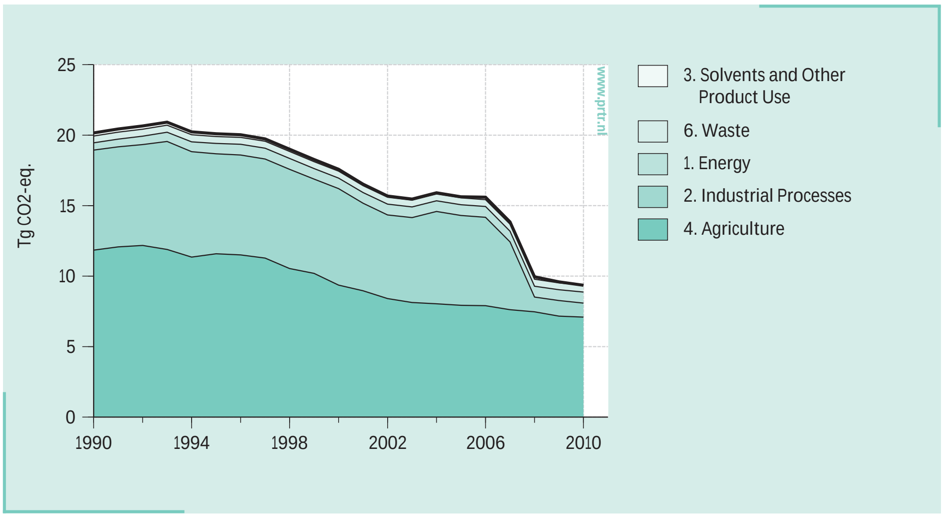


Figure 2.4 N_2O: trend and emission levels of sectors, 1990–2010.



2.2.4 Fluorinated gases

Figure 2.5 shows the trend in F-gas emissions included in the national greenhouse gas inventory. The emission level of the total F-gases decreased by 68% between 1995 and 2010, from 8.2 Tg CO_2 eq in 1995 (base year for F-gases) to 2.7 Tg CO_2 eq in 2010. Emissions of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) decreased by approximately 62% and 89% respectively during this same period, while sulphur hexafluoride (SF_6) emissions decreased by 36%.
Emissions between 2009 and 2010 increased by respectively 12%, 24% and 8% for HFCs, PFCs and SF_6. The aggregated emissions of F-gases increased by 12.5%.
Figure 2.5 Fluorinated gases: trend and emission levels of individual F-gases, 1990–2010.

2.2.5 Uncertainty in emissions specified by greenhouse gas

The uncertainty in the trend of CO_2 equivalent emissions of the six greenhouse gases together is estimated to be approximately 3%, based on the IPCC Tier 1 Trend Uncertainty Assessment; see section 1.7. Per individual gas, the trend uncertainty in total emissions of CO_2, CH_4, N_2O and the sum of the F-gases is estimated to be ±3%, ± 8%, ±8% and ±11%, respectively. For all greenhouse gases together, the uncertainty estimate in annual emissions is ±3% and for CO_2 ±3%. The uncertainty estimates in annual emissions of CH_4 and N_2O are ±25% and ±50% respectively, and for HFCs, PFCs and SF_6, ± 50% (see section 1.7).

Figure 2.5 Fluorinated gases: trend and emission levels of individual F-gases, 1990–2010.

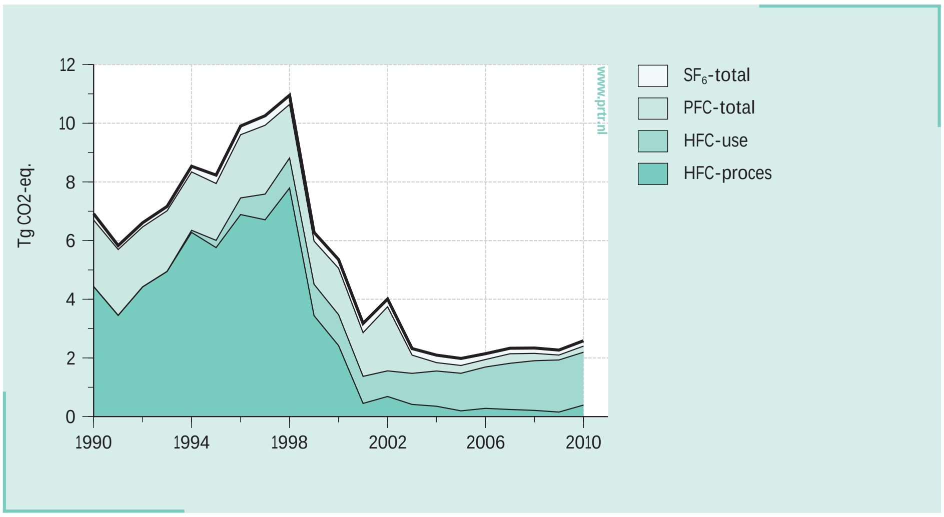
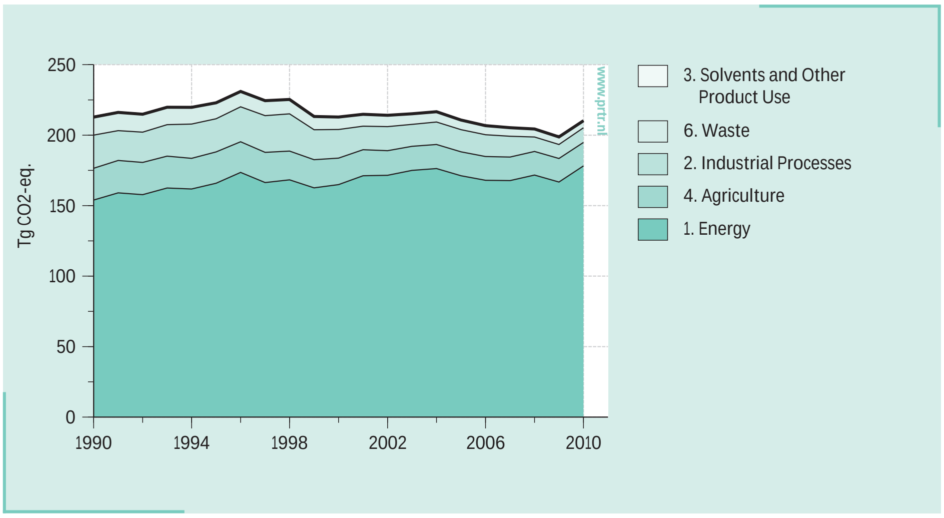


Figure 2.6 Aggregated greenhouse gases: trend and emission levels of sectors (excl. LULUCF), 1990-2010.



2.3 Emission trends specified by source category

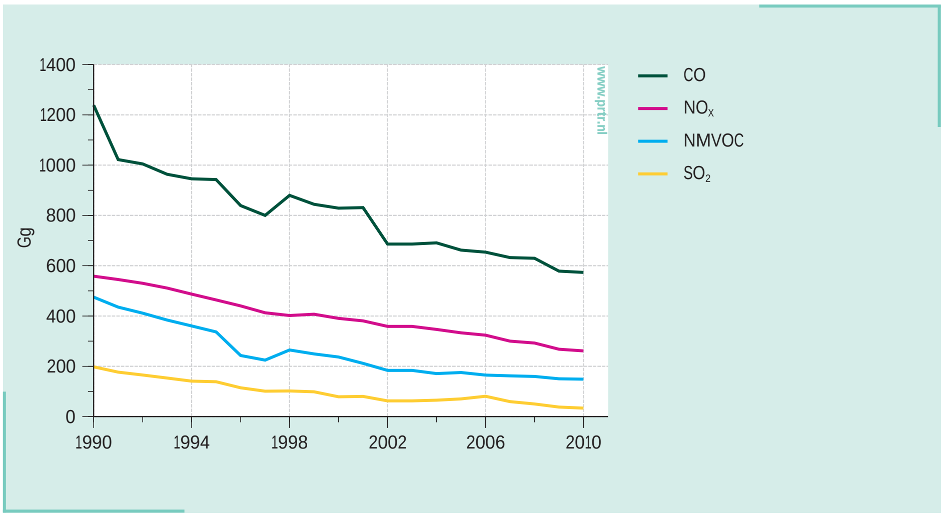
Figure 2.6 provides an overview of emission trends per IPCC sector in Tg CO_2 equivalents.
The IPCC Energy sector is by far the largest contributor to the total greenhouse gas emissions in the national inventory (contributing 72% in the base year and 85% in 2010). The relative share of the other sectors decreased correspondingly. The emission level of the Energy sector increased by approximately 16% in the period 1990–2010, and total greenhouse gas emissions from the Waste, Industrial Processes and Agriculture sectors decreased by 61%, 56%, and 26% respectively in 2010 compared to the base year.

Compared to 2009, greenhouse gas emissions in the Energy sector increased by about 11.5 Tg in 2010, this is mainly due to an increased use of natural gas in 1A4 Other sectors as a result of the cold winter. Trends in emissions by sub-category are described in more detail in chapters 3–8.

2.3.1 Uncertainty in emissions by sector

The uncertainty estimates in annual CO_2 equivalent emissions of IPCC sectors Energy [1], Industry [2], Solvents and product use [3], Agriculture [4], and Waste [6] are about ±2%, ±11%, ±27%, ±37% and ±29% respectively; for sector 5 LULUCF it is ±100%. The uncertainty in the trend of CO_2 equivalent emissions per sector is calculated for

Figure 2.7 Emission levels and trends of NO_2, CO, NMVOC and SO_2 (Units: Gg).



sector 1 Energy at ±3% in the 16% increase, for sector 2 Industry at ±5% in the 56% decrease, for sector 4 Agriculture at ±9% in the 31% decrease and for sector 6 Waste at ±7% in the 61% decrease.

2.4 Emission trends for indirect greenhouse gases and SO_2

Figure 2.7 shows the trends in total emissions of carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). Compared to 1990, CO and NMVOC emissions in 2010 were reduced by 54% and 69% respectively. For SO_2 this was as much as 83%, and for NO_x, 2010 emissions are 53% lower than the 1990 level. With the exception of NMVOC, most of the emissions stem from fuel combustion.

Because of the problems identified with annual environmental reporting (see section 1.3.2), emissions of CO from industrial sources are not verified. However, experts have suggested that possible errors will have a minor effect on total emission levels. Due to lack of data, the time-series for 1991–1994 and 1996–1999 was interpolated between 1990 and 1995.

In contrast to direct greenhouse gases, calculations of emissions of precursors from road transport are not based on fuel sales according to the national energy statistics but are directly related to transport statistics on a vehicle-kilometre basis. To some extent, this is different from the IPCC approach (see section 3.2.8.4).
Uncertainty in the emission factors for NO_x, CO and NMVOC from fuel combustion is estimated to be in the range of 10–50%. The uncertainty in the emission factors of SO_2 from fuel combustion (basically the sulphur content of the fuels) is estimated to be 5%. For most compounds, the uncertainty in the activity data is relatively small compared to the uncertainty in the emission factors. Therefore, the uncertainty in the overall total of sources included in the inventory is estimated to be in the order of 25% for CO, 15% for NO_x, 5% for SO_2 and approximately 25% for NMVOC (TNO, 2004).

3
Energy [CRF Sector 1]

Major changes in the Energy sector compared to the National Inventory Report 2011

Emissions:	Compared to 2009 the GHG emissions in the energy sector increased by 7%
Key sources:	Two sources are no longer a key source compared to the previous submission (NIR 2011): 1A3 Mobile combustion: water-borne navigation (CO_2) 1A5 Military use of fuels (1A5 Other) (CO_2)
Methodologies:	As a result of the in-country review of September 2011, the emissions of several small sources have been added to this year's submission. These sources are CH_4 and N_2O emissions from charcoal use (1A4b), CH_4 emissions from charcoal production (1B1b) and CO_2 emissions from gas transmission (1B2biii). These emissions have also been submitted within the resubmission of CRF2011 (as a result of the in-country review of September 2011).

3.1 Overview of sector

3.1.1 The Dutch Energy System

Energy Supply and Energy Demand
As for most developed countries, the energy system in the Netherlands is largely driven by the combustion of fossil fuels (Figure 3.1). In 2010, natural gas is supplying about 47.1% of the total primary fuels used in the Netherlands, followed by liquid fuels (37.4%) and solid fossil fuels (9.1%). The contribution of non-fossil fuels, including renewables and waste streams is rather limited.
Part of the supply of energy is not used for energy purposes. It is either used as feed stocks in the (petro-) chemical or fertiliser industry (20.5%) or lost as waste heat in cooling towers and cooling water in power plants (14.6%).
Emissions from fuel combustion are consistent with the national energy statistics. The time-series of the energy statistics is not fully consistent at the detailed sector and detailed fuel-type levels for the years 1991 to 1994. This inconsistency is caused by revisions in the economic classification scheme implemented in 1993, a change from the 'special trade' to 'general trade' system to define the domestic use of oil products, some error corrections and the elimination of statistical differences. These changes were incorporated into the data sets for 1990, 1995 and subsequent years, thus creating the existing inconsistency with the 1991–1994 dataset. For the base year 1990, CBS has re-assessed the original statistics and made them compatible with the 'new' 1993 classification system and ECN (Energy Research Centre of the Netherlands) was commissioned to re-allocate the statistics of 1991–1994 at a higher level of detail (for both fuels and sectors). This is also visible in Figure 3.1, where fuel use is only shown as a total value.

Trends in fossil fuel use and fuel mix
Natural gas represents a very large share of the national energy consumption in all non-transport sectors: power generation, industry and other sectors (mainly for space heating). Oil products are primarily used in the transport sector, refineries and in the petrochemical industry, while the use of coal is limited to power generation and steel production.
Although the combustion of fossil waste (reported under Other Fuels) has increased fourfold since 1990, its share in total fossil fuel use is still only 1% at the present time.
In the 1990–2010 period, total fossil fuel combustion increased by 25%, due to a 26% increase in gas consumption, while liquid fuel use increased by 38%. At the same time, the combustion of solid fuels decreased by 13%. Total fossil fuel consumption for combustion increased by about 8% between 2009 and 2010, mainly due to a 12% increase in gas consumption.

3.1.2 GHG Emissions from the energy sector

During combustion, carbon and hydrogen from fossil fuels are converted mainly into carbon dioxide (CO_2) and water (H2O), releasing the chemical energy in the fuel as heat. This heat is generally either used directly or used (with some conversion losses) to produce mechanical energy, often to generate electricity or for transportation.

The energy sector is the most important sector in the Dutch greenhouse gas emission inventory, and contributes approximately 96% of CO_2 emissions in the country. The contribution of the energy sector to total greenhouse gas emissions in the country increased from 72% in 1990 to 85% in 2010. The greenhouse gas emissions from this sector are for over 98% in the form of CO_2 (see the previous chapter, Figure 2.2).
The energy sector includes:
- exploration and exploitation of primary energy sources;
- conversion of primary energy sources into more useable energy forms in refineries and power plants;
- transmission and distribution of fuels;
- final use of fuels in stationary and mobile applications.

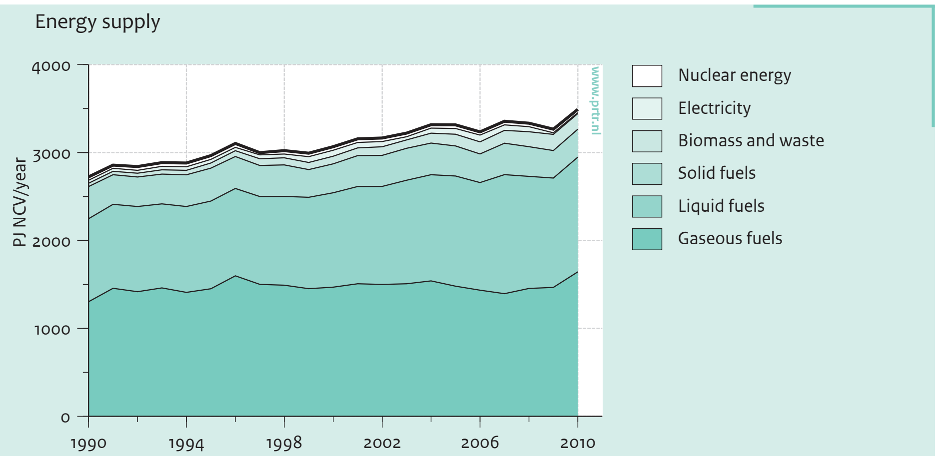
Emissions arise from these activities by combustion and as fugitive emissions or escape without combustion.
Emissions from the energy sector are to be reported in the source category split as shown in Figure 3.2.

Overview of shares and trends in emissions
Table 3.1 and Figure 3.2 show the contribution of the source categories in the Energy sector to the total national greenhouse gas inventory. About 51% of CO_2 emissions from fuel combustion stems from the combustion of natural gas, 16% from solid fuels (coal) and 31% from liquid fuels. CH_4 and N_2O emissions from fuel combustion contribute 1.8% to the total emissions from this sector.

Key sources
Table 3.1 presents the key categories in the Energy sector specified by both level and trend (see also Annex 1). The key categories in 1A1, 1A2, 1A3 and 1A4 are based on aggregated emissions by fuel type and category, which is in line with the IPCC Good Practice Guidance (see Table 7.1 in IPCC 2001). Since CO_2 emissions have the largest share in the total of national greenhouse gas emissions, it is not surprising that a large number of CO_2 sources are identified as key categories. The total CH_4 emissions from stationary combustion sources together are also identified as a key category. Compared to the previous submission, two sources are no longer a key source:

1A3 Mobile combustion: water-borne navigation CO_2
1A5 Military use of fuels (1A5 Other) CO_2

Figure 3.1 Overview of energy supply and energy demand in the Netherlands. (For the years 1990 – 1994, only the total fuel use is shown. See section 3.1.1 for more details).



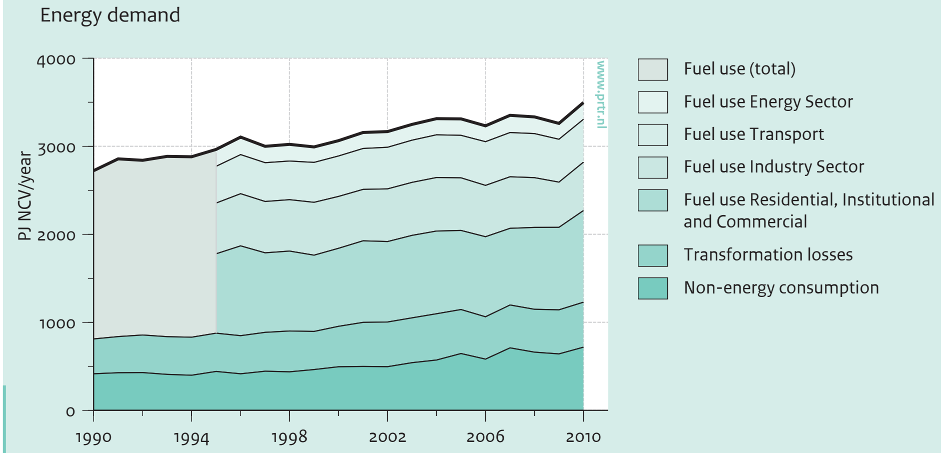


Figure 3.2 Sector 1 'Energy': trend and emission levels of source categories, 1990-2010.

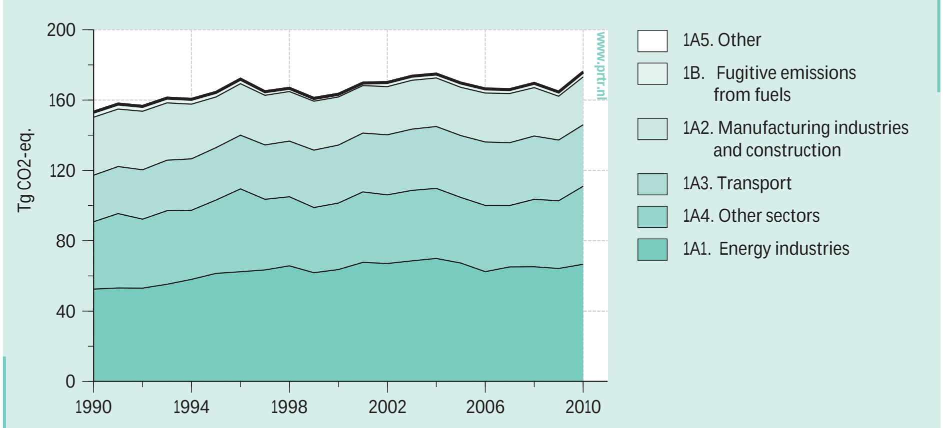


Table 3.1 Contribution of main categories and key sources in CRF sector 1 Energy.

Sector/category	Gas	Key	Emissions in Tg CO_2 eq: Base year	2009	2010	Change 2010 - 2009	Contribution to total in 2010 (%): by sector	of total gas	of total CO_2 eq
1 Energy	CO_2		151.1	163.6	174.6	11.0	98.2%	96.4%	83.1%
	CH_4		2.4	2.4	2.4	0.0	1.4%	14.6%	1.2%
	N_2O		0.5	0.8	0.8	0.0	0.4%	8.3%	0.4%
	All		154.0	166.8	177.8	11.1	100.0%		84.7%
1A Fuel combustion	CO_2		149.9	162.0	172.6	10.6	97.1%	95.3%	82.2%
	CH_4		0.7	1.6	1.7	0.1	1.0%	10.2%	0.8%
	N_2O		0.5	0.1	0.8	0.0	0.4%	8.3%	0.4%
	All		151.1	164.4	175.1	10.7	98.5%		83.4%
1A Emissions from stationary combustion	CH_4	L,T	0.6	1.6	1.7	0.1	0.9%	9.9%	0.8%
1A1 Energy Industries	CO_2		52.5	64.2	66.2	2.0	37.2%	36.6%	31.5%
1A1a Public Electricity and Heat Production	CO_2		39.9	52.6	54.6	2.0	30.7%	30.1%	26.0%
1A1a liquids	CO_2	L1	0.2	0.7	0.7	0.0	0.4%	0.4%	0.3%
1A1a solids	CO_2	L,T1	25.8	23.6	24.1	0.5	13.6%	13.3%	11.5%
1A1a gas	CO_2	L1,T1	13.3	25.7	27.3	1.6	15.3%	15.1%	13.0%
1A1a other fuels: waste incineration	CO_2	L,T	0.6	2.5	2.5	-0.1	1.4%	1.4%	1.2%
1A1b Petroleum refining	CO_2		11.0	9.7	9.6	-0.1	5.4%	5.3%	4.6%
1A1b liquids	CO_2	L,T	10.0	7.2	6.6	-0.6	3.7%	3.6%	3.1%
1A1b gases	CO_2	L1,T1	1.0	2.6	3.1	0.5	1.7%	1.7%	1.5%
1A1c Manufacture of Solid Fuels and Other Energy Industries	CO_2		1.5	1.9	2.0	0.1	1.1%	1.1%	1.0%
1A1c gases	CO_2	L,T	1.5	1.9	2.0	0.1	1.1%	1.1%	1.0%
1A2 Manufacturing industries and construction	CO_2		33.0	24.9	27.2	2.3	15.3%	15.0%	13.0%
1A2 liquids	CO_2	L,T1	9.0	8.4	9.3	0.8	5.2%	5.1%	4.4%
1A2 solids	CO_2	L,T1	5.0	3.9	4.1	0.2	2.3%	2.3%	2.0%
1A2 gases	CO_2	L,T1	19.0	12.6	13.8	1.2	7.8%	7.6%	6.6%
1A2a. Iron and steel	CO_2		4.0	4.1	4.4	0.3	2.5%	2.4%	2.1%
1A2b Non-Ferrous Metals	CO_2		0.2	0.2	0.2	0.0	0.1%	0.1%	0.1%
1A2c Chemicals	CO_2		17.1	11.6	13.2	1.6	7.4%	7.3%	6.3%
1A2d Pulp, Paper and Print	CO_2		1.7	1.1	1.2	0.1	0.7%	0.7%	0.6%
1A2e Food Processing, Beverages and Tobacco	CO_2		4.1	3.3	3.4	0.2	1.9%	1.9%	1.6%
1A2f Other	CO_2		5.8	4.7	4.8	0.1	2.7%	2.6%	2.3%

Sector/category	Gas	Key	Emissions in Tg CO_2 eq Base year	2009	2010	Change 2010 - 2009	Contribution to total in 2010 (%) by sector	of total gas	of total CO_2 eq
1A3 Transport	CO_2		26.0	34.0	34.5	0.5	19.4%	19.0%	16.4%
	N2O		0.3	0.4	0.4	0.0	0.2%	4.7%	0.2%
	All		26.5	34.5	35.0	0.5	19.7%		16.7%
1A3a Civil aviation	CO_2		0.04	0.04	0.04	0.0	0.0%	0.0%	0.0%
1A3b Road	CO_2		25.5	33.3	33.8	0.4	19.0%	18.6%	16.1%
1A3b gasoline	CO_2	L,T1	10.9	12.8	12.8	0.0	7.2%	7.1%	6.1%
1A3b diesel oil	CO_2	L,T	11.8	19.5	20.0	0.5	11.2%	11.0%	9.5%
1A3b LPG	CO_2	L1,T	2.7	1.0	0.9	-0.1	0.5%	0.5%	0.4%
1A3b Road	N_2O	L2	0.3	0.4	0.4	0.0	0.2%	4.6%	0.2%
1A3c Railways	CO_2		0.1	0.1	0.1	0.0	0.1%	0.1%	0.1%
1A3d Navigation	CO_2		0.4	0.6	0.6	0.0	0.3%	0.3%	0.3%
1A4 Other sectors	CO_2		37.8	38.5	44.3	5.8	24.9%	24.4%	21.1%
	CH_4		0.5	1.4	1.5	0.1	0.8%	8.8%	0.7%
	All		38.3	39.9	45.8	5.8	25.7%		21.8%
1A4 liquids (excl. from 1A4c)	CO_2	T	1.4	0.5	0.6	0.0	0.3%	0.3%	0.3%
1A4a Commercial/ Institutional	CO_2		8.4	11.2	13.2	2.0	7.4%	7.3%	6.3%
1A4a Gas	CO_2	L,T	7.6	10.9	12.9	2.0	7.3%	7.1%	6.2%
1A4b Residential gas	CO_2	L,T1	19.5	18	21	2.8	11.7%	11.5%	9.9%
	CH_4		0.4	0.3	0.4	0.0	0.2%	2.3%	0.2%
1A4b gases	CO_2		18.7	17.7	20.5	2.8	11.5%	11.3%	9.7%
1A4c Agriculture/ Forestry/Fisheries	CO_2		9.9	9.3	10.3	1.0	5.8%	5.7%	4.9%
1A4c liquids	CO_2	L,T	2.6	1.8	1.8	0.0	1.0%	1.0%	0.8%
1A4c gases	CO_2	L,T	7.3	7.5	8.5	1.0	4.8%	4.7%	4.1%
1A5 Other	CO_2		0.6	0.3	0.3	0.0	0.2%	0.2%	0.2%
1B Fugitive emissions from fuels	CO_2		1.2	1.6	2.0	0.4	1.1%	1.1%	0.9%
	CH_4		1.7	0.8	0.7	0.0	0.4%	4.4%	0.4%
	All		2.9	2.4	2.7	0.3	1.5%		1.3%
1B1b Coke production	CO_2	L,T	0.4	0.5	1.0	0.4	0.5%	53.7%	0.5%
1B2 venting/flaring	CO_2	T	0.3	0.0	0.0	0.0	0.0%	0.8%	0.0%
1B2 venting/flaring	CH_4	T	1.2	0.3	0.2	-0.1	0.1%	1.5%	0.1%
Total national emissions	CO_2		159.3	169.9	181.2	11.7		100%	86.3%
	CH_4		25.7	17.1	16.8	-0.3		100%	8.0%
	N_2O		20.2	9.6	9.4	-0.2		100%	4.5%
National Total GHG emissions (excl. CO_2 LULUCF)	All		213.3	198.9	210.1	11.5			100.0%

Note: Key sources in the 1A1, 1A2, and 1A4 categories are based on aggregated emissions of CO_2 by fuel type.

Table 3.2 Energy Supply Balance for the Netherlands (PJ NCV/year).

Year	Role	Indicator Name	Solid fuels	Crude oil and petroleum	Gas
1990	Supply	Primary production	0	171	2,301
		Total imports	491	5,367	85
		Stock change	-22	2	0
		Total exports	-101	-4,076	-1,081
		Bunkers	0	-500	0
	Gross inland consumption	Gross inland consumption	-368	-1,274	-1,305
	Demand	Final non-energy consumption	-11	-328	-101
2010	Supply	Primary production	0	61	2,657
		Total imports	543	8,214	773
		Stock change	-67	61	-1
		Total exports	-158	-6,310	-1,786
		Bunkers	0	-729	0
	Gross inland consumption	Gross inland consumption	-318	-1,274	-1,643
	Demand	Final non-energy consumption	-9	-647	-94

3.2 Fuel Combustion [1A]

3.2.1 Comparison of the sectoral approach with the reference approach

Emissions from fuel combustion are generally estimated by multiplying fuel quantities combusted at specific energy processes with fuel and, in case of non-CO_2 greenhouse gases, source category dependent emission factors. This Sectoral Approach (SA) is based on fuel demand statistics. The IPCC guidance requires – as a quality control activity – also estimating CO_2 emissions from fuel combustion on the basis of a national carbon balance, derived from the fuel supply statistics. This is the Reference Approach (RA). In Annex 4, a detailed comparison of the sectoral approach with the reference approach is shown.

Energy Supply balance

The energy supply balance for the Netherlands in 1990 and 2010 is shown in Table 3.2 at a relatively high aggregation level. The Netherlands produces large amounts of natural gas, both onshore (Groningen gas) and offshore; 67% of the gas produced is exported. Natural gas represents a very large share of the national energy supply.
With carbon contents of each specific fuel, a national carbon balance can be derived from the energy supply balance and from this the national CO_2 emissions can be estimated by determining how much of this carbon is oxidised in any process within the country. To allow this, international bunkers are to be considered as 'exports' and subtracted from the gross national consumption.

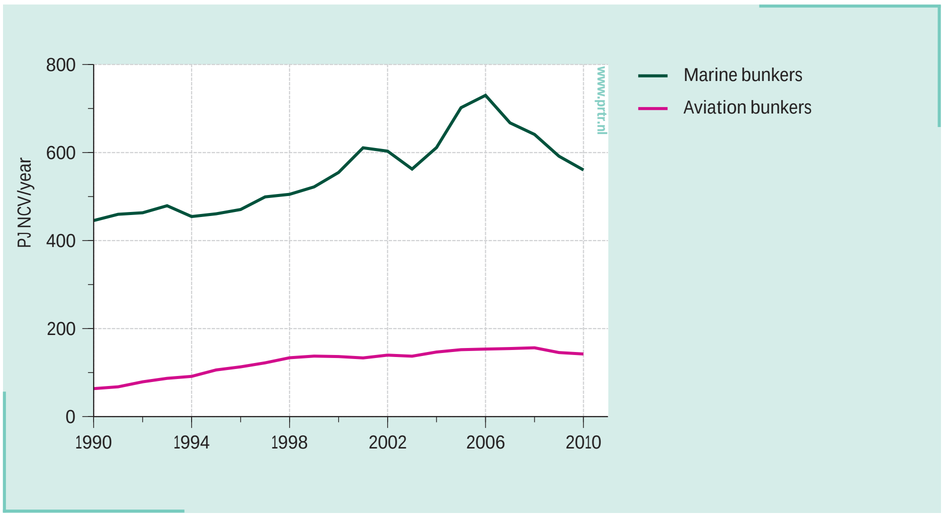
3.2.2 International bunker fuels

The Rotterdam area has four large refineries, producing relatively large quantities of heavy fuel oils. An important fraction of these heavy fuel oils is sold as international bunkers. In addition, most marine fuel oil produced in Russia is transported to Rotterdam, where it is sold on the market. Combined, this makes Rotterdam the world's largest supplier of marine bunker oils. The quantities of this bunker fuel are presented in Figure 3.3.
The Dutch refineries also produce considerable amounts of aviation fuels delivered to air carriers at the airports. In addition, Schiphol Airport is Western Europe's largest supplier of aviation bunker fuels (jet fuel). Given the small size of the country, almost all of the aviation fuel is used in international aviation. Figure 3.3 presents the time-series of the fuel quantities exported to marine and aviation bunkers.

3.2.3 Feed stocks and non-energy use of fuels

Table 3.2 shows that in 2010, 51% of the gross national consumption of petroleum products is used in non-energy applications. These fuels are mainly used as feedstock (naphta) in the petrochemical industry and in products in many applications (bitumen, lubricants, etc.). Also a fraction of the gross national consumption of natural gas (6%, mainly in ammonia production) and coal (3%, mainly in iron and steel production) is used for non-energy applications and hence not directly oxidised. In many cases, these products will finally be oxidised in waste incinerators or during use (e.g., lubricants in two-stroke engines). In the Reference Approach these product flows are excluded from the calculation of CO_2 emissions.

Figure 3.3 International navigation and aviation bunkers (PJ NCV/year).



3.2.4 CO_2 capture from flue gases and subsequent CO_2 storage, if applicable

Not yet applicable.

3.2.5 Country-specific issues

See above.

3.2.6 Energy Industries [1A1]

Source category description

'Energy Industries' are the main source category contributing to the Energy sector, accounting for 37.6% of the greenhouse gas emissions from this sector in 2010. In this sector, three source categories are included: Public Electricity and Heat Production [1A1a], Petroleum Refining [1A1b] and Manufacture of Solid Fuels and Other Energy Industries [1A1c]. Within these categories, natural gas and coal combustion by public electricity and heat production and oil combustion by petroleum refining are the dominating key sources. However, other key sources are liquid fuels and other fuels (waste) in public electricity and heat production, and natural gas combustion in petroleum refining and in manufacturing of solid fuels and other energy industries. CH_4 and N_2O emissions from 1A1 'Energy Industries' contribute relatively little to the total national inventory of greenhouse gas emissions. CH_4 from stationary combustion is a key source, due to an increase of the CH_4 emission factor from small CHP plants. N_2O emissions from 'Energy Industries' are not identified as a key source (see Table 3.1).
In 2010, CO_2 emissions from category 1A1 'Energy Industries' contributed 82% to the total national greenhouse gas emission inventory (excluding LULUCF), while CH_4 and N_2O emissions from this same category contributed relatively little to the total national greenhouse gas emissions. The share contributed by 1A1 'Energy Industries' to the total greenhouse gas emissions from the Energy sector increased from 34% in 1990 to 37% in 2010 (see Figure 3.2), partly due to a change in ownership of CHP plants (joint ventures, which are allocated to this source category).
Between 1990 and 2010, total CO_2 emissions from 1A1 'Energy Industries' increased by 26% (see Figure 3.4). In 2010, CO_2 emissions from 1A1 'Energy Industries' increased 3.1% compared to the emission in 2009.

Public Electricity and Heat Production [1A1a]

The Dutch electricity sector has a few notable features: it has a large share of coal-fired power stations and a large fraction of gas-fired cogeneration plants, with many of the latter being operated as joint ventures with industries. Compared to other countries in the EU, nuclear energy and renewable energy provide very little of the total primary energy supply in the Netherlands. The two main renewable energy sources are biomass and wind. This source category also includes all emissions from large-scale waste incineration, since all incineration facilities also produce heat and/or electricity and hence, the waste incinerated in these installations is regarded as a fuel. In addition, a large fraction of the blast furnace gas and a significant part of coke oven gas produced by the one iron and steel plant in the Netherlands is combusted in the public electricity sector, see Figure 3.5.

In 2010, 1A1a 'Public Electricity and Heat Production' was the largest source category within the 1A1 Energy industries, accounting for 82% of the total greenhouse gas emissions from this category (see Figure 3.4 and Table 3.1).

Figure 3.4 1A1 ‘Energy industries’: trend and emission levels of source categories, 1990-2010.

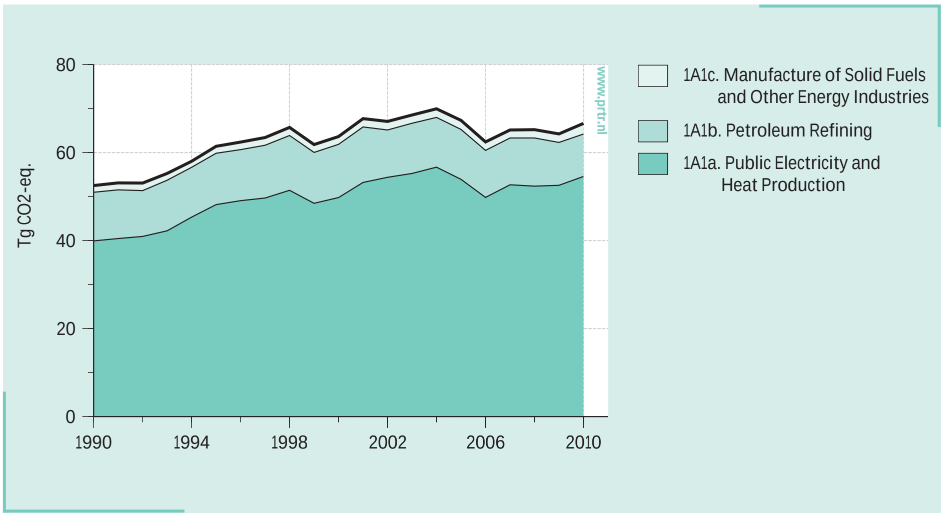
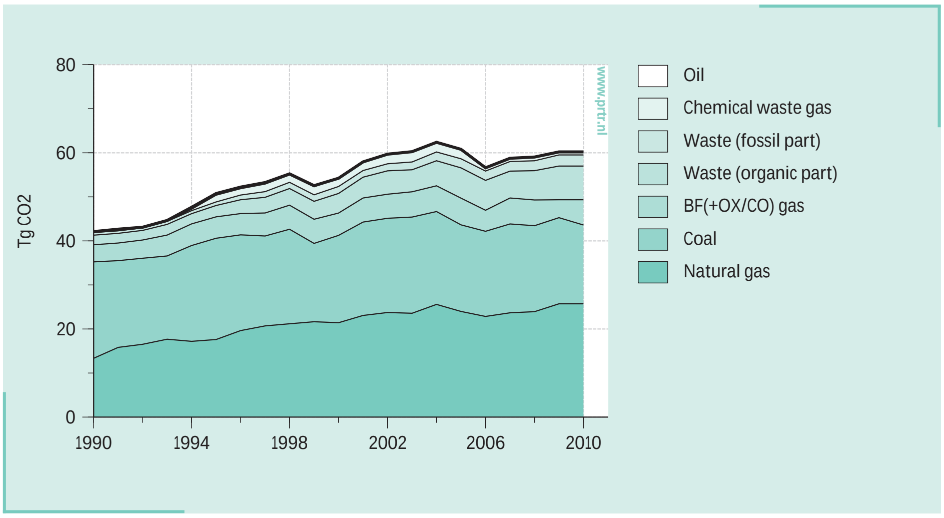


Figure 3.5 Trend in sources of CO2 from fuel use in power plants.



CO_2 emissions from waste incineration of fossil carbon represent 5% of the total greenhouse gas emissions in 1A1a Public electricity and heat production. In 2010, the emissions of CO_2 from the combustion of fossil fuels in this source category increased by 3.8%.
Between 1990 and 2010, total CO_2 emissions from ‘Public Electricity and Heat Production’ increased by 37%. The increasing trend in electric power production corresponds to considerably increased CO_2 emissions from fossil fuel combustion by power plants, which are partly compensated for by a shift from coal to natural gas and the increased efficiency of power plants.
The CO_2 emission level from waste incineration of fossil carbon increased from 0.6 Tg CO_2 in 1990 to 2.5 Tg CO_2 in 2010 due to the increasing amounts of municipal waste that are combusted instead of being deposited in landfills, which is the result of environmental policy to reduce waste disposal in landfills (see chapter 8). The increase in the CO_2 emission factor for ‘other fuels’ since 2004 is due to the increase in the share of plastics (which have a high carbon fraction) in the combustible waste (see Table 8.6 on the composition of incinerated waste). The decrease in 2006 and 2008 in the implied emission factor for CO_2 from biomass is due to the increase of the share of pure biomass (co-combusted with coal-firing), as opposed to the organic carbon in waste combustion with energy recovery. For the former type a lower emission factor is applied than for the latter.
Between 1990 and 1998, changed ownership relations of plants (joint ventures) caused a shift of cogeneration plants

from category 1A2 'Manufacturing Industries' to 1A1a 'Public Electricity and Heat Production'. Half of the almost 30% increase in natural gas combustion that occurred between 1990 and 1998 is largely explained by cogeneration plants and a few large chemical waste gas-fired steam boilers being shifted from 'Manufacturing Industries' to the 'Public Electricity and Heat Production' due to changed ownership (joint ventures). The corresponding CO_2 emissions allocated to the Energy sector increased from virtually zero in 1990 to 8.5 Tg in 1998 and 9.1 Tg in 2005. The same criterion applies for emissions from waste incineration, which are included in this category since they all are subject to heat or electricity recovery, albeit this is not their main activity. Most of the combustion of biogas recovered at landfill sites is in CHP operated by utilities; therefore, it is allocated in this category.
A remarkable drop is shown in the emissions from 1A1a 'Electricity and heat production' in 1999 (–6% compared to 1998), which is, however, associated with the increasing emission trend in the 1990–1998 period and 2000 and thereafter. In fact, electricity consumption in the Netherlands was 2% higher in 1999 than in 1998. The relatively low emissions for 1999 are explained by the higher share of imported electricity in domestic electricity consumption in that year, which was almost double that in 1998 (10% in 1998 versus 20% in 1999), and to a relatively large shift from coal to chemical waste gas and natural gas in 1999. The high import of electricity corresponds to approximately 4 Tg CO_2, while the shift from coal to natural gas and oil corresponds to approximately 1 Tg CO_2 in 1999. The net import of electricity decreased again in 2001, and this was compensated for by an increased production of electricity from gas and coal combustion in the public electricity sector. In 2004, CO_2 emissions increased by 3% as a direct result of the start-up in 2004 of a large new gas-fired 790 MWe cogeneration plant and a 2% decrease in coal combustion.
The strong increase in liquid fuel use in 1994 and 1995, with a sharp increase in 1995, is due to chemical waste gas being used in joint venture electricity and heat production facilities. This also explains the somewhat lower IEF for CO_2 from liquids since 1995.

Petroleum Refining [1A1b]

The Rotterdam harbour area houses four major refineries (a fifth one is located at Vlissingen) which export about 50% of their products to the European market. Consequently, the Dutch petrochemical industry is relatively large.
The share of 1A1b 'Petroleum Refining' in total greenhouse gas emissions from the category 1A1 'Energy Industries' was 21% in 1990 and 14% in 2010. However, the combustion emissions from this category should be viewed in relation to the fugitive emissions reported under category 1B2. Between 1990 and 2010 total CO_2 emissions from the refineries (including fugitive CO_2 emissions from hydrogen production reported in 1B2a-iv Refining) fluctuated between 10 and 12 Tg.
For 1A1b 'Petroleum Refining' the calculation of emissions from fuel combustion is based on the sectoral energy statistics, using the fuel consumption for energetic purposes as activity data (including the consumption of residual refinery gases). From 2002 onwards, the quality of the data is improved by incorporating the CO_2 emissions reported by the individual refineries.
Since 1998, one refinery has operated the SGHP unit, supplying all the hydrogen for a large-scale hydrocracker. When producing hydrogen, CO_2 is also produced as a co-product from the chemical processes (CO_2 removal and a two stage CO shift reaction). Refinery data specifying these fugitive CO_2 emissions are available and used for 2002 onwards and are reported in the category 1B2. The fuel used to provide the carbon for this non-combustion process is subtracted from the fuel consumption used to calculate the combustion emissions reported in this category.
The use of plant-specific emission factors for refinery gas for 2002 onwards – arithmetically resulting from the reported CO_2 emissions and combustion emissions as calculated using the default data – also causes changes in the implied emission factor for CO_2 for total liquid fuel compared to the years prior to 2002 (emission factor for refinery gas is adjusted to obtain exact correspondence between the total calculated CO_2 emissions and the total CO_2 emissions officially reported by the refineries). Besides this non-energy/feedstock use of fuel for hydrogen production, for years prior to 2002 the energy and carbon balance between the oil products produced does not match the total crude oil input and of fuel used for combustion. The conclusion drawn, therefore, is that not all residual refinery gases and other residual fuels are accounted for in the national energy statistics. The carbon difference is always a positive figure. As such, it is assumed for the years up to 2002 that part of the residual refinery gases and other residual fuels are all combusted (or incinerated by flaring) but not monitored/reported by the industry are thus unaccounted for. The CO_2 emissions from this varying fuel consumption are included in the fuel type 'liquids'. This represents approximately 10% (5–20%) of the total fuel consumption accounted for in the statistics. For 1998-2001, the unspecified CO_2 process emissions from the hydrogen plant are also included.
The interannual variation in the IEFs for CO_2, CH_4 and N_2O from liquid fuels is explained both by the high and variable shares (between 40% and 55%) of refinery gas in total liquid fuel, which has a relatively low default emission factor compared to most other oil products and has variable emission factors for the years 2002 onward, and by the variable addition of 'unaccounted for' liquids that is only used for estimating otherwise missing CO_2 emissions

(but not for CH_4 and N_2O). However for 2002 onwards, the 'unaccounted for' amount has been reduced substantially due to the subtraction of fuel used for the non-combustion process of producing hydrogen (with CO_2 as by-product), of which the emissions are now reported under 1B2.
All remaining differences between the CO_2 calculation using plant specific data and the CO_2 calculation based on the national energy statistics and default emission factors are, therefore, effect the calculated carbon content of the combusted refinery gas and thus in the implied emission factor of CO_2 for liquid fuel. CO_2 emissions from both calculation methods are the same.

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

In accordance with IPCC classification guidelines, emissions from fuel combustion for on-site coke production by the iron and steel company (Tata steel, formerly known as Corus) are included in 1A2 'Manufacturing Industries and Construction' since this is an integrated coke, iron and steel plant (see section 3.2.7). The emissions from the combustion of solid fuels of one independent coke production facility (Sluiskil), the operation of which discontinued in 1999, are also included in category 1A2. Source category 1A1c comprises:

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

The share of 1A1c 'Manufacture of solid fuels (coke) and other energy industries' (fuel production) in the total greenhouse gas emissions from the category 1A1 'Energy Industries' is approximately 3% in 1990 and 4% in 2010. This category comprises mostly CO_2 emissions from the combustion of natural gas. The dominating source is the use for energy purposes in oil and gas production and in the transmission industry. The combustion emissions from oil and gas production refer to 'own use' of the gas and oil production industry, which is the difference between the amounts of fuel produced and sold, after subtraction of the amounts of associated gas which is either flared or vented or otherwise lost by leakage. Production and sales data are based on the national energy statistics; amounts flared and vented are based on reports from the sector. CO_2 emissions from this source category increased from 1.5 Tg in 1990 to 2.4 Tg CO_2 in 2010 mainly due to the exploitation of less favourable production sites for oil and gas production compared with those exploited in the past. This fact explains the steady increase in time shown by this category with respect to gas consumption. The interannual variability in the emission factors for CO_2 and CH_4 from gas combustion is mainly due to differences in gas composition and the variable losses in the compressor stations of the gas transmission network, which are reported in the Annual Environmental Reports (AER) of the gas transport company and are included here.

Methodological issues

The emissions from this source category are essentially estimated by multiplying fuel use statistics with country specific emission factors (Tier 2 method for CO_2 and CH_4, Tier 1 for N_2O). Activity data are derived from the aggregated statistical data from the national energy statistics, which are published annually by CBS (see www.cbs.nl). The aggregated statistical data from the national energy statistics is based on confidential data from individual companies. When necessary, emission data from individual companies are also used; for example, when companies report a different emission factor for derived gases (see the following section).
For CO_2 and N_2O, IPCC default emission factors are used (see Annex 2, Table A2.1), with the exception of CO_2 for natural gas, chemical waste gas and coal, for which country-specific emission factors are used. When available, company-specific or sector-specific emission factors have been used, in particular for derived gases such as refinery gas, chemical waste gas and blast furnace gas. If companies report different emission factors for derived gases, it is possible to deviate from the standard emission factor for estimating the emissions for these companies. The CH_4 emission factors are taken from Scheffer and Jonker, 1997. An overview of the emission factors used for the most important fuels (up to 95% of the fuel use) in the sector Energy Industries [1A1] is provided in Table 3.3. Since some emission data in this sector originate from individual companies, the values (in Table 3.3) represent partly implied emission factors.

Notes to the source specific emission factors:

- The standard CH_4 emission factor for natural gas is 5.6 g/GJ. Only in category 1A1c other energy industries natural gas directly extracted from the wells is used for combustion. For this unprocessed gas a higher emission factor is used, which explains the higher emission factor for this sector.
- The CO_2 and N_2O emission factors for natural gas deviate from the standard emission factors (56.6 kg CO_2/GJ and 0.1 g N_2O/GJ), because this sector includes the emissions from the combustion of crude gas ('own' fuel use by the oil and gas production industry for heating purposes), which has a different emission factor.
- The CO_2 emissions from waste gas are CO_2 emissions occurring in the chemical industry and in refineries. The

Table 3.3 Overview of emission factors used in 2010 in the sector Energy Industries [1A1].

Fuel	Amount of fuel used in 2010 (TJ NCV)	Implied Emission factors (g/GJ) CO_2 (x 1000)	N_2O	CH_4
Natural gas	569,872	57.5	0.14	6.69
Coal	195,481	93.9	1.40	0.44
Waste Gas	86,495	74.7	0.10	3.59
Waste, biomass	33,864	126.9	5.90	0.00
Solid biomass	33,801	109.6	4.00	30.00
Waste, fossil	29,953	82.6	4.47	0.00
Other	35,501	NA	NA	NA

emissions are partly based on emission data from the NEa.

- The CO_2 emissions from coal are CO_2 emissions occurring in the public electricity sector. The emissions are based on emission data from NEa.
- The N_2O emission factor from waste combustion (fossil and biomass) is depending on the amount of waste incinerated in incinerators with or without a SNCR, which have emission factors of 9.43 g/GJ and 1.89 g/GJ respectively. The emission factor for CH_4 from waste incineration has been changed to 0 g/GJ as a result of a recent study on emissions from waste incineration (DHV, 2010, and Agentschap NL 2011b). The emissions are reported in the CRF with the notation key NO (as the CRF holds problems with handling 0 (zero) values). The emission factor of CO_2 is depending on the carbon content of the waste, which is determined annually.

More details on emission factors, methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie, Protocol 12-002: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels' and Protocol 12-038: Emissions from biomass combustion). According to the IPCC Guidelines, only fossil-fuel related CO_2 emissions are included in the total national inventory, thus excluding CO_2 from organic carbon sources from the combustion of biomass. The CO_2 from biomass from waste incineration is reported as a memo item.

Uncertainties and time-series consistency

The uncertainty in CO_2 emissions of this category is estimated to be 2% (see section 1.7 for more details). The accuracy of fuel consumption data in power generation and oil refineries is generally considered to be very accurate, with an estimated uncertainty of approximately 0.5%. The high accuracy in most of these activity data is due to the limited number of utilities and refineries that report their large fuel consumption as part of the national energy statistics and which are verified as part of the European Emission Trading Scheme. The two exceptions are solids in power generation and liquids in refineries, which have a larger estimated uncertainty of 1% and 10%, respectively, based on the share of blast furnace gas in total solid consumption, the 'unaccounted for' liquids calculated for refineries and the recalculations made for 2002-2004 as presented in this report (Olivier et al., 2009). The high uncertainty in the liquids in refineries apply mainly to the years prior to 2002, for which accurate reported CO_2 emissions are not available at the required aggregation level. The consumption of gas and liquid fuels in the 1A1c category is mainly from the oil and gas production industry, where the split into own use and venting/flaring has proven to be quite difficult, and thus a high uncertainty of 20% is assigned. For other fuels a 10% uncertainty is used, which refers to the amount of fossil waste being incinerated and thus to the uncertainties in the total amount of waste and the fossil and biomass fractions.

For natural gas, the uncertainty in the CO_2 emission factor is estimated to be 0.25% based on the fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier et al. (2009). This value is used in the uncertainty assessment in section 1.7 and key source assessment in Annex 1. For hard coal (bituminous coal), an analysis was made of coal used in power generation (Van Harmelen and Koch, 2002). For the default coal emission factor in power plants, 94.7 CO_2/GJ is the mean value of 1,270 samples taken in 2000, which is accurate within about 0.5%. However, in 1990 and 1998 the emission factor varies ±0.9 CO_2/GJ (see Table 4.1 in Van Harmelen and Koch, 2002); consequently, when the default emission factor is applied to other years, the uncertainty is apparently larger, about 1%. Analysis of the default CO_2 emission factors for coke oven gas and blast furnace gas reveals uncertainties of about 10% and 15%, respectively (data reported by the steel plant). Since the share of BF/OX gas in total solid fuel emissions from power generation is about 15-20%, the overall uncertainty in the CO_2 emission factor of solids in power generation is estimated to be about 3%. The CO_2 emission factors of chemical waste gas and – to a lesser extent – of BF/OX gas are more uncertain than those of other fuels used by utilities. Thus, for liquid fuels in these sectors a higher uncertainty of 10% is assumed in view of the quite variable composition of the refinery gas used in both sectors. For natural gas and liquid fuels in 'Oil and Gas Production' (1A1c), uncertainties of 5% and 2% are assumed, respectively, which refer to the variable composition of the offshore gas and oil produced. For the CO_2 emission factor of other fuels (fossil waste), an uncertainty of 5% is assumed, which reflects the limited accuracy of the waste composition and of the carbon fraction per waste stream. The uncertainty in the emission factors of CH_4 and N_2O from stationary combustion is estimated at about 50%, which is an aggregate for the various subcategories (Olivier et al., 2009).

Source-specific QA/QC and verification
The trends in fuel combustion in the 'Public Electricity and Heat Production' (1A1a) are compared to trends in domestic electricity consumption (production plus net imports). Large annual changes are identified and explained (e.g., changes in fuel consumption by joint ventures). For 'Oil Refineries' (1A1b), a carbon balance calculation is made to check completeness. Moreover the trend in total CO_2 reported as fuel combustion from refineries is compared to trends in activity indicators, such as total crude throughput. The IEF trend tables are then checked for changes and interannual variations are explained in this NIR.
Furthermore in 2011, a quantitative assessment was made of the possible (in)consistencies in CO_2 emissions between data from ETS, NIR and National Energy Statistics. The figures that were analysed concerned about 40% of the CO_2 emissions in the Netherlands in 2010. The differences could reasonably be explained (e.g., different scope) within the given time available for this action (De Ligt, 2011).

More details on the validation of the energy data are to be found in the monitoring protocol 12-002: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'

Source-specific recalculations
No source specific recalculations have been done within the Energy Industries sector [1A1].

Source-specific planned improvements
No source-specific improvements have been planned for the Energy Industries sector [1A1].

3.2.7 Manufacturing Industries and Construction [1A2]

Source category description
This source category consists of the six categories 1A2a 'Iron and Steel', 1A2b 'Non-ferrous Metals', 1A2c 'Chemicals', 1A2d 'Pulp, Paper and Print', 1A2e 'Food Processing, Beverages and Tobacco' and 1A2f 'Other'. Within these categories, liquid fuel and natural gas combustion by the chemical industry, solid fuel combustion by the iron and steel industry and natural gas combustion by the food processing and other industries are the dominating emission sources. However, natural gas in the pulp and paper industries and liquid fuels (mainly for off-road machinery) in the other industries are also large emission sources. The shares of CH_4 and N_2O emissions from industrial combustion are relatively small and these are no key sources. Natural gas is mostly used in the chemical, food and drinks and other industries; solid fuels (that means coal and coke-derived fuels, such as blast furnace/oxygen furnace gas) are mostly used in 1A2a 'Iron and Steel' industry; liquid fuels are mostly used in 1A2c 'Chemicals' industry and in 1A2f 'Other' industries (see Table 3.4).

Another feature of industry in the Netherlands is that it operates a large number of combined heat and power (CHP) facilities (and sometimes also steam boilers). Several of these facilities have changed ownership over time and are now operated as joint venture concerns with electrical utilities, the emissions of which are reported in 'Energy Industries' (1A1).
Within the category 1A2 'manufacturing industries and construction' the category 1A2c 'Chemicals' is the largest fuel user (see Table 3.4). In this industry liquid fuel use is 113 PJ and natural gas use is 93 PJ in 2010. A second important industry is included in 1A2f other industries and includes emissions from mineral products (cement, bricks, glass, other building materials), textiles, wood, wood products and building construction industry. Solid fuels (32 PJ in 2010) are almost exclusively used in 1A2a 'Iron and Steel. In this industry, a limited amount of natural gas is also used. All other industries are almost completely run on natural gas.

In 2010, the share of CO_2 emissions from 1A2 'Manufacturing Industries and Construction' in the total national greenhouse gas emission inventory was estimated to be 13% compared to 15% in 1990. In contrast, the share of the other greenhouse gas emissions in this category is relatively small. Category 1A2c 'Chemicals' is the largest contributor to CO_2 emissions, accounting for approximately 48% of the total emissions from manufacturing industry in 2010.

In the period 1990–2010, CO_2 emissions from combustion in 1A2 'Manufacturing Industries and Construction' decreased by 17% (see Figure 3.6). The chemical industry contributes the most to this decrease in emissions in this source category, with its contribution to CO_2 emissions decreasing by 1.6 Tg. Total CO_2 emissions from 1A2 'Manufacturing Industries and Construction' in 2010 increased 9% compared to 2009. This is caused by

Table 3.4 Fuel use in 1A2 'Manufacturing Industries and Construction' in selected years (TJ PJ NCV/year).

	Amount of fuel used (PJ NCV)				
Fuel type/Category	**1990**	**1995**	**2000**	**2005**	**2010**
Gaseous fuels					
Iron and Steel	11.7	13.0	13.7	12.5	12.0
Non-Ferrous Metals	3.8	4.3	4.2	4.0	3.6
Chemicals	134.8	115.7	99.7	92.7	30.2
Pulp, Paper and Print	30.2	24.4	27.4	29.7	21.0
Food Processing, Beverages and Tobacco	63.7	68.3	73.7	67.1	59.0
Other	58.6	63.0	66.8	59.9	55.9
Liquid fuels					
Iron and Steel	0.3	0.3	0.2	0.2	0.2
Non-Ferrous Metals	0.0	0.0	0.3	0.0	NO
Chemicals	116.2	82.0	81.7	92.7	112.9
Pulp, Paper and Print	0.3	0.1	0.1	0.0	0.0
Food Processing, Beverages and Tobacco	3.1	1.6	0.7	0.7	0.2
Other	27.7	25.4	25.0	22.6	19.6
Solid fuels					
Iron and Steel	29.8	35.0	25.2	29.0	27.8
Non-Ferrous Metals	0.0	NO	NO	NO	NO
Chemicals	12.8	0.2	2.1	1.7	1.2
Pulp, Paper and Print	0.1	NO	NO	NO	NO
Food Processing, Beverages and Tobacco	2.4	1.3	1.1	0.6	1.0
Other	3.7	2.2	2.4	1.6	1,7
	11.7	13.0	13.7	12.5	12,0

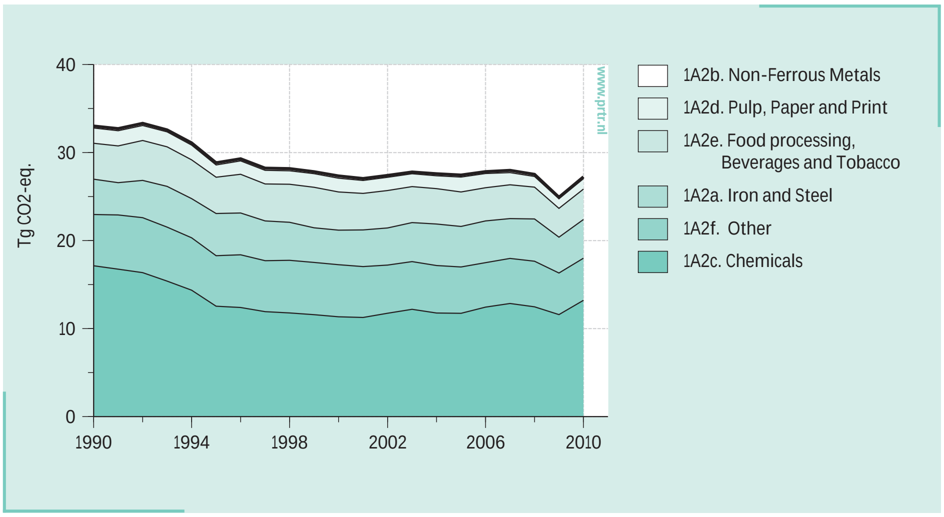
economic growth after the economic crisis in 2008/2009.

The derivation of these figures, however, should also be viewed in the context of industrial process emissions of CO_2 since the separation of the source categories is not always fixed. Most industry process emissions of CO_2 are reported in CRF sector 2 (soda ash, ammonia, carbon electrodes and industrial gases such as hydrogen and carbon monoxide). However, in manufacturing processes, this oxidation is accounted for in the energy statistics as the production and combustion of residual gases (e.g., in the chemical industry) – as is often the case in the Netherlands – then the corresponding CO_2 emissions are reported as combustion in sector 1A2 and not as an industrial process in sector 2.

Iron and Steel [1A2a]

This sector refers mainly to the integrated steel plant Tata Steel, which produces approximately 6000 kton of crude steel (in addition to approximately 100 kton of electric steel production and iron foundries). Since Tata Steel is an integrated plant, the category includes fuel combustion for on-site coke production as well as the emissions of the combustion of blast furnace gas and oxygen furnace gas in the steel industry. This sector also includes electric arc furnaces from another (small) plant.
The emission calculation of this sector is based on a mass balance, which will not be included in the National Inventory Report (due to confidentiality), but can be made available for the UNFCCC review.
The contribution of 1A2a 'Iron and steel' to the CO_2 emissions from 1A2 'Manufacturing Industries and Construction' was about 12% in 1990 and 16% in 2010. Interannual variations in CO_2 emissions from fuel combustion from the iron and steel industry can be explained as being mainly due to varying amounts of solid fuels used in this sector. In 2010 CO_2 emissions from solid fuel combustion of the iron and steel industry increased slightly (+0.2 Tg).
The 14% decrease in solid fuel use in 1999 and the 10% decrease in associated CO_2 emissions corresponds with the 8% decrease in crude steel production. When all CO_2 emissions from the sector are combined – including the net process emissions reported under category 2C1 – total emissions closely follow the interannual variation in crude steel production. Total CO_2 emissions have remained rather constant in the period 1990–2010, even though

Figure 3.6 1A2 'Manufacturing Industries and Construction': trend and emission levels of source categories, 1990-2010.



production has increased by about 30%. This indicates a substantial energy efficiency improvement in the sector. The interannual variation in the IEF for CO_2 from solid fuels is due to variable shares of BF/OX gas and coke oven gas, which have much higher and lower emission factors, respectively, than hard coal and coke have. The relative low IEFs in 1990–1994 compared to later years are due to the higher share of coke oven gas in the solid fuel mix in those years due to CO gas combustion by the independent coke manufacturer in Sluiskil, which was in these years not accounted for in the energy statistics separately but included in this category.

Non-Ferrous Metals [1A2b]

This category consists mainly of two aluminium smelters. CO_2 emissions from anode consumption in the aluminium industry are included in 2C. This small source category only contributes about 0.2 Tg CO_2 to the total national greenhouse gas inventory, predominantly from the combustion of natural gas. Energy use in the aluminium industry is largely based on electricity, the emissions of which are included in 1A1a 'Public electricity and heat production'.
The amounts of liquid and solid fuels vary considerably between years, but the differences in the amounts and related emissions are almost negligible. The interannual variation of the IEFs from liquid fuels is a result of changes in the mix of underlying fuels (e.g., the share of LPG which has a relatively low emission factor) and partly due to the small amounts used.

Chemicals [1A2c]

The share of 1A2c 'Chemicals' to the total CO_2 emissions from 1A2 'Manufacturing Industries and Construction' decreased from 52% in 1990 to 48% in 2010. The combustion of natural gas and liquid fuels accounts for 40% respectively 59% in the CO_2 emissions from the chemical industry. CO_2 emissions from this source category have decreased by approximately 23% since 1990, which is mainly due to the 44% decrease in the consumption of natural gas during the same period.

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

Taking into account all CO_2 emissions, including the net process emissions included in category 2B and the re-allocation of CO_2 emissions to the energy industry, the total CO_2 emission level from the chemical industry was rather constant in the period 1990–2010. Given that since 1990 production has increased significantly, the constant emission level indicates substantial improvements in the efficiency of energy use and/or structural changes within the chemical industry.

The increase in 2003 of the IEF for CO_2 from liquid fuels is also explained by the increase in the use of chemical waste gas and the change in composition. For CO_2 from waste gas from liquid and solid fuels, source-specific emission factors are used for 1995 onwards based on data of selected years. For 16 individual plants, residual chemical gas from liquids is hydrogen, for which the specific CO_2 emission factor is 0. For CO_2 from phosphorous furnace gas, plant-specific values are used, with values around 149.5 kg/GJ. This gas is made from coke and therefore included in solid fuels. The operation of the phosphorous plant started around 2000, which explains the increase in the IEF for solid fuels to about 149.5 kg/GJ. For another 9 companies, plant-specific CO_2 emission factors were used based on annual reporting by the companies (most in the 50-55 range, with exceptional values of 23 and 95). The increased use of chemical waste gas (included in liquid fuels) since 2003 and the changes in the mix of compositions explain the increase in the IEF for liquid fuels from about 55 to about 67 kg/GJ. For 1990, an average sector-specific value for the chemical industry was calculated using the plant-specific factors for 1995 from the 4 largest companies and the amounts used per company in 1990. For more details, see Appendix 2 of the NIR 2005.

Pulp, Paper and Print [1A2d]
The contribution of 1A2d 'Pulp, paper and print' to CO_2 emissions from 1A2 'Manufacturing Industries and Construction' is estimated to be approximately 5% in 1990 and about 4% in 2010. In line with the decreased consumption of natural gas, CO_2 emissions have decreased by approximately 32% since 1990, of which a substantial fraction is used for cogeneration. The relatively low CO_2 emissions in 1995 can be explained by re-allocation of emissions to the energy sector, due to the above-mentioned formation of joint ventures.
The amounts of liquid and solid fuel combustion vary considerably between years, but the amounts and related emissions are almost negligible. The interannual variation in the IEFs for liquid fuels is due to variable shares of derived gases and LPG in total liquid fuel combustion.

Food Processing, Beverages and Tobacco [1A2e]
The share of 1A2e 'Food processing, beverages and tobacco industries' in the CO_2 emission from 1A2 'Manufacturing Industries and Construction' was 12% in 1990 and 13% in 2010. CO_2 emissions decreased by almost 16% in the period from 1990–2010. This is due to a decrease since 2003 of joint ventures of cogeneration plants located in the pulp and paper industry, of which the emissions were formerly allocated in 1A2e but are now reported under public electricity and heat production (1A1a). This shift in allocation corresponds with a CO_2 decrease of about 0.3 Tg. In 2010, CO_2 emissions from gaseous fuel combustion in this source category increased by about 5.6% compared to last submission.

The amounts of liquid and solid fuels vary considerably between years, but the amounts and related emissions are verifiably small. The interannual variation in the IEFs for liquid fuels is due to variable shares of LPG in total liquid fuel combustion.

Other [1A2f]
This category includes all other industry branches, including mineral products (cement, bricks, other building materials, glass), textiles, wood and wood products. Also included are emissions from the building construction industry and from off-road vehicles (mobile machinery) for building construction and for the construction of roads and waterways and other off-road sources except agriculture (liquid fuels). The latter refers mainly to sand and gravel production.
The share of category 1A2f 'Other' (including construction and other off-road machinery) in CO_2 emissions from 1A2 'Manufacturing Industries and Construction' was approximately 18% in 1990 and 18% in 2010. Most of the 4.8 Tg CO_2 emissions from this source category in 2010 stem from gas combustion (3.2 Tg), while the remaining CO_2 emissions are mainly associated with the combustion of biomass (1.1 Tg CO_2) and the combustion of liquid fuels (1.5 Tg CO_2), of which off-road machinery accounts for 1.3 Tg CO_2. CO_2 emissions from this source category have decreased by 18% since 1990. In 2010, total CO_2 emissions from the other manufacturing industries increased by 1% compared to 2009.

Methodological issues
The methods used for this source category are the same as those used for 1A1 'Energy Industries'. A country-specific top-down method (Tier 2 method for CO_2 and CH_4, Tier 1 for N_2O) is used for calculating emissions for fuel combustion from 'Manufacturing Industries and Construction' (1A2). Fuel combustion emissions in this sector are calculated using fuel consumption data from national sectoral energy statistics and IPCC default emission factors for CO_2 and N_2O (see Annex 2, Table A2.1), with the exception of CO_2 for natural gas, chemical waste gas and coal, for which country-specific emission factors are used. When available, company-specific or sector-specific emission factors have been used, in particular for derived gases such as chemical waste gas, blast furnace gas and coke oven gas.
More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie).
An overview of the emission factors used for the most important fuels (up to 95% of the fuel use) in the Manufacturing Industries and Construction sector [1A2] is provided in Table 3.5. Since some emission data in this sector originate from individual companies, the values in Table 3.5 represent partly implied emission factors.

Table 3.5 Overview of emission factors used (in 2010) in the sector Manufacturing Industries and Construction [1A2].

Fuel	Amount of fuel used in 2010 (TJ NCV)	Amount of fuel used (PJ NCV)		
		CO_2 (x 1000)	N_2O	CH_4
Natural gas	244,179	56.6	0.10	6.79
Chemical Waste Gas	109,959	69.0	0.10	3.60
Gas/Diesel oil	18,826	74.3	0.60	4.93
Coke Oven Gas	14,848	42.8	0.10	2.80
Blast Furnace Gas	12,545	240.9	0.10	0.35
Other	20,576	NA	NA	NA

Notes to the implied emission factors:
- The standard CH_4 emission factor for natural gas is 5.7 g/GJ. Only for gas powered CHP is a higher emission factor used, which explains the higher emission factor for this sector.
- The CO_2 emissions from coke oven gas, blast furnace gas and waste gas are based on emission data from the NEa. Therefore, the implied emission factor is different from the standard country-specific emission factor.
- Emission factors for CH_4 and N_2O from gas/diesel oil used in Machinery are based on source-specific estimation methods.

More details on emission factor methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie).
In 'Iron and Steel Industry', a substantial large fraction of total CO_2 emissions is reported as process emissions in CRF 2C1, based on net losses calculated from the carbon balance from the coke and coal inputs in the blast furnaces and the blast furnace gas produced. Since the fraction of BF/OX gas captured and used for energy varies over time, the trend in the combustion emissions of CO_2 accounted for by this source category should be viewed in association with the reported process emissions. The fuel combustion emissions from on-site coke production by the iron and steel company Tata Steel are included here in 1A2a instead of in 1A1c, since these are reported in an integrated and aggregated manner. In addition to including the emissions from Tata Steel, this category also includes the combustion emissions of a small electric steel producer and – for the period 1990–1994 – of one small independent coke production facility for which the fuel consumption was not separately included in the national energy statistics during this period. The fugitive emissions, however, from all coke production sites are reported separately (see section 3.2.7.1). The emission calculation of the 'Iron and Steel Industry' is based on a mass balance.
For the chemical industry, CO_2 emissions from the production of silicon carbide, carbon black, methanol and ethylene from the combustion of residual gas (produced as a by-product from the non-energy use of fuels) are included in 1A2c 'Chemicals'. Although these CO_2 emissions are more or less process-related, they are included in 1A2 for practical purposes: consistency with Energy statistics that account for the combustion of residual gases. This inclusion in 1A2 is justified since there is no strict IPCC guidance on where to include those emissions.
The fuel consumption data in 1A2f 'Other Industries for Construction' and 'Other Off-road' are not based on large surveys. Therefore, the energy consumption data of this part of the Category 1A2f are the least accurate.
Details of the method for this source category are described in Protocol 12-002: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'

Uncertainties and time-series consistency
The uncertainty in CO_2 emissions of this category is estimated to be about 3% (see section 1.7 for more details). The accuracy of fuel consumption data in the manufacturing industries is generally considered to be rather accurate, about 2%, with the exception of those for derived gases included in solids and liquids (Olivier et al., 2009). This includes the uncertainty in the subtraction of the amounts of gas and solids for non-energy/feedstock uses, including the uncertainty in the conversion from physical units to Joules, and the completeness of capturing blast furnace gas in total solid consumption and chemical waste gas in liquid fuel consumption.
For natural gas, the uncertainty in the CO_2 emission factor is estimated to be 0.25% based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier et al. (2009). The 5% uncertainty estimate in the CO_2 emission factor for liquids is based on an uncertainty of 10% in the emission factor for chemical waste gas in order to account for the quite variable composition of the gas and its more than 50% share in the total liquid fuel use in the sector. An uncertainty of 10% is assigned for solids, which reflects the uncertainty in carbon contents of blast furnace gas/oxygen furnace gas based on the standard deviation in a 3-year average. BF/OX gas accounts for the majority of solid fuel use in this sector.

Source-specific QA/QC and verification
The trends in CO_2 emissions from fuel combustion in the iron and steel industry, non-ferrous industry, food processing,

pulp and paper and other industries are compared to trends in the associated activity data: crude steel and aluminium production, indices of food production, pulp and paper production and cement and bricks production. Large annual changes are identified and explained (e.g., changed fuel consumption by joint ventures). Moreover, for the iron and steel industry the trend in total CO_2 emissions reported as fuel combustion-related emissions (included in 1A2a) and industrial process emissions (included in 2C1) is compared to the trend in the activity data (crude steel production). A similar comparison is made for the total trend in CO_2 emissions from the chemical industry (sum of 1A2c and 2B) and trends split per main fuel type or specific process (chemical waste gas combustion and process emissions from ammonia production). IEF trend tables are checked for large changes and large interannual variations at different levels and explained in the NIR. More details on the validation of the energy data are found in the monitoring protocol 12-002: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

Source-specific recalculations
As a result of the in-country review of September 2011, the emissions from the integrated iron and steel company have been reassessed and a mass balance has been made available to the review team. As a result of this, minor corrections have been performed because the emission factor for blast furnace gas appeared to be too low for the years 2005, 2006 and 2009 (category 1A2). Furthermore, for the years 2005 to 2009 the correction for the process emission from limestone use and the steelmaking process was kept constant at 300 kton CO_2 in the calculation of the other emissions. In the recalculation the correct correction terms were used (as reported in 2C11 and 2C151), resulting in changed figures for the carbon loss as reported in 2C152 and the emissions from coke production in 1B1b. The mass balance will not be included in the National Inventory Report (due to confidentiality) but can be made available for the UNFCCC review.

The above recalculations were already included in the resubmission of November 2011.

Diesel fuel consumption and resulting emissions by non-road mobile machinery has been recalculated in the current submission. In a recent research project TNO concluded that the load factor for diesel fork lift trucks was overestimated in the EMMA model that is used to calculate energy use and emissions of non road mobile machinery in the Netherlands (Hulskotte & Verbeek, 2009). The average engine load factor was previously estimated to be 78% but has now been reduced to 60%. This is more in line with figures that are used internationally (e.g., EPA, 2010). In the Belgian version of the EMMA, the load factor for fork lift trucks was also set to 60% after a workshop with sector representatives (TML & TNO, 2005).

The readjustment of the load factor for diesel forklift trucks has led to a decrease of diesel fuel consumption of approximately 1% (0.3/0.4 PJ) in the time-series. Greenhouse gas emissions also decreased by approximately 1% (20/30 Gg CO_2 equivalents).
In 1990 the emission of N_2O from biomass was missing but this has now been corrected.

These recalculations were not included in the resubmission of November 2011 and thus are included in the recalculation sheet.

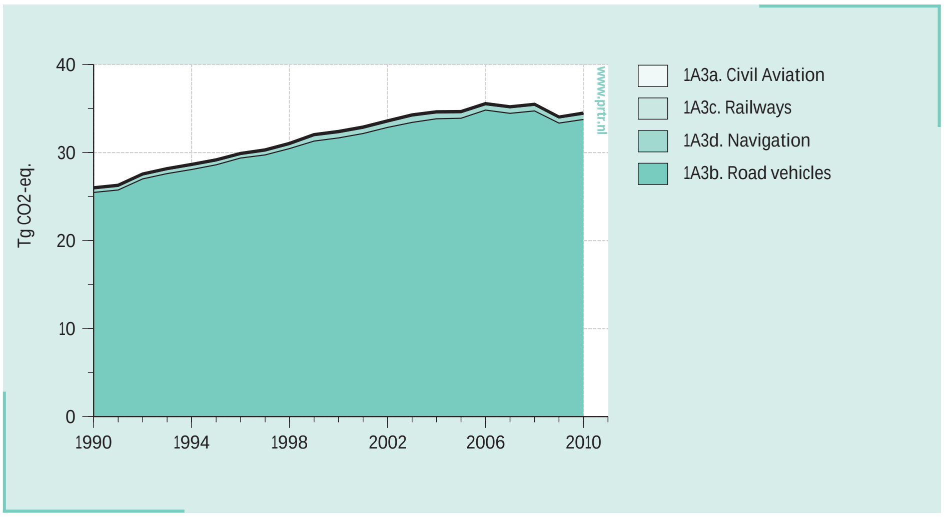
Source-specific planned improvements,
There is no source-specific improvement planned.

3.2.8 Transport [1A3]

Source category description
The source category 1A3 'Transport' comprises the following sources: 'Civil Aviation' (1A3a), 'Road Transportation' (1A3b), 'Railways' (1A3c), 'Water-borne Navigation' (1A3d) and 'Other Transportation' (1A3e). The source category 'Civil Aviation' only includes emissions from domestic civil aviation, i.e., civil aviation with departure and arrival in the Netherlands. In the same manner, the source category 'Water-borne Navigation' only includes emissions from domestic inland navigation. Emissions from international aviation and navigation (aviation and marine bunkers) are reported separately in the inventory; see section 3.2.2. Emissions from fuel combustion by military aviation and shipping activities are included in 1A5 'Other'; see section 3.2.10. The source categories 'Road Transportation' and 'Railways' include all emissions from fuel sold to road transport and railways in the Netherlands.
The source category 'Other Transportation' (1A3e) is not used; instead emissions from other mobile sources are reported in different source categories in the inventory. Emissions from agricultural non-road mobile machinery, such as tractors, are included in 1A4c 'Agriculture, Forestry and Fisheries'; see section 3.2.9, whereas emissions from other non-road mobile machinery, such as road and building construction equipment, are reported under category 1A2f 'Other'; see section 3.2.7. Energy consumption for pipeline transport is not recorded separately in the national energy statistics but is included in 1A1c for gas compressor stations and in 1A4a for pipelines for oil and other products.

Overview of shares and trends in emissions
The source category 1A3 'Transport' is responsible for 17% of total greenhouse gas emissions in the Netherlands. Between 1990 and 2010, greenhouse gas emissions from transport increased by 32% to 35.0 Tg CO_2 eq in 2010. This increase was mainly caused by an increase in fuel consumption and corresponding CO_2 emissions from road

Figure 3.7 1A3 'Transport': trend and emission levels of source categories, 1990-2010.



transport. The greenhouse gas emissions from the transport sector are summarised in Figure 3.7. CO_2 emissions from 1A3b 'Road transportation' are dominant in this source category, accounting for 98% of total emissions over the whole time-series.
Greenhouse gas emissions from transport increased by 1% from 2009 to 2010. This increase is primarily caused by a 39% decrease (6 PJ) in the use of biofuels. Total energy use by the transport sector remained constant between 2009 and 2010.

Civil Aviation [1A3a]

The share of 1A3a 'Civil Aviation' in total greenhouse gas emissions in the Netherlands was less than 0.1% in both 1990 and 2010. The reported energy use and greenhouse gas emissions by domestic civil aviation in the Netherlands are based on a rough estimate of fuel consumption in 2000, which is applied to the whole time-series (see section 3.2.8.2). Therefore, emissions remain constant over the time-series.

Road transportation [1A3b]

The contribution of 1A3b 'Road transportation' to the national greenhouse gas emissions was 12% in 1990 and 16% in 2010. Between 1990 and 2010, greenhouse gas emissions from road transport increased from 25.9 to 34.2 Tg CO_2 equivalents. This increase is mainly caused by a large increase in diesel fuel consumption. Between 1990 and 2010, diesel fuel consumption by road transport increased by 69% (110 PJ), due to a large growth in freight transportation and the growing number of diesel passenger cars and light duty vehicles in the Dutch car fleet. As a consequence, the share of diesel in fuel sales to road transportation (PJ) has increased from 45% to 58% between 1990 and 2010, as is shown in Figure 3.8. The share of LPG has decreased significantly, while the share of gasoline has decreased slightly.

The use of natural gas in road transportation is still very small, although it has increased significantly in recent years. In 2005, natural gas use in road transport was estimated to be 30 TJ, whereas in 2010 this was estimated to be 460 TJ. In previous inventory reports, natural gas use in road transportation was reported elsewhere in the inventory. During the in-country review of the NIR2011 is was concluded that not all natural gas use in transport was accounted for in the inventory, therefore emission figures were corrected in a resubmission of the CRF. In the current NIR, the preliminary estimates made for the in-country review are still used for the years 2005-2009, see also section 3.2.8.2.

In 2010, CO_2 emissions from road transport increased by 1% (0.4 Tg) compared to 2009, primarily because of a decrease in the use of biodiesel between 2009 and 2010: in 2010 the share of biofuels in total energy use by road transport decreased to 2.0% (compared to 3.3% in 2009). CH_4 emissions from road transport fell from 7.5 Gg in 1990 to 2.4 Gg in 2010, which translates to a decrease of about 69%. Between 2009 and 2010, CH_4 emissions from road transport decreased by approximately 4% (0.1 Gg). The continuing decrease in CH_4 emissions from road transport is caused by a reduction in total VOC emissions resulting from the implementation of European Union emission legislation for new road vehicles. Total combustion and evaporative VOC emissions by road transport decreased by approximately 83% between 1990 and 2010, primarily due to the penetration of catalyst- and canister-equipped vehicles in the passenger car fleet. The share of CH_4 in the total greenhouse gas emissions by road transport (in CO_2 eq) is very small (0.2% in 2010).

N_2O emissions from road transport increased from 0.9 Gg in 1990 to 1.6 Gg N_2O in 1997, but have since decreased to 1.4 Gg in 2010. The increase in N_2O emissions up to 1997 can be explained by the increased penetration of petrol cars equipped with a catalytic converter in the Dutch passenger car fleet, as the latter emit more N_2O than petrol cars without a catalytic converter. The subsequent decrease in N_2O emissions between 1997 and 2010, despite an increase in vehicle-kilometres in this period, can be explained by a mixture of developments:
Subsequent generations of catalytic converters (the second was introduced in 1996) appear to have lower N_2O emissions (Gense and Vermeulen, 2002);
The share of diesel cars in the passenger car fleet, which have lower N_2O emissions per vehicle-kilometre than catalyst-equipped petrol cars, has increased throughout the last few years.

Between 2009 and 2010, N_2O emissions from road transport increased slightly (0.02 Gg). The share of N_2O in total greenhouse gas emissions from road transport (in CO_2 eq) was 1.3% in 2010.

Railways [1A3c]
Up until 2008, total diesel fuel consumption by 1A3c 'Railways' remained fairly constant in the time-series: in both 1990 and 2008 total energy use was 1.2 PJ. In 2009 diesel fuel consumption decreased by 26% compared to 2008. This decrease was mainly caused by a decrease in traffic volume resulting from the economic crisis: total freight traffic by rail (in ton-km) decreased by 20% from 2008 to 2009 according to Statistics Netherlands. In 2010, diesel fuel consumption by railways increased by approximately 60% (0.5 PJ) to 1.4 PJ. This large increase can partly be explained by an increase in traffic volume of 15% in 2010 compared to 2009. Also in 2010 a new data source was used to obtain fuel sales data to railways, see section 3.2.8.2.

The share of 1A3c 'Railways' in total greenhouse gas emissions from the transport sector is small throughout the entire time-series (0.2-0.3%).

Water-borne Navigation [1A3d]
The share of domestic water-borne navigation (1A3d) in total national greenhouse gas emissions from the transport sector varies between 1.5 and 2% in the time-series. Total greenhouse gas emissions increased from 0.4 Tg CO_2 equivalents in 1990 to 0.6 Tg in 2010. This increase is mainly caused by an increase in freight transport by inland shipping. In 2009, the economic crisis led to a 7% decrease in diesel fuel consumption by domestic water-borne navigation. In 2010, diesel fuel consumption increased slightly by 0.1 PJ (1%).

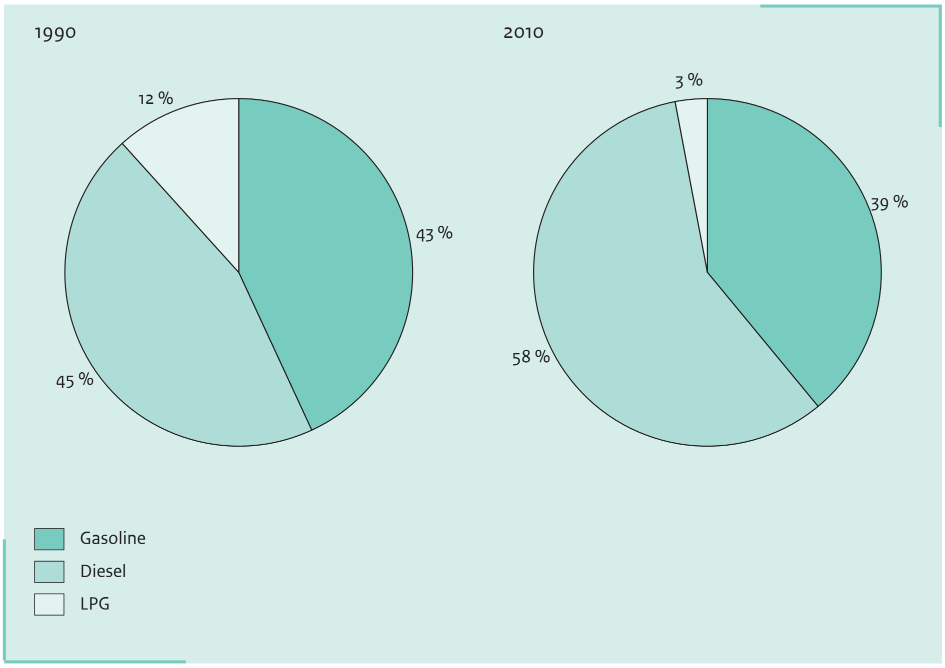
Key sources
CO_2 emissions from 1A3b 'Road Transportation' (all fuel types), are identified as key sources. This also applies to N_2O emissions from 1A3b 'Road Vehicles'.

Methodological issues
A detailed description of the methodologies and data sources used to calculate transport emissions is provided in Klein et al. (2012) and in the monitoring protocols that can be found at www.nlagency.nl/nie and are listed in section 3.1.

Civil Aviation [1A3a]
An IPCC Tier 2 methodology is used for calculating the greenhouse gas emissions of civil aviation. There are however no reliable data available on the distribution of fuel sales between national, international and military aviation. Therefore, the figures included in the national energy statistics (CBS Energy Balance) are not used in the inventory. Instead, fuel consumption by domestic aviation has been roughly estimated based on the 2000 consumption figures of aviation petrol (avgas) and jet kerosene for domestic flights in the Netherlands reported by the Civil Aviation Authority Netherlands (Pulles, 2000). Because of the very small amounts involved (342 TJ aviation petrol and 230 TJ jet kerosene), no attempt has been made to make new estimates for recent years. Since the number of domestic flights has decreased since 2000, there is no reason to expect an increase in energy use and emissions since 2000. Therefore, the figures for the year 2000 are used for the entire time-series. The emission factors used to calculate CO_2 emissions from kerosene and aviation petrol are derived from Vreuls and Zijlema (2012). Default IPCC emission factors for kerosene and aviation petrol are used to calculate emissions of CH_4 and N_2O. Emissions of precursor gases (NO_x, CO, NMVOC and SO_2) reported in the NIR under domestic aviation are the uncorrected emission values from the Netherlands Pollutant Emissions Register and refer to aircraft emissions associated with the Landing and Take-Off (LTO) cycles at Schiphol Airport. By far the most aircraft activities (>90%) in the Netherlands are related to Schiphol Airport; therefore emissions from other airports are ignored. No attempt has been made to estimate non-greenhouse gas emissions specifically related to domestic flights (including cruise emissions of these flights), since these emissions are almost negligible.

Road Transportation [1A3b]
An IPCC Tier 1 methodology is used for calculating CO_2 emissions from road transport, using national data on fuel sales to road transport from Statistics Netherlands (CBS) and country-specific emission factors, as reported in Klein et al. (2012) and in Vreuls and Zijlema (2012). See Annex 2 for more details.

Figure 3.8 Shares of petrol (gasoline), diesel and LPG in fuel sales to 'Road Transport' 1990 and 2010.



An IPCC Tier 3 methodology is used for calculating CH_4 emissions from road transport, using fuel sales data from Statistics Netherlands and data on the mass fractions of different compounds in total VOC emissions (Ten Broeke and Hulskotte, 2009). Total VOC emissions from road transport are calculated bottom-up using data on vehicle-kilometres driven from Statistics Netherlands (CBS), and VOC emission factors obtained from the Netherlands Organisation for Applied Scientific Research (TNO), as reported in Klein et al. (2011). The calculation methodology for total VOC emissions distinguishes several vehicle characteristics, such as vehicle type, age, fuel type and weight. In addition, the methodology also distinguishes three road types and takes into account cold starts. The mass fraction of CH_4 in total VOC-emissions is dependent on the fuel type, vehicle type and – for petrol vehicles – whether or not the vehicle is equipped with a catalyst. Petrol-fuelled vehicles equipped with a catalyst emit more CH_4 per unit of VOC than vehicles without a catalyst. In absolute terms, however, passenger cars with catalysts emit far less CH_4 than passenger cars without a catalyst because total VOC emissions are far lower.
To make sure the reported CH_4 emissions from road transport are consistent with fuel sales data, the bottom-up approach described above is used to calculate average CH_4 emission factors per unit of fuel used. These emission factors are consequently combined with the fuel sales data from Statistics Netherlands to derive total CH_4 emissions from road transport.
N_2O emissions from road transport are calculated using a similar IPCC Tier 3 methodology as for CH_4. The emission factors for passenger cars and light-duty vehicles using petrol or LPG are based on country-specific data (Gense and Vermeulen, 2002). Emission factors for diesel light-duty vehicles, heavy-duty vehicles, motorcycles and mopeds are derived from Dröge (2011).
Emissions of all other compounds, including ozone precursors and SO_2, which are more directly involved in air quality, are calculated bottom-up using data on vehicle-kilometres driven.
Emissions from biodiesel and ethanol in gasoline are reported separately in the CRF. The emission calculation is comparable to the emission calculation for diesel/gasoline and is based on the sold amount of biodiesel and ethanol, as reported by Statistics Netherlands. Emissions of CH_4 and N_2O from biodiesel and ethanol are calculated using the same emission factors as for regular (fossil) diesel and gasoline, respectively.

Natural gas in road transport

During the in-country review of the NIR2011 it was noted by the Expert Review Team (ERT) that emissions resulting from the use of natural gas in road transport were not reported in the inventory. After discussions with Statistics Netherlands, it was concluded that energy use and resulting emissions from CNG (compressed natural gas) in road transport were for the most part accounted for in the inventory but reported under source category 1A4a Commercial/Institutional. A small part of the energy use (0.03 PJ) and resulting emissions were not reported in the inventory. In the Dutch Energy Balance total energy use from natural gas in road transportation in 2005 was estimated by Statistics Netherlands to be 30 TJ. This estimate was subsequently used in later years up until 2009, but was not part of the emission inventory. The increase in the use of natural gas for road transport after 2005 was not reported separately in the Energy Balance. Instead, energy use (and resulting emissions) was reported under Commercial/Institutional.

To correct for the missing emissions, a resubmission of the CRF was done in November 2011. In this resubmission, a preliminary estimate was made of emissions resulting from the use of natural gas in road transport that were not already reported elsewhere in the inventory, using IPCC default emission factors for CH_4 and N_2O and country specific emission factors for CO_2 from natural gas. It was also taken into account that the CH_4 emission factor used for natural gas in 1A4a Commercial/Institutional is lower than the IPCC default emission factor for CNG use in road transport (5.7 kg/TJ compared to 50 kg/TJ for road transport). Therefore, CH_4 emissions resulting from CNG use in road transport that were reported under 1A4a were actually underestimated. In the resubmission, these extra CH_4 emissions were also reported.

In the new inventory, the preliminary estimates made in the resubmission have remained unchanged. Statistics Netherlands is currently working on a new time-series for natural gas use in road transportation. These figures and resulting emissions will be reported in next year's submission. Currently, emissions from natural gas in road transport in 2006-2009 are still, for the most part, reported under 1A4a. The remainder is reported under 1A3b 'Road Transportation' using the country specific emission factors for CO_2 and the IPCC default emission factors for N_2O and CH_4. The extra CH_4 emissions stemming from the higher CH_4 emission factor for natural gas in Road Transportation (compared to 1A4a) are also reported under 1A3b. Since energy use is reported under 1A4a but the (extra) CH_4 emissions are reported under 1A3a, the implied emission factor for CH_4 increases between 2005 and 2009. The same default emission factor for CH_4 has been used though for CNG use in road transport throughout the entire time-series.

In the 2010 Energy Balance, Statistics Netherlands reported a new estimate for natural gas use in road transport in 2010. This estimate of 460 TJ was therefore used in the current inventory to estimate greenhouse gas emissions from natural gas in road transport in 2010, again using the country specific CO_2 emission factor for natural gas and the default IPCC emission factors for N_2O and CH_4. In next year's submission, all natural gas use in road transport and resulting emissions will be reported under 1A3b, using the new time-series in the Energy Balance.

Railways [1A3c]

Until 2009, information on diesel fuel sold to the railway sector, as reported by Statistics Netherlands in the Energy Balance, was obtained from the Dutch Railways (NS). In last year's submission it was however reported that fuel sales to the railway sector in the Netherlands might be underestimated in the inventory. A research project by Ecorys (2010) showed higher diesel fuel sales in 2008. Therefore, fuel sales data to the railway sector in the Energy Balance is now derived from Vivens, a recently founded co-operation of rail transport companies that now purchases diesel fuel for the railway sector in the Netherlands. Vivens only has data available from 2010 onwards. This has led to an inconsistency in the time-series: diesel fuel sales to the railway sector in the Netherlands in 2010, as reported by Vivens, is 60% (0.5 PJ) higher than diesel fuel sales in 2009, as reported by NS. This increase can only partially be explained by the increase in transport volumes of approximately 15% between 2009 and 2010. In 2012 Statistics Netherlands will assess if an adjustment of the historical time-series is required.

For calculating CO_2 emissions, country-specific emission factors are used (Olivier, 2004); see Annex 2 for more details. For CH_4 and N_2O emissions, IPCC default emission factors are used.

Water-borne navigation [1A3d]

An IPCC Tier 2 methodology is used for calculating CO_2 emissions from domestic water-borne navigation. CO_2 emissions are calculated based on fuel deliveries to water-borne navigation in the Netherlands and country-specific emission factors (Klein Goldewijk et al., 2004). In the Netherlands, domestic commercial inland vessels are allowed to use bunker fuels (sold without levies and VAT). Although the national energy statistics (CBS Energy Balance) distinguish between trips on the Rhine River and other inland shipping in the fuel consumption data for shipping, the sum of bunker fuel sales and domestic fuel sales to water-borne navigation in the national energy statistics includes fuel used for international navigation that should not be reported as part of domestic shipping according to IPCC Good Practice. Using the Dutch Emission Monitor Shipping (EMS) however, it is possible to distinguish between national and international navigation based on ton-kilometres travelled by ships (AVV, 2003). The share of fuel used by international navigation as calculated with the EMS is therefore subtracted from the total fuel sales to navigation in order to arrive at the fuel sales to national navigation, which is reported under 1A3d. The present Tier 2 methodology level complies with the IPCC Good Practice Guidance (IPCC, 2001).

Uncertainties and time-series consistency
The uncertainty in fuel sales to 1A3b 'Road Transportation' is estimated to be +/- 3% for petrol, +/- 5% for diesel oil and +/- 10% for LPG. These estimates are based on the annual differences between the fuel sales data from Statistics Netherlands and the bottom-up calculation of fuel used by road transport (see section 3.2.8.2). The uncertainty in the CO_2 emission factors for petrol, diesel and LPG is estimated to be +/- 2%. For petrol and diesel fuel, the uncertainty in the CO_2 emission factor was previously calculated to be +/- 0.2% and +/- 0.4% respectively, based on the analysis of 50 samples of petrol and diesel fuel from petrol stations in the Netherlands in 2004 (Olivier, 2004). There are however indications that the carbon content of petrol and diesel fuel for road transport is changing due to tightening of European fuel quality standards. Since no recent measurements have been performed, the uncertainty is expected to have increased and is currently estimated to be +/- 2% for all three fuel types. This estimation is based on expert judgment. Based on these estimates, total uncertainty in annual CO_2 emissions from road transport is estimated to be approximately +/- 5%.
The uncertainty in CH_4 emissions from road transport is estimated to be +/- 50% in annual emissions. The uncertainty in the total VOC emissions of road transport is roughly estimated to be +/- 30%. The uncertainty in the share of CH_4 in VOC emissions is estimated by Ten Broeke and Hulskotte (2009) to be +/- 40% for petrol and +/- 25% for diesel. Combined with the uncertainties in fuel sales and the share of both fuel types in total CH_4 emissions from road transport, the uncertainty of the CH_4 emissions from road transport is estimated to be +/- 50%. The uncertainty in annual N_2O emissions from road transport is also estimated to be +/- 50%. N_2O emission factors have not been updated recently and therefore are relatively uncertain (+/- 50%).
The uncertainty in fuel used by domestic civil aviation is estimated to be about +/- 50%. Uncertainty is high due to the lack of data on fuel sales specifically for domestic flights. The uncertainty in emission factors for Civil Aviation is estimated to be +/- 0.5% for CO_2 and +/- 100% for CH_4 and N_2O. This results in a total uncertainty estimate of +/- 50% for CO_2 emissions and +/- 112% for CH_4 and N_2O emissions.
The uncertainty in fuel used by domestic water-borne navigation is estimated to be approximately +/- 20%. The uncertainty in emission factors is estimated to be +/- 0.2% for CO_2 and +/- 100% for CH_4 and N_2O. This results in a total uncertainty estimate of 20% for CO_2 emissions and 102% for CH_4 and N_2O emissions from domestic waterborne navigation. For more details on the uncertainty estimates for 1A3 'Transport', see Olivier et al. (2009).

Source-specific QA/QC and verification
The CO_2 emissions from 1A3b 'Road Transportation' are calculated based on fuel sales data. To check the quality of the emission totals, CO_2 emissions from road transportation are also calculated using a bottom-up approach based on vehicle-kilometres travelled and fuel consumption per kilometre for different vehicle types. A comparison between the fuel sales data and the calculated fuel consumption gives an indication of the validity of the (trends in the) fuel sales data. The bottom-up calculation of petrol consumption shows good agreement with the petrol sales data from Statistics Netherlands: differences between both figures vary between +/- 3% for most of the time-series and both time-series show similar trends.
The time-series for diesel shows larger differences, with the diesel fuel sales figures being higher than the bottom-up calculated diesel fuel consumption. Differences vary between 13 and 26%, with the differences growing larger in more recent years. The differences between both figures can partly be explained by the fact that current long-haul distribution trucks can travel several thousand kilometres on a full tank. The fuel sold to these trucks in the Netherlands can for the most part be consumed abroad and therefore is not included in the bottom-up calculated diesel fuel consumption. The differences can also partly be explained by a lack of reliable fuel consumption figures per vehicle-kilometre for most vehicle types, especially for light and heavy duty vehicles (almost all of which are diesel vehicles in the Netherlands). This makes the calculated diesel fuel consumption rather uncertain.
The time-series for bottom-up calculated fuel consumption and reported fuel sales of LPG also show rather large differences. For the entire time-series from 1990 to 2010, fuel sales data for LPG are on average approximately 30% higher than the bottom-up calculated LPG consumption by road transport. This difference can partly be explained by the use of LPG in non-road mobile machinery (i.e., forklift trucks). In the Netherlands, the EMMA model (Hulskotte & Verbeek, 2009) is used to calculate fuel consumption and (greenhouse gas) emissions from non-road mobile machinery. According to the model, industrial non-road mobile machinery uses 2-3 PJ of LPG annually in the Netherlands. This fuel consumption is however not separately reported in the Dutch energy statistics. This could explain approximately half of the difference between the fuel sales and the bottom-up calculation of fuel consumption of LPG. The remaining difference can partly be explained by the lack of reliable fuel consumption figures for LPG vehicles.
The time-series for the bottom-up calculated diesel and LPG consumption by road transport do show similar trends to the fuel sales data from Statistics Netherlands. In 2012, a research project will be carried out by TNO and Statistics Netherlands to improve the bottom-up calculation of fuel use and CO_2 emissions from road transport in the

Netherlands. This study should shed more light on the potential causes of the differences between fuel sold and fuel used for diesel and LPG in the Netherlands.
To validate energy use by railways and waterborne navigation, trends are compared with trends in traffic volumes, see also section 3.2.8.1. Trends in energy use by waterborne navigation show rather good agreement with trends in transport volumes. For railways, agreement between energy use and transport volumes is less good. This can at least partially be explained by the electrification of freight transport by rail. In recent years, more electric locomotives are used for freight transportation by rail in the Netherlands. Figures by Rail Cargo (2007 & 2011) show that in 2007 only 10% of all locomotives used in the Netherlands was electric, whereas in 2011 the share of electric locomotives increased to approximately 40%. Therefore, diesel fuel consumption has not increased as much as transport volumes.

Source-specific recalculations

Recalculations as result of the 2011 in-country review

In the latest official CRF-submission by the Netherlands from November 2011, greenhouse gas emissions from road transport were re-estimated based on the preliminary estimates of the CNG-use in road transport that was not reported under 1A4a Commercial/Institutional, see also section 3.2.8.2. This recalculation was already submitted and therefore does not show up in the recalculation sheet of the current CRF.

Other recalculations

In this year's submission the CH_4 emissions from 1A3b 'Road Transportation' have been recalculated for the entire time-series, using new estimates of total VOC-emissions for motorcycles and mopeds. In 2010 TNO developed a new emission model for two-wheeled vehicles in the Netherlands (Dröge et al., 2011). New emission factors were estimated based on international literature and a vehicle fleet model was developed using sales data and vehicle fleet data from RAI-BOVAG and Statistics Netherlands. The old emission model did not take into account the EU emission legislation for motorcycles and mopeds but instead used average emission factors for the entire time-series. As a consequence, total VOC emissions were underestimated in the earlier years of the time-series and overestimated in later years. TNO also derived new VOC species profiles for motorcycles and mopeds, but the mass fraction of CH_4 in total VOC emissions did not change compared to the VOC species profiles that were previously used. The old and new time-series of CH_4 emissions from 1A3b 'Road Transportation' are shown in Figure 3.9. In earlier years of the time-series, emissions are up to 10% (0.6 Gg) higher compared to last years' submission whereas in recent years emissions are up to 8% (0.2 Gg) lower.

Also in this year's submission greenhouse gas emissions from biofuels and energy use in inland waterborne navigation in 2009 have been recalculated using new definitive estimates of energy use, whereas in last year's submission preliminary estimates were used. Energy use by domestic waterborne navigation in 2009 is now reported to be 0.3 PJ (3%) lower than reported last year, whereas the use of bio diesel in 2009 is now estimated to be 0.2 PJ (2%) higher than reported last year.

Source-specific planned improvements

In the coming year, the Netherlands plans to improve the fuel sales data for 1A3a 'Aviation'. Statistics Netherlands annually reports the amount of jet kerosene delivered for inland aviation in the Netherlands. These figures include both fuel deliveries for civil aviation and military aviation. Until recently, it was not possible to split these figures between civil aviation and military aviation. Emissions from military aviation are not part of source category 1A3a but are reported under source category 1A5b. Therefore, the figures of Statistics Netherlands have until now not been used in the inventory. Statistics Netherlands is planning to report separate time-series for fuel deliveries to civil aviation and military aviation. A new research project must show if these figures can be used to calculate emissions from 1A3a Civil Aviation (and also from military aviation, as reported under 1A5).

As was noted by the ERT during the in-country review of the NIR2011, current N_2O emission factors for the bottom-up calculation of N_2O emissions from road transport have not been updated since 2003. Therefore, in 2012 TNO will perform a study on N_2O emission factor for road transport. The ERT also noted that the average carbon content of fossil fuels for road transport that is used to calculate CO_2 emissions has not been updated recently. In 2012, a preliminary study will be done to check if the use of the current carbon contents is still warranted or if a new measurement programme is required. Also in 2012 the time-series of energy use and emission from CNG vehicles will be updated based on new data from Statistics Netherlands, see also section 3.2.8.2.

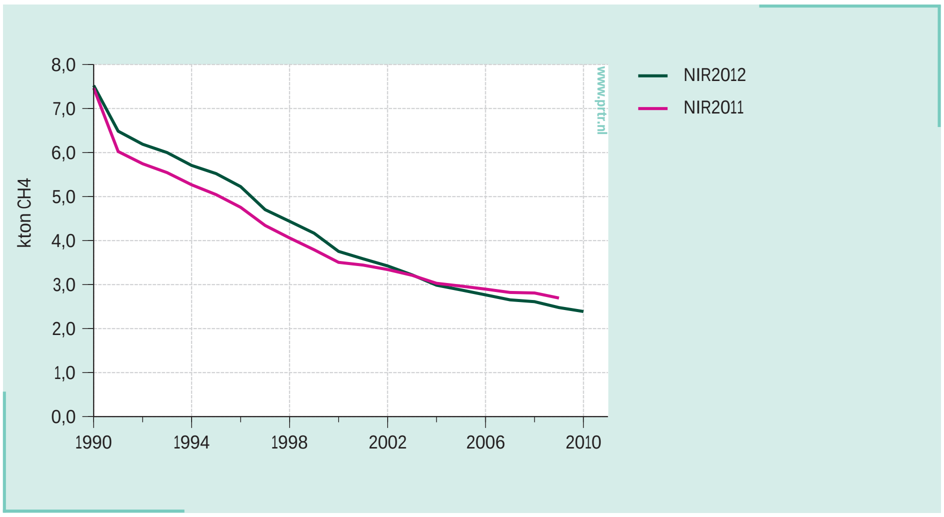
3.2.9 Other Sectors [1A4]

Source category description

Source category 1A4 'Other sectors' comprises the following categories:

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

Figure 3.9 Comparison of old (NIR2011) and new (NIR2012) time-series of CH_4 emissions from 1A3b 'Road Transportation'.



- 1A4b 'Residential'. This sector refers to fuel consumption by households for space heating, water heating and cooking. Space heating requires about three-quarters of the total consumption of natural gas.
- 1A4c 'Agriculture, Forestry and Fisheries'. This sector comprises stationary combustion emissions from agriculture, horticulture, greenhouse horticulture, cattle breeding and forestry and fuel combustion emissions from fisheries and from off-road machinery used in agriculture (mainly tractors).

CO_2 emissions of 1A4 'Other sectors' increased by 17% in the period from 1990–2010 (see Figure 3.10). In 2010, CO_2 emissions from 1A4 'Other sectors' increased by 15% compared to the 2009 level.

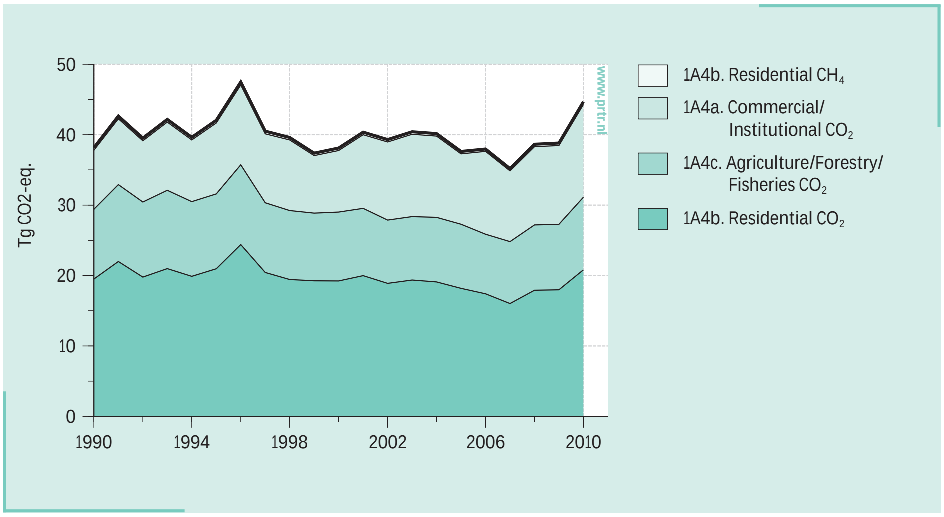
The share of CO_2 emissions from 1A4 'Other sectors' in total national CO_2 equivalent emissions (excluding LULUCF) was about 18% in 1990 and 21% in 2010, respectively. The share of CH_4 emissions from this source category in the national total greenhouse gas emissions is very small (0.7%); the share of N_2O emissions is almost negligible; 1A4b 'Residential' is the main contributor, contributing approximately 10% to the total national CO_2 equivalent emissions.
About 16% of the total CH_4 emissions in the Energy sector originate from the 'Residential' sector (0.4 Tg CO_2 eq, see Table 3.1). Almost 80% of these CH_4 emissions stem from gas combustion in particular from cooking losses; the remainder is from bio fuel combustion. The decreased emissions in 'Agricultural' are due to energy conservation measures in the category of greenhouse horticulture, CO_2 emissions from off-road machinery used in agriculture and from fisheries are included in the total emissions from category 1A4c (total CO_2 emissions from 1A4c: approximately 10 Tg CO_2).

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

Commercial/Institutional [1A4a]

The CO_2 emission in the 'Commercial/Institutional Services' sector has increased since 1990 by 57%. However, when a temperature correction is taken into account, the structural, anthropogenic trend shows a somewhat lower increase in this period.
The emission trends should not be considered to be very robust. The fossil fuel consumption of natural gas and the small uses of liquid and solid fuels in this category show a very large interannual variation due to the relatively large inaccuracy of fuel consumption data in the energy statistics. This large inaccuracy is a result of the calculation scheme used in the national energy statistics, which allocates all fossil fuel use remaining after subtraction of the amounts allocated to the previous source categories (1A1, 1A2, 1A3) and other categories (1A4b and 1A4c) to this category. Thus, all uncertainties in the other allocations accumulate in this remaining category, which also results in large interannual changes in the underlying fuel mix of solid and liquid fuels. This explains the relatively large interannual variation that can be observed in the IEFs of CO_2, CH_4 and N_2O for solid and liquid fuels.
For 1991–1994 in particular, the detailed fuel mix assumed for liquid and solids fuels was different from the adjoining years 1990 and 1995 due to the revision of the energy statistics at a high aggregation level (discussed in section 3.1.1). The biomass combustion reported here refers mainly to the combustion of biogas recovered by waste water treatment plants (WWTP), which shows a rather smooth increasing trend, and biomass consumption by industrial companies, which are classified in this economic sector, for example landfill gas used as fuel. According to

Figure 3.10 1A4 'Other sectors': trend and emission levels of source categories, 1990-2010.



the renewable energy statistics, the latter increased substantially in 2005.

Residential [1A4b]

When corrected for the interannual variation in temperatures, the trend in total CO_2 – i.e., in gas consumption – becomes quite smooth, with interannual variations of less than 5%. The variations are much larger for liquid and solid fuels because of the much smaller figures. The biomass consumption is almost all wood (fuel wood, other wood). For details see the monitoring protocol 12-038 on biomass fuel combustion

The IEF for CH_4 from national gas combustion is the aggregate of the standard emission factor for gas combustion of 5.7 g/GJ plus the 35 g/GJ of total residential gas combustion that represents start-up losses, which occur mostly in cooking but also in central heating and warm water production devices. This second component is neither accounted for in the IPCC default nor in emission factors used by most other countries.

In the 'Residential' sector, CO_2 emissions have remained almost constant since 1990. The structural anthropogenic trend including a temperature correction shows a significant decrease in this period. Although the number of households and residential dwellings has increased since 1990, the average fuel consumption per household decreased more, mainly due to the improved insulation of dwellings and the increased efficiency of heating apparatuses (increased use of high-efficiency boilers for central heating). The year 2010 was relatively cold, which caused a large increase in fuel consumption.

Agriculture/Forestry/Fishing [1A4c]

Most of the energy in this source category is used for space heating and water heating; although some energy is used for cooling. The major fuel used in the categories is natural gas, which accounts for approximately 83% of total fossil fuel consumption; much less liquid fuel is used by off-road machinery and by fisheries. Almost no solid fuels are used in these sectors.

Total CO_2 emissions in the 'Agriculture, Forestry and Fisheries' category have decreased since 1990, mainly due to a decrease in gas consumption for stationary combustion as a result of different energy conservation measures (amongst others in greenhouse horticulture). The surface area of heated greenhouses has increased but their energy consumption has been reduced. It should be noted that about 1 Tg of the CO_2 emissions from the agricultural sector are emissions from cogeneration facilities, which may also provide electricity to the public grid. Please note that the increased use of internal combustion engines in combined heat power plants operated on natural gas increased the implied emission factor for methane in this sector. These engines are characterised by high methane emission.

In addition, since the autumn of 2005 CO_2 from the hydrogen production plant in a refinery is starting to be used for crop fertilisation in greenhouse horticulture, thereby avoiding some CO_2 emissions otherwise generated by CHP facilities merely for producing CO_2 for horticulture. Total annual amounts, however, will be limited to a few tenths of Tg CO_2. In addition, in 2010, the production and use of biogas from composting of manure in the 'Agriculture/Forestry/Fisheries' category increased from virtually zero to 6 PJ. The CO_2 emissions from off-road machinery in agriculture in 2010 amount to 1.1 Tg, whereas total greenhouse gas emissions from fisheries amount to about 0.6 Tg CO_2 equivalents. CO_2 emissions from fisheries have shown a decreasing trend in recent years. This is caused by a decrease in the number of ships in the Netherlands: between 1990 and 2010 the number of shipping vessels in the Netherlands decreased by 40% according to Statistics Netherlands. The installed engine power on these ships also decreased by almost 40%. Because of the smaller fleet, energy use and related emissions have decreased significantly throughout the time-series. CO_2-emissions from agricultural machinery have fluctuated in recent years. In 2010, the CO_2 emissions from agricultural machinery remained stable compared to 2009.

Methodological issues
In this category liquid and gaseous fossil fuels are key sources of CO_2 emissions (in particular, gaseous fossil fuels, which cover about 93% of the source category 1A4). Emissions from the combustion of gases in the categories 1A4a, 1A4b and 1A4c are identified as key sources, as are the emissions from the combustion of liquids in 1A4c. IPCC (Tier 2 method for CO_2 and CH_4, Tier 1 for N_2O) methodologies are used to calculate greenhouse gas emissions from stationary and mobile combustion in this category. More details on methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie).
The activity data for the 'Residential' sector (1A4b) and from stationary combustion in agriculture (1A4c-i) are compiled using data from separate surveys for these categories. However, due to late availability of the statistics on agricultural fuel use, preliminary data are often used for the most recent year in the national energy statistics. Also, it is likely that trends in agricultural fuel consumption are estimated using indicators that take no account of the varying heating demand due to changes in heating degree days. The fuel consumption data in 1A4a 'Commercial/Institutional Services' is determined by subtracting the energy consumption allocated to the other source categories (1A1, 1A2, 1A3) and other categories (1A4b, 1A4c and 1A5) from the total energy consumption, which means that resulting activity data are the least accurate of all three categories. The emission factors for CO_2 from natural gas and from diesel fuel are based on country-specific data; for the CH_4 emission factors country specific values are also used, which for the residential gas combustion includes start-up losses, a factor mostly neglected by other countries. For other fuels IPCC defaults were used (see Annex 2 and the monitoring protocols on www.nlagency.nl/nie).
Emissions from 'Off-road Machinery and Fisheries' in this category (1A4c-ii) are calculated based on IPCC Tier 2 methodologies. The fuel use data is combined with country-specific emission factors for CO_2 and IPCC default emission factors for N_2O and CH_4. Fuel consumption by 'Fisheries' (1A4c-ii) is included in the Netherlands international bunker statistics, which are part of the national energy statistics. However, since the national energy statistics do not separately account for fisheries, it is not possible to use fuel sales figures from the national energy statistics. Instead, the fuel consumption of diesel oil and heavy fuel oil by fisheries is estimated based on statistics of the number of days at sea ('hp-days') of four types of Dutch fishing vessels. This information is compiled by LEI, and the estimate includes specific fuel consumption per vessel (per day and per unit of power (hp) based on a study of TNO (Hulskotte, 2004b)). This amount is reported as part of category 1A4c and subtracted from the amount of bunker fuel consumption in the national energy statistics. The modified bunker figures are reported as a Memo item. For more details, see the monitoring protocol 12-010 for Fisheries.
Fuel consumption by off-road agricultural machinery is derived from the EMMA model (Hulskotte, 2009). This model is based on sales data for different types of mobile machinery and assumptions on the average use (hours per year) and the fuel consumption (kilograms per hour) for different machine types. It is assumed that only diesel fuel is used by mobile machinery. The use of gasoline and LPG is small and not specifically part of the national energy statistics. Instead, it is part of the total use of gasoline and LPG in the transport sector. An overview of the emission factors used for the most important fuels (up to 95% of the fuel use) in the Other Sectors [1A4] is provided in Table 3.6. Since some emission data is used for individual companies, some of these values represent implied emission factors.

Notes to the implied emission factors:
- The standard CH_4 emission factor for natural gas is 5.7 g/GJ. Only for gas engines, a higher emission factor is used, which explains the higher emission factor for this sector.
- Emission factors for CH_4 and N_2O from gas/diesel oil used in Machinery are based on source specific estimation methods.

More details on emission factors, methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie).

Uncertainties and time-series consistency
It should be noted that the energy consumption data for the total category 1A4 'Other sectors' are much more accurate than the data for the subcategories of 1A4. In particular, energy consumption by the Commercial/Institutional and – to some extent – agricultural categories (in particular the latest year) is monitored less accurately than that by the 'Residential' sector. Trends of emissions and activity data of these categories should be treated with some caution when drawing conclusions. The uncertainty in total CO_2 emissions from this source

Table 3.6 Overview of emission factors used (in 2010) in the Other Sectors [1A4].

		Emission factors (g/GJ)		
Fuel	Amount of fuel used in 2010 (TJ NCV)	CO_2 (x 1000)	N_2O	CH_4
Natural gas	741,087	56.6	0.10	89.34
Gas/Diesel Oil	24,364	74.3	0.60	4.82
Other	31,640	NA	NA	NA

category is about 7%, with an uncertainty of the composite parts of about 5% for the 'Residential' sector, 10% for the 'Agricultural' sector and 20% for the 'Service' sector (see section 1.7 and Annex 1 for more details).

The uncertainty in gas consumption data is estimated at 5% for the 'Residential' sector, 10% for 'Agriculture' and 20% for the 'Commercial' sector. An uncertainty of 20% is assumed for liquid fuel use for 'Off-road Machinery and Fisheries' and in the 'Service' sector. Since the uncertainty in small figures in national statistics is generally larger than with large numbers, as also indicated by the high interannual variability of the data, the uncertainty in solid fuel consumption is estimated to be even higher, at 50%. However, the uncertainty of fuel statistics for the total 'Other sectors' is somewhat smaller than the data for the sectors: consumption per fuel type is defined as the remainder of total national supply after subtraction of the amount used in the 'Energy', 'Industry' and 'Transport' sectors. Subsequently, energy consumption by the residential and agricultural sectors is estimated separately using a trend analysis of sectoral data ('HOME' survey of the 'Residential' sector and LEI data for 'Agriculture').
For natural gas the uncertainty in the CO_2 emission factor is estimated at 0.25% based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier et al. (2009). For the CO_2 emission factors for liquids and solids, uncertainties of 2% and 5% were assigned. The uncertainty in CH_4 and N_2O emission factors is estimated to be much higher (about 50%).

Since most of the fuel consumption in this source category is used for space heating, the gas consumption from the 'Other sectors' varies considerably across years due to variations in winter temperatures over time. For trend analysis a method is used to correct the CO_2 emissions from gas combustion for the varying winter temperatures. This involves the use of the number of heating degree-days under normal climate conditions, which is determined by the long-term trend as explained in Visser (2005).
The deviating IEFs in the 1991–1994 period of CH_4 for liquids and gas and of N_2O for liquids are due to the higher aggregation level used in the revised energy statistics.

Source-specific QA/QC and verification
The trends in CO_2 from the three categories were compared to trends in related activity data: the number of households, number of persons employed in the 'Service' sectors and the area of heated greenhouses. Large annual changes were identified in special trend tables and explanations were sought (e.g., interannual changes in CO_2 emissions by calculating temperature-corrected trends to identify the anthropogenic emission trends). The trend tables for the IEFs were then used to identify large changes and large interannual variations at the category level for which explanations were sought and included in the NIR. More details on the validation of the energy data can be found in the monitoring protocol 12-002: CO_2, CH_4 and N_2O from 'Stationary Combustion: Fossil Fuels'.

Source-specific recalculations
Emissions from charcoal use have been calculated and added as a result of the in-country review of September 2011. Furthermore, a new survey on natural gas use in the agricultural sector led to a revision of the fuel use in agriculture and therefore also in commercial and services. As for these sectors different emission factors for N_2O apply and CH_4 the emissions in these subsectors changed for the years 2002-2009 compared to the latest submission.

Source-specific planned improvements,
There are no source-specific recalculations envisaged.

3.2.10 Other [1A5]

Source category description
Category 1A5 'Others' includes the emissions from military vessels and aircraft (in 1A5b). CO_2 emissions from this source category are approximately 0.4 Tg, with some interannual variation caused by different levels of operations, including fuel use for multilateral operations, which are included here. Emissions of CH_4 and N_2O are negligible.
The emission factors used are presented in Table 3.7.

Methodological issues
A country-specific top-down (Tier 2) method is used for calculating the emissions for fuel combustion from 1A5 'Others'. The fuel combustion emissions in this sector are

Table 3.7 Emission factors used for military marine and aviation activities (g/GJ)[1].

Category		Emission factors (g/GJ) CO_2 (x 1000)	N_2O	CH_4
Military ships	Emission factor	75,250	2.64	1.87
Military aviation	Emission factor	72,900	10	5.8
Total	Emissions in 2010 (Gg)			

[1] Source: Hulskotte, 2004a.

calculated using fuel consumption data for both shipping and aviation that have been obtained from the Ministry of Defence and are the total emissions for domestic military shipping and aviation activities and the so-called multilateral operations. The fuel data for aviation consist of a mixture of jet kerosene, F65 and SFC. In the national energy statistics these activity data are included in the bunker fuel consumption. The sector-specific emission factors that are used are those reported by the Ministry of Defence. The methodology and data sources for the calculation of these emissions can be found on the website www.nlagency.nl/nie.

Uncertainties and time-series consistency
The uncertainty in CO_2 emissions from fuel combustion from 1A5 'Others' is estimated to be about 20% in annual emissions. The uncertainty for CH_4 and N_2O emissions is estimated to be about 100%. The accuracy of fuel consumption data is tentatively estimated at 20%. For emission factors, the uncertainties were estimated at 2% for CO_2 and 100% for CH_4 and N_2O.
A consistent methodology is used throughout the time-series. The time-series consistency of the activity data is good due to the continuity in the data provided.

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

Source-specific recalculations
New fuel consumption data have been obtained from the Ministry of Defence for the 2007-2009 time period. An internal audit by the ministry revealed that fuel consumption had previously been underestimated in 2007 and 2009 and overestimated in 2008. The new data show a more consistent time-series between 2005 and 2010. The emission estimates for 2007 and 2009 have increased by 43 and 54 Gg CO_2 equivalents, whereas the new emission estimates for 2008 decreased by 40 Gg CO_2 equivalents.

Source-specific planned improvements
In 2012 a research project must show if the fuel sales figures for military aviation (that will then be reported by Statistics Netherlands) can be used to calculate emissions from military aviation, see also section 3.2.8.6.

3.3 Fugitive emissions from fuels [1B]

This source category includes fuel-related emissions from non-combustion activities in the energy production and transformation industries:
1B1 'Solid Fuels' (coke manufacture)
1B2 'Oil and Gas' (production, gas processing, hydrogen plant, refineries, transport, distribution).

The contribution of emissions from source category 1B to the total national greenhouse gas emissions inventory was 1.3% in 1990 and 1.3% in 2010. Table 3.1 shows that total greenhouse gas emissions in 1B decreased from 2.9 Tg to 2.7 Tg between 1990 and 2010.

3.3.1 Solid fuels [1B1]

Source category description
Fugitive emissions from this category refer mainly to CO_2 from 1B1b 'Coke Manufacture' (see Table 3.1). The Netherlands currently has only one on-site coke production facility at the iron and steel plant of Tata Steel. A second independent coke producer in Sluiskil discontinued its activities in 1999. The fugitive emissions of CO_2 and CH_4 from both coke production sites are included here. There are no fugitive emissions from coal mining and handling activities (1B1a) in the Netherlands; these activities ceased with the closing of the last coal mine in the early 1970s.
With respect to fugitive emissions from 'Charcoal Production', the Netherlands had until 2009 one large state-of-the-art production location that serves most of the Netherlands and also occupies a large share of the market of our neighbouring countries. The production at this location stopped in 2010. Until recently these emissions were not accounted for because no activity data were available on a regular basis. In 3.3.1.5 'Recalculations as result of the 2011 in-country review' the recalculation method of the emission time-series of the production of charcoal is given.
Table 3.1 shows that the CO_2 emissions in 1B1 remained rather stable between 1990 and 2009. In 2010 the emissions doubled, compared to 2009.

Methodological issues
The CO_2 emissions related to transformation losses (1B1) from coke ovens are based on national energy statistics of

coal inputs and coke and coke oven gas produced and a carbon balance of the losses. The completeness of the accounting in the energy statistics of the coke oven gas produced is not an issue, since the not-captured gas is by definition included in the net carbon loss calculation used for the process emissions. Detailed information on activity data and emission factors can be found in the monitoring protocols on the website www.nlagency.nl/nie.

Uncertainties and time-series consistency
For emissions from 'Coke Production' (included in 1B1b) the uncertainty in annual CO_2 emissions from this source category is estimated to be about 50%. This uncertainty refers to the precision with which the mass balance calculation of carbon losses in the conversion from coking coal to coke and coke oven gas can be made (for details, see Olivier et al., 2009).
The methodology used to estimate emissions from solid fuel transformation is consistent throughout the time-series.

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

Source-specific recalculations

Recalculations as result of the 2011 in-country review
As a result of the in-country review of September 2011, the emissions from the integrated **iron and steel** company have been reassessed and a mass balance has been made available to the review team. As a result of this, minor corrections have been performed. For the years 2005 to 2009 the correction for the process emission from limestone use and the steelmaking process was kept constant at 300 kton CO_2 in the calculation of the other emissions. In the recalculation the correct correction terms were used (as reported in 2C11 and 2C151) resulting in changed figures for the carbon loss as reported in 2C152 and the emissions from coke production in 1B1b. Furthermore, the emission factor for blast furnace gas appeared to be too low for the years 2005, 2006 and 2009 (category 1A2). The mass balance will not be included in the National Inventory Report (due to confidentiality) but can be made available for the UNFCCC review.

Based on newly available information, an emission time-series for the CH_4 emission of the **production from charcoal** is presented. The following emission factors have been used:
- 1990-1997: 0.03 kg CH_4/kg charcoal (IPCC 1996 Guidelines)
- 1998-2010: 0.0000111 kg CH_4/kg charcoal (Reumermann,P.J. Frederiks, B., proceedings 12th European conference on Biomass for Energy, Industry and Climate protection, Amsterdam, 2002).

The lower EF for 1998-2010 has been used because the operator changed from traditional production to the Twin retort system (Charcoal production with reduced emissions). Activity data based on the production data of charcoal have become available in 'IEA Renewable Information 2011'. The emission is added to CRF category 1B1b.

The above-mentioned recalculations were included in the latest official CRF submission from November 2011 and therefore, do not show up in the recalculation sheet of the current CRF.

Other recalculations
Apart from the recalculations as result of the 2011 in-country review, there have been no source-specific recalculations in comparison to the previous submission.

Source-specific planned improvements
No source-specific improvements planned.

3.3.2 Oil and Natural Gas [1B2]

Source category description
The fugitive emissions from category 1B2 comprise:
- non-fuel combustion emissions from flaring and venting (CO_2, CH_4)
- emissions from oil and gas production (CO_2, CH_4);
- emissions from oil and gas transport (compressor stations) (CO_2, CH_4)
- gas distribution networks (pipelines for local transport) (CO_2, CH_4)
- oil refining (CH_4)
- hydrogen plant (CO_2).

The fugitive CO_2 emissions from refineries are included in the combustion emissions reported in category 1A1b. In addition, the combustion emissions from exploration and production are reported under 1A1c.
From the 2007 submission the Process emissions of CO_2 from a hydrogen plant of a refinery (about 0.9 Tg CO_2 per year) are reported in this category. Refinery data specifying these fugitive CO_2 emissions are available from 2002 onwards (environmental report from the plant) and re-allocated from 1A1b to 1B2a-iv for 2002 onwards. CO_2 from gas flaring (including the venting of gas with high carbon dioxide content) and methane from gas venting/flaring are identified as key sources (see Table 3.1).
Gas production, of which about 50% is exported and gas transmission vary according to demand - in cold winters, more gas is produced – which explains the peak in 1996. The length of the gas distribution network is still gradually expanding as new neighbourhoods are being built; mostly using PVC and PE, which are also used to replace cast iron pipelines (see Table 3.44 in NIR 2005). The IEF for gas

distribution gradually decreases as the share of grey cast iron pipelines decreases due to gradual replacement and expansion of the network. The present share is about 5%; in 1990 this was still 11%.
There is very little oil production in the Netherlands. The emission factors of CO_2 and CH_4 from oil and gas production, in particular for venting and flaring, have been reduced significantly and are now about 25% of the 1990 level. This is due to the implementation of environmental measures to reduce venting and flaring by optimising the utilisation of energy purposes of produced gas that was formerly wasted.
The CO_2 emissions from the hydrogen plant remained rather stable between 2002 and 2010. The emissions from oil and gas transport and gas distribution networks remained rather stable between 1990 and 2010.

Methodological issues
Country-specific methods comparable with the IPCC Tier 3 method are used to estimate the emission of fugitive CH_4 and CO_2 emissions from 'Oil and Gas Production and Processing' (1B2) (Grontmij, 2000). The emissions for CH_4 from gas venting and flaring are plant-specific.
The IPCC Tier 3 method for CH_4 from 'Gas Distribution' due to leakages (1B2) is based on two country-specific emission factors: 610 m3 (437 Gg) methane per km of pipeline for grey cast iron, and 120 m3 (86 Gg) per km of pipeline for other materials. The emission factors are based on seven measurements of leakage per hour on grey cast iron at one pressure level and on 18 measurements at three pressure levels for other materials (PVC, steel, nodular cast iron and PE) and subsequently aggregated to factors for the material mix in 2004. From 2004 onwards, the gas distribution sector annually records the number of leaks found per material, and any future possible trends in the emission factors are derived from these data. Fugitive emissions of methane from refineries in category 1B2 are based on a 4% share in total VOC emissions reported in the annual environmental reports of the Dutch companies (Spakman et al., 2003). For more information, see the monitoring protocols available on www.nlagency.nl/nie.

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

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

Source-specific recalculations

Recalculations as result of the 2011 in-country review
Gas transmission
Total emissions of both CO_2 and methane (CH_4) due to the transport of natural gas are taken from the V,G&M (safety, health and environment) annual reports submitted by the NV Nederlandse Gasunie. These emissions are not split into process and combustion emissions but because the CO_2 emissions are primarily combustion emissions, these were reported under IPCC category 1A1c. After thoroughly going through the V,G&M annual reports it cannot be said with absolute certainty that fugitive emissions during the transportation of natural gas are part of the total CO_2 emissions of the NV Nederlandse Gasunie. As from the resubmission of November 2011, the Netherlands has accounted for fugitive emissions of gas transmission using the total transmission pipeline length and default IPCC CO_2 emission factor. The default IPCC emission factor is taken from the IPCC Good Practice guidelines Table 2.16 page 2.86. The transmission pipeline length is taken from the publication Transport insight 2009 of Gas Transport Services B.V. (separate company for the transport services of Gasunie). The emission of 0.184 Gg CO_2-eq is added to CRF category 1B2b3 for the whole time-series.

The above-mentioned recalculations were included in the latest official CRF submission from November 2011 and therefore, do not show up in the recalculation sheet of the current CRF.

Other recalculations
Apart from the recalculations as result of the 2011 in-country review, there have been no source-specific recalculations in comparison to the previous submission.

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

4 Industrial processes [CRF Sector 2]

Major changes in the sector Industrial Processes compared to the National Inventory Report 2011

Emissions:	In 2011 the NIR2010 was reviewed by an UNFCCC Expert Review Team (ERT). On the ERT's recommendation the Netherlands has added the CO_2 process emission from anode use during the steel production in the electric arc furnace (EAF). Furthermore, the following recalculations have been made: - CO_2 emissions from Metal production - Iron and steel production (2C1) - CO_2 emissions from Metal production - Aluminium production (2C3) Mainly caused by the economic recovery, the total greenhouse gas emissions in this sector increased by 5% in 2010 compared to 2009. Because several new sources of information became available, the HFC emissions of Stationary refrigeration and Mobile air-conditioning and the SF_6 emissions from Electrical equipment and Electron microscopes have been changed for a number of years.
Key sources:	No changes in key sources in this sector.
Methodologies:	There have been no methodological changes in this sector.

Table 4.1 Aggregated estimate of the potential emissions (Units: Gg CO_2 eq)

Fuel	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Refrigeration and air conditioning:																	
HFC-134a (Included Mobile air-conditioning)	230	283	421	441	330	402	367	473	436	538	486	666	737	752	804	799	1,035
HFC-125	0	140	286	274	333	543	650	750	671	814	741	749	792	891	923	764	1,105
HFC-143a	0	129	315	350	456	642	821	825	830	975	918	899	934	1,060	1,097	1,039	962
HFC-32	0	15	36	30	32	12	54	21	19	25	24	28	32	35	36	34	42
Unspecified HFCs	0	0	0	0	0	0	8	29	53	78	102	126	148	170	191	208	215
Other sources:																	
Unspecified HFCs	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
PFC use	C	C	C	C	C	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	C	C	C	C	C

4.1 Overview of sector

Emissions of greenhouse gases in this sector include all non-energy-related emissions from industrial activities (including construction) and all emissions from the use of the F-gases HFCs, PFCs and SF_6 (including their use in other sectors). Please note that due to the specific Dutch estimation methods and absence of required activity data, only the actual emissions of F-gases can be estimated in detail. The potential emissions cannot be calculated in the detail that is required in the CRF. Therefore, it has been decided to report all the potential emissions as 'NE' in the CRF. In Table 4.1 the correct aggregated estimates of the potential emissions from refrigeration and air conditioning (the main source of F-gases) are given. In comparison with the last submission, several corrections have been made.

Greenhouse gas emissions from fuel combustion in industrial activities are included in the Energy sector. Fugitive emissions of greenhouse gases in the Energy sector (not relating to fuel combustion) are included in IPCC category 1B Fugitive emissions. The main categories (2A–G) in the CRF sector 2 Industrial processes are discussed in the following sections.

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

- Protocol 12-003: CO_2, CH_4 and N_2O from Process emissions: fossil fuels;
- Protocol 12-014: CO_2, CH_4 and N_2O from Process emissions and product use;
- Protocol 12-015: N_2O from Nitric acid production (2B2);
- Protocol 12-016: N_2O from Caprolactam production (2B5);
- Protocol 12-017: PFCs from Aluminium production (2C3);
- Protocol 12-018: HFC-23 from HCFC-22 production (2E1);
- Protocol 12-019: HFCs from Handling (2E3);
- Protocol 12-020: HFCs from Stationary refrigeration (2F1);
- Protocol 12-021: HFCs from Mobile air conditioning (2F1);
- Protocol 12-022: HFCs from Other Use (2F2 - 2F5);
- Protocol 12-024: SF_6 from Other Use (2F9);
- Protocol 12-025: SF_6 and PFCs from Semiconductor manufacturing (2F7);
- Protocol 12-026: SF_6 from Electrical equipment (2F8).

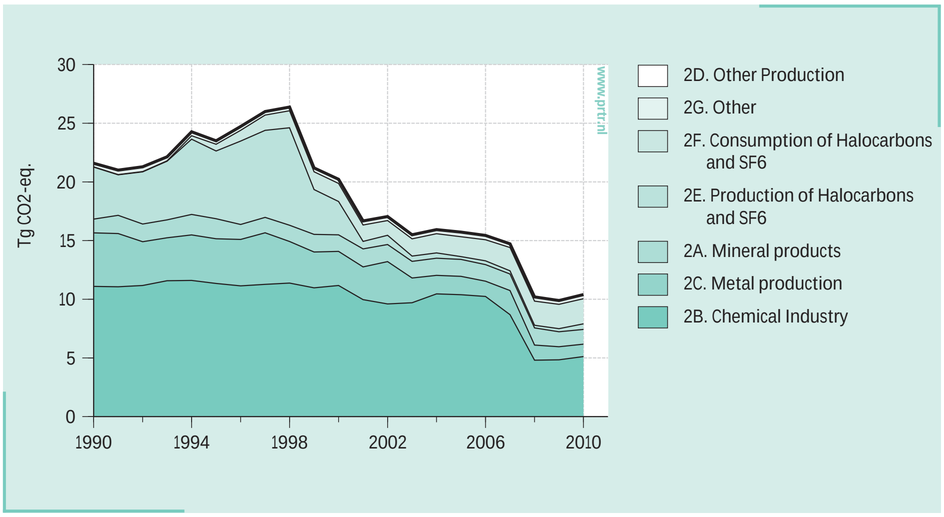
Key sources

The key sources in this sector are presented in Table 4.2. Annex 1 presents all sources identified in the Industrial processes sector in the Netherlands. Nitric acid production is a Tier 1 trend key source, due to the reduction achieved in this category. Other key sources are CO_2 emissions from ammonia production, iron and steel production and the manufacture of other chemical products.
PFC from aluminium production and HFC-22 manufacture are Tier 1 trend key sources for F gases and Consumption of Halocarbons and SF_6 is a Tier 1 level and trend key source for HFC.

Overview of shares and trends in emissions

Figure 4.1 and Table 4.2 show the trends in total greenhouse gas emissions from the sector Industrial processes.
In 2010, Industrial processes contributed 5% to the total national greenhouse gas emissions (without LULUCF) in comparison to 11% in the base year. The sector is a major source of N_2O emissions in the Netherlands, accounting for 11% of the national total N_2O emissions.

Figure 4.1 Sector 2 'Industrial processes': trend and emission levels of source categories, 1990 - 2010.



Compared to the base year, total CO_2 equivalent greenhouse gas emissions of the sector declined by 13.1 Tg to 10.4 Tg CO_2 eq in 2010 (–56%). CO_2 emissions from Industrial processes decreased 18% during the period from 1990–2010. N_2O emissions decreased 90% in the same period. Total emissions of fluorinated gases (F-gases) have been strongly reduced.

In 2010, total greenhouse gas emissions of the sector remained almost at the same level as in 2009 (9.9 Tg CO_2 eq in 2009 versus 10.4 Tg CO_2 eq in 2010). CO_2 emissions increased by 0.3 Tg, HFC emissions showed an increase of 0.27 Tg CO_2 eq and PFC emissions increased by 0.04 Tg CO_2 eq, while N_2O and SF_6 emissions remained at the same level as the previous year.

Category 2B Chemical industry contributes most to emissions from this sector. Compared to the base year, total CO_2 equivalent greenhouse gas emissions of this category declined by 6.0 Tg to 5.1 Tg CO_2 eq in 2010 (–54%).

4.2 Mineral products [2A]

4.2.1 Source category description

General description of the source categories
This category comprises emissions of greenhouse gases related to the production and use of non-metallic minerals in:
- 2A1 Cement clinker production: CO_2 emissions;
- 2A3 Limestone and dolomite use: CO_2 emissions;
- 2A4 Soda ash production and use: CO_2 emissions;
- 2A7 Other (the production of glass and other production and use of minerals): CO_2 emissions.

The CO_2 emission from 2A2, Lime production, is included elsewhere (IE). The production is known to occur only in four plants of the sugar industry and it is not possible to separate the emissions from lime production from other emissions. Therefore, those emissions are accounted for as part of the food and drink category (2D). Lime production in the paper industry does not occur in the Netherlands. CO_2 emissions from 2A5 Asphalt roofing and 2A6 Road paving with asphalt are not estimated.

4.2.2 Key sources

There are no key sources identified from this source category.

4.2.3 Overview of shares and trends in emissions

Total CO_2 emissions in category 2A increased from 1.17 Tg in 1990 to 1.25 Tg in 2010 (see Table 4.2). Total CO_2 emissions in category 2A remained at the same level as the previous year (1.27 Tg in 2009 and 1.25 Tg in 2010), because the economic recovery in the Iron and steel production was raised by the economic crisis in the construction industry.

4.2.4 Activity data and (implied) emission factors

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

Table 4.2 Contribution of the main categories and key sources in CRF sector 2 Industry.

Sector/category	Gas	Key	Emissions base-year	2009	2010	Absolute 2010 - 2009	Contribution to total in 2010 (%)		
			Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq		by sector	of total gas	of total CO_2 eq
2 Industry	CO_2		7.9	6.2	6.5	0.3		4	3.1
	CH_4		0.3	0.3	0.3	0.00		2	0.1
	N_2O		7.1	1.1	1.0	0.00		11	0.5
	HFC		6.0	2.0	2.3	0.2		100	1.1
	PFC		1.9	0.2	0.2	0.04		100	0.1
	SF_6		0.3	0.2	0.2	0.00		100	0.1
	All		23.5	9.9	10.4	0.5			5.0
2A Mineral Products	CO_2		1.2	1.3	1.3	-0.02	12	0.7	0.6
2B Chemical industry	CO_2		3.7	3.5	3.9	0.4	37	2.1	1.8
	N_2O		7.1	1.1	1.0	0.00	9	10	0.5
	All		11.1	4.8	5.1	0.3	49	2	2.4
2B1 Emissions from ammonia production	CO_2	L1	3.1	2.9	3.2	0.3	30	2	1.5
2B2 Emissions from nitric acid production	N_2O	T	6.3	0.5	0.3	0.00	3	3	0.1
2B5 Emissions from caprolactam production	N_2O	L	0.8	0.6	0.7	0.00	7	7	0.3
2B5 Other chemical product manufacture	CO_2	L	0.6	0.7	0.7	0.1	7	0.4	0.3
2C Metal Production	CO_2		2.7	1.1	1.0	-0.1	10		0.5
	PFC		1.9	0.04	0.1	0.01	0.6	28	0.03
	All		1.4	1.1	1.1	-0.1	10		0.5
2C1 Iron and steel production (carbon inputs)	CO_2	L1,T1	2.3	0.8	0.7	-0.1	7	0.4	0.3
2C3 PFC emissions from aluminium production	PFC	T	1.9	0.04	0.1	0.01	1	28	0.03
2D Other Production	CO_2		0.1	0.03	0.03	0.00	0.3	0.02	0.01
2E Production of halocarbons and SF_6	HFC		5.8	0.3	0.5	0.2	5	21	0.2
2E1 HFC-23 emissions from HCFC-22 manufacture	HFC	T	5.8	0.2	0.4	0.2	4	17	0.2
2F Consumption of Halocarbons and SF6	HFC	L1,T1	0.2	1.8	1.8	0.03	17	79	0.9
	PFC		0.04	0.1	0.2	0.03	1	72	0.1
	SF_6		0.3	0.2	0.2	0.00	2	100	0.1
	All		0.6	2.1	2.1	0.1	20		1.0
2G Other	CO_2		0.2	0.3	0.3	0.03	3	0.2	0.1
	N_2O		0.00	0.01	0.01	0.00	0.1	0.1	0.01
	All			0.3	0.3	0.03	3	0.2	0.2
Total National emissions	CO_2		159.2	169.9	181.2	11.7			
	CH_4		25.7	17.1	16.8	-0.3			
	N_2O		20.2	9.6	9.4	-0.2			
	HFCs		6.0	2.0	2.3	0.2			
	PFCs		1.9	0.2	0.2	0.04			
	SF_6		0.3	0.2	0.2	0.01			
National Total GHG emissions (excl. CO_2 LULUCF)	All		213.3	198.9	210.1	11.5			

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

Activity data are based on the following sources:

- Cement clinker production: the environmental reports (AER) of the single Dutch company are used.
- Limestone and dolomite use: environmental reports are used for emission data. Activity data on plaster production for use in desulphurising installations for power plants are based on the environmental reports of the coal-fired power plants. To calculate the CO_2 emissions from the limestone use in Iron and steel production the amount of limestone reported in the annual environmental reports of Tata Steel (Corus) are used. Data on the consumption of limestone and dolomite are based on statistical information obtained from Statistics Netherlands (CBS) and can be found on the website www.cbs.nl.
- Soda ash production and use: the environmental reports for data on the non-energy use of coke are used. For activity data on soda use, see the following bullet, Glass production.
- Glass production: activity data are based on data from Statistics Netherlands (CBS) and the trade organisation.

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

- Cement clinker production: because of changes in raw material composition it is not possible to estimate reliable CO_2 process emissions by calculating the clinker production (as AD) by a default EF. For that reason the company has chosen to base the calculation of CO_2 emissions on the carbonate content of the process input. For more information, see section 4.2.5
- Limestone use: EF= 0.440 t/t (IPCC default)
- Dolomite use: EF= 0.477 t/t (IPCC default)
- Soda ash production: EF= 0.415 t/t (IPCC default)
- Glass production: Plant-specific EFs have been used for the years 1990 (0.13 t CO_2/t glass), 1995 (0.15 t CO_2/t glass) and 1997 (0.18 t CO_2/t glass). For other years in the time-series, there were not enough data available to calculate plant-specific EFs. For the missing years 1991-1994 and 1996, EFs have been estimated by interpolation. Because no further measurement data are available, the emission factor for 1998–2010 is kept at the same level as the EF of 1997 (0.18 t CO_2/t glass).

4.2.5 Methodological issues

For all the source categories, country-specific methodologies are used to estimate emissions of CO_2, in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and emission factors are found in Protocols 12-003 and 12-014 on www.nlagency.nl/nie, as indicated in section 4.1.

- 2A1 Cement clinker production: the CO_2 process emissions from this source category are from 2002 based on (measured) data reported by the single company in the Netherlands that produces clinkers. The methodology for measurements and for calculating emissions can be described as follows:
  The first carbonate input in the kiln is the raw material. The CO_2 emission is calculated on a monthly basis by multiplying the amount of raw material by a derived process EF. From every batch in a month a sample is taken just before the raw material is fed into the kiln. The process EFs and composition data for batches of raw material are determined in a laboratory. The EF is determined by measuring the weight loss of the sample (excluding the amount of organic carbon). The monthly EF is set as the average of all sample EFs determined that month. The second carbonate input in the kiln is sewage sludge. The CO_2 emission from this source is also calculated monthly by multiplying the amount of sewage sludge by the monthly derived process EF. Besides the CO_2 emissions resulting from calcination of the carbonate input in the kiln, the company considers the CO_2 emission from burning off the small amount of organic carbon in the raw material as a process emission. As a result, the total yearly process emissions of the company are the sum of all monthly emissions of the following sources:

A. CO_2 from the calcination of the carbonate input of the raw material, marl;
B. CO_2 from the calcination of the carbonate input of sewage sludge;
C. CO_2 from the burning of organic carbon in the raw material.

Before 2002 only total CO_2 emissions from the annual environmental report are available. Because no detailed information is available for that period, it is not possible to split the total CO_2 emissions. Therefore, for that period, the CO_2 process emissions have been calculated by multiplying the average IEF of 2002 and 2003 by the clinker production. CO_2 process emissions from the environmental report related to clinker production figures give the implied CO_2 emission factor (IEF) for clinker production. Table 4.3 shows the trend in the implied CO_2 emission factor (IEF) for clinker production during the period 2002–2010 (IPCC Default = 0.51 t/t clinker).

Table 4.3 Implied emission factor for CO_2 from clinker production (Units: t/t clinker) (2A1).

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010
CO_2	0.54	0.54	0.54	0.52	0.51	0.48	0.48	0.52	0.50

There is a monitoring protocol applied for emissions trading (this protocol is approved by the Netherlands Emission authority (NEa); the Government organisation responsible for emissions trading (ETS) in the Netherlands). This organisation is also responsible for the verification of the reported data from the company that produces clinkers.

- 2A3 Limestone and dolomite use: the CO_2 emissions from this source category are based on consumption figures for limestone use for flue gas desulphurisation (FGD) with coal-fired power plants and in Iron- and steel production and for apparent dolomite consumption (mostly used for road construction).
  Compared to the last submission, the allocation of Limestone use in the Iron- and steel production has been moved from 2C1 to 2A3.
  From 2000 onwards, data reported in the annual environmental reports of Tata Steel (Corus) are used to calculate the CO_2 emissions from the limestone use. For the period 1990–2000 the CO_2 emissions were calculated by multiplying the average IEF (107.9 kg CO_2 per ton of crude steel produced) over the 2000–2003 period by the crude steel production. CO_2 from limestone use = limestone use * ZF(limestone) * $EF_{limestone}$
  No activity data are available to estimate other sources of limestone and dolomite use.
- 2A4 Soda ash production and use: only one company in the Netherlands is producing soda ash using the Solvay process. CO_2 emissions are calculated based on the non-energy use of coke, assuming the 100% oxidation of carbon.
- 2A7 Other: CO_2 emissions from this source category refer to Glass production. Emissions are estimated based on gross glass production data and country-specific emission factors.

4.2.6 Uncertainties and time-series consistency

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

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

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

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

4.2.7 Source-specific QA/QC and verification

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

4.2.8 Source-specific recalculations

Recalculations as result of the 2011 in-country review
The allocation of Limestone use in Iron- and steel production has been moved from 2C1 to 2A3, limestone and dolomite use.
The above-mentioned recalculations were included in the latest official CRF submission from November 2011 and therefore, do not show up in the recalculation sheet of the current CRF.

Other recalculations
No recalculations have been made.

4.2.9 Source-specific planned improvements

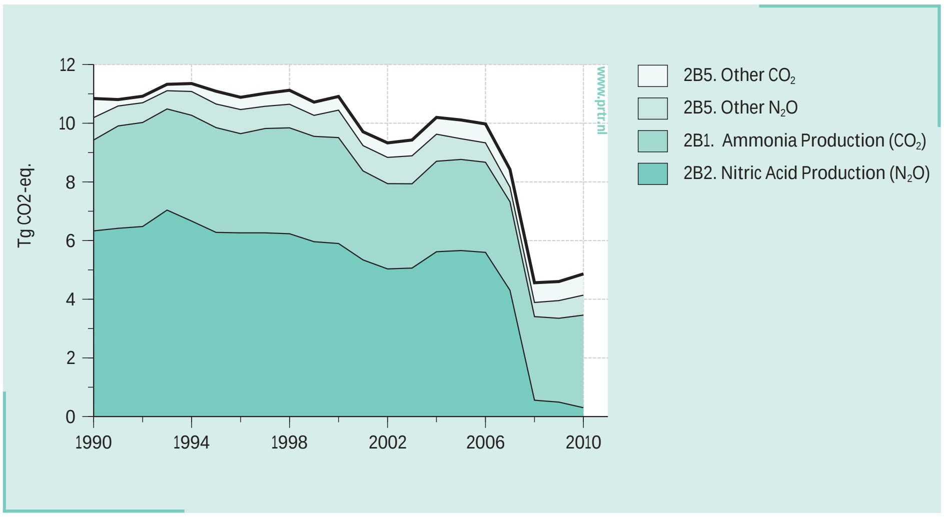
The statistical information on sales (value) of asphalt roofing and asphalt for road paving was stopped in 2002. Therefore, it is not possible to calculate CO_2 emissions from these sources at this moment. In the coming years, the Netherlands will try to obtain/collect this information from new sources (branch organisations).

4.3 Chemical industry [2B]

4.3.1 Source category description

The national inventory of the Netherlands comprises emissions of greenhouse gases related to four source categories as belonging to this category:
- 2B1 Ammonia production: CO_2 emissions: in the Netherlands, natural gas is used as feedstock for ammonia production. CO_2 is produced as a by-product during the chemical separation of hydrogen from the natural gas. During the process of ammonia (NH_3)

Figure 4.2 2B 'Chemical industry': trend and emission levels of source categories, 1990-2010.



production, hydrogen and nitrogen are combined to react together to manufacture ammonia. Only prompt process emissions from the ammonia/urea production are included in this source category.

- 2B2 Nitric acid production: N_2O emissions: the production of nitric acid (HNO_3) generates nitrous oxide (N_2O) as a by-product of the high-temperature catalytic oxidation of ammonia. Until 2010 three companies, each with two HNO_3 production plants, were responsible for the N_2O emissions from nitric acid production in the Netherlands. Two plants of one company were closed in 2010 and one of these has been moved to one of the other companies. So, at this moment (2010) two companies, one with three and one with two HNO_3 production plants are responsible for the N_2O emissions from nitric acid production in the Netherlands.
- 2B4 Carbide production: CH_4 emissions: petrol cokes are used during the production of silicon carbide; the volatile compounds in the petrol cokes form CH_4.
- 2B5 CO_2 and N_2O emissions from Other chemical product manufacture:
  - o Industrial gas production: hydrogen and carbon monoxide are produced mainly from natural gas used as chemical feedstock but they can also be produced from petroleum coke and coke, during which processes CO_2 is produced.
  - o Carbon electrode production: carbon electrodes are produced from petroleum coke and coke used as feedstock, during which processed CO_2 is produced.
  - o Activated carbon production: Norit is one of world's largest manufacturers of activated carbon, for which peat is used as a carbon source and CO_2 is produced as a by-product.
  - o Caprolactam production: N_2O emissions result from the production of caprolactam.
  - o Ethylene oxide production: CO_2 emissions result from the production of ethylene oxide.

Adapic acid (2B3) and calcium carbide (included in 2B4) are not produced in the Netherlands. CO_2 emissions resulting from the use of fossil fuels as feedstocks for the production of silicon carbide, carbon black, ethylene and methanol are included in the Energy sector (1A1a and 1A2c; see sections 3.2.7.2. and 4.3.1. for more details).

4.3.2 Key sources

'Ammonia production' and 'Other chemical product manufacture' are identified as key-sources for CO_2 emissions, while 'Caprolactam production' is identified as a key-source for N_2O emissions. Since 2008 Nitric acid production is no longer a Tier 2 level key source for N_2O emissions. Due to the emission reduction in 2007 and 2008, it is devalued to a trend key source (see Table 4.2).

4.3.3 Overview of shares and trends in emissions

Figure 4.2 shows the trend in CO_2 equivalent emissions from 2B 'Chemical industry' in the period from 1990–2010. Table 4.2 gives an overview of shares in emissions of the main categories.

Emissions from this category contributed 5% to the total national greenhouse gas emissions (without LULUCF) in the base year and 2% in 2010. Caprolactam and Nitric acid production are the most important sources of N_2O emissions from industrial processes in the Netherlands.

Table 4.4 Trend in N_2O emissions from Chemical industry processes (2B) (Units: Gg CO_2 eq).

Gas	1990	1995	2000	2005	2006	2007	2008	2009	2010
B2 Nitric acid production	6,330	6,278	5,898	5,659	5,597	4,305	558	493	301
B5 Other	766	805	936	705	662	497	481	603	681
Total	7,096	7,083	6,834	6,364	6,259	4,802	1,039	1,096	982

The contribution of N_2O emissions from 2B 'Chemical industry' was 3% of the total national greenhouse gas emission inventory in the base year and 0.5% in 2010.

From 1990 to 2008, total greenhouse gas emissions in 2B 'Chemical industry' decreased by 54% or 6.0 Tg CO_2 eq, mainly due to the reduction of N_2O emissions from the production of nitric acid. In 2009 and 2010, total greenhouse gas emissions in 2B 'Chemical industry' remained at almost the same level as in 2008.

Table 4.4 shows that N_2O emissions from the chemical industry remained rather stable between 1990 and 2000 (when there was no policy aimed at controlling these emissions).

2B2 Nitric acid production

Until 2002, N_2O emissions from nitric acid production were based on default IPCC emission factors. N_2O emission measurements made in 1998 and 1999 have resulted in a new emission factor of 7.4 kg N_2O/ton nitric acid for the total nitric acid production. Plant specific emission factors for the period from 1990-1998 are not available. Because no measures have been taken and the operational conditions did not change during the period 1990-1998, the emission factors obtained from the measurements have been used to recalculate the emissions for the period 1990-1998. Technical measures (optimising the platinum-based catalytic convertor alloys) implemented at one of the nitric acid plants in 2001 resulted in an emission reduction of 9% compared to 2000. The decreased emission level in 2002 compared to 2001 is related to the decreased production level of nitric acid in that year. In 2003, emissions and production did not fluctuate, whereas in 2004 the increased emission level is once again related to the marked increase in production. In 2005 and 2006, the N_2O emissions of the nitric acid plants remained almost at the same level as in 2004.

Technical measures implemented at all nitric acid plants in the third quarter of 2007 resulted in an emission reduction of 23% compared to 2006. In 2008, the full effect – a reduction of 90% compared to 2006 – of the measures is reflected in the low emission. The reduction in 2009 is mainly caused by the economic crisis. Because of the closure of one of the plants and the improved catalytic effect in one of the plants, the emissions decreased in 2010.

Table 4.5 gives an overview with detailed information per plant that explains the significant reduction of the N_2O emissions from nitric acid production in 2007 and 2008.

From 2008 onwards, the N_2O emissions of HNO_3 production in the Netherlands were opted in in the European emission trading scheme (EU-ETS). For this purpose the companies developed monitoring plans that were approved by the Dutch Emissions authority (NEa), the government organisation responsible for EU-ETS in the Netherlands. In 2011 the companies again sent their verified emission reports (2010 emissions) to the NEa.

The reported and verified (by an independent verifier) emissions (2010) by the companies to NEa were checked against those as reported in the CRF tables (2010). No differences were found between the emission figures in the CRF and the verified emissions in the emission reports under EU-ETS.

2B5 Caprolactam production

After 2002, more accurate measurements were performed to estimate N_2O emissions from caprolactam production (2B5). From the 2003 and 2004 measurements and the production-indices (real production data are confidential business information) of 2003 and 2004 an average IEF has been derived. For the period 1990-2002 calculations are based on the production-indices for the 1990-2002 period and the average IEF.

The emission fluctuations during the period 2003-2010 are mainly caused by the uncertainty of the measurements within the plant. Annual emissions are actually based on only a few emission measurements per point per year.

4.3.4 Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in monitoring protocols 12-003, 12-014, 12-015 and 12-016 on the website www.nlagency.nl/nie. Activity data are based on the following sources:

- Ammonia production: activity data on use of natural gas are obtained from Statistics Netherlands (CBS). Although ammonia and urea production data are considered confidential, international statistics such as UN, IFA and USGS do report production data for the Netherlands.

Table 4.5 Overview with detailed information per nitric acid plant.

Plant	1	2	3	4	5	6
Type of production technology	Mono pressure (3.5 bar)	Dual pressure (4/10 bar)	Mono pressure (3.5 bar)	Dual pressure (4/10 bar)	Dual pressure (4-6/10-12 bar)	Dual pressure (4-6/10-12 bar)
Abatement technology implemented	Catalyst, which breaks down N_2O, in existing NH_3 reactors, just below the platinum catalyst system	EnviNO$_x$ [1)] process variant 1 system from UHDE (tertiary technique	Idem 1	Idem 2	Catalyst (pellets) technology which breaks down N_2O in the first stage of nitric acid production when ammonia is burned	Idem 5
Time of installation	Oct. 2007	Dec. 2007	Oct. 2007	Dec. 2007	Nov. 2007	May. 2007
N_2O Emission in tons						
2006:	1,269	1,273	770	4,015	4,527	5,888
2007:	1,190	1,026	631	3,275	4,448	3,311
2008:	415	0.05	143	2.26	318	921
2009:	387	3.4	107	40	310	741
2010:	0	1.4	139	44	352	436
Abatement efficiency 2007 – 2008 [2)]	80.40 %	99.94 %	69.68 %	99.997 %	92.84 %	84.80 %

1) Besides in 2 Dutch plants 'EnviNOx process variant 1 systems' are also in operation with similar, very high N_2O abatement rates (99% and above) in other nitric acid plants (for example, in Austria).

2) The abatement efficiency concerns IEFs. Because the IEFs are confidential, they are not included in this table.

- Nitric acid production: activity data are confidential. Emissions are reported by the companies.
- Carbide production: silicon carbide production figures are derived from the Environmental Report (MJV) of the relevant company.
- Other: activity data on caprolactam production are confidential. Only emissions are reported by the companies. This year a production-index series over the period 1990-2010 was received from the company. For ethylene oxide production only capacity data are available; therefore, a default capacity utilisation rate of 86% is used to estimate CO_2 emissions (based on Neelis et al., 2005). Activity data for estimating CO_2 emissions are based on data for feedstock use of fuels provided by Statistics Netherlands (CBS).

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

4.3.5 Methodological issues

For all the source categories of the chemical industry, the methodologies used to estimate the greenhouse gas emissions are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). Country-specific methodologies are used for the CO_2 process emissions from the chemical industry. More detailed descriptions of the methods used and emission factors can be found in the protocols (12-002, 12-014, 12-015 and 12-016) described on the website www.nlagency.nl/nie, as indicated in section 4.1:
- 2B1 Ammonia production: a method equivalent to IPCC Tier 1b; the amount of natural gas used as feedstock and a country-specific emission factor are used to estimate CO_2 emissions. This emission factor is based on the assumption that the fraction of carbon in the gas-feedstock oxidised during the ammonia manufacture is 17%. This figure is based on reported carbon losses from

urea production (Neelis et al., 2003).
- 2B2 Nitric acid production: an IPCC Tier 2 method is used to estimate N_2O emissions. The emission factors are based on plant-specific measured data, which are confidential. The emissions are based on data reported by the nitric acid manufacturing industry and are included in the emission reports under EU-ETS and the national Pollutant Release and Transfer Register (PRTR).
- 2B5 Other chemical products: N_2O emissions from 2B5 Other chemical industry, which mainly originate from Caprolactam production, are also based on emission data reported by the manufacturing industry (based on measurements). Emission factors and activity data are confidential. The aggregated CO_2 emissions included in this source category are identified as a key source and based on country-specific methods and emission factors. These refer to the production of:
  - o Industrial gases: CO_2 emissions are estimated based on use of fuels (mainly natural gas) as chemical feedstock. An oxidation fraction of 20% is assumed, based on reported data in environmental reports from the relevant facilities.
  - o Carbon electrodes: CO_2 emissions are estimated based on fuel use (mainly petroleum coke and coke). A small oxidation fraction – 5% – is assumed, based on reported data in the environmental reports.
  - o Activated carbon: CO_2 emissions are estimated on the basis of the production data for Norit and by applying an emission factor of 1 t/t Norit. The emission factor is derived from the carbon losses from peat uses reported in the environmental reports. As peat consumption is not included in the national energy statistics, the production data since 1990 have been estimated based on an extrapolation of production level of 33 Tg reported in 2002. This is considered to be justified because this source contributes relatively little to the national inventory of greenhouse gases.
  - o Ethylene oxide: CO_2 emissions are estimated based on capacity data by using a default capacity utilisation rate of 86% and applying an emission factor of 0.45 t/t ethylene oxide.

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

4.3.6 Uncertainties and time-series consistency

Uncertainties
The Tier 1 uncertainty analysis in Annex 7 shown in Table A7.1 and A7.2 provides estimates of uncertainties according to IPCC source categories.
No accurate information is available for assessing the uncertainties of the emissions reported by the facilities which belong to 2B1 Ammonia production, 2B4 Carbide production and 2B5 Other activities. Activity data are assumed to be relatively certain. The uncertainties in CO_2 emissions from 'Ammonia production' and 'Other chemical products' are estimated to be approximately 2% and 70%, respectively, in annual emissions. The uncertainty in the annual emissions of N_2O from Caprolactam production is estimated to be approximately 30%.

Since the N_2O emissions of HNO_3 production in the Netherlands were opted in in the European emission trading scheme (EU-ETS), all companies have continuous measuring of their N_2O emissions. This has resulted in a lower annual emission uncertainty of approximately 8%.

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

4.3.7 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in chapter 1. The N_2O emissions of HNO_3 production are also verified by EU-ETS.

4.3.8 Source-specific recalculations

Recalculations as result of the 2011 in-country review
No recalculations have been made.

Other recalculations
For 2009 a difference was found between the emission figures for N_2O emissions from 2B2, Nitric acid production, from the AER (which was used for the NIR 2011) and the verified emissions in the emission reports under EU-ETS. This error (+45.5 Gg CO_2-eq) is corrected in this submission.

4.3.9 Source-specific planned improvements

There are no source-specific improvements planned.

4.4 Metal production [2C]

4.4.1 Source category description

The national inventory of the Netherlands comprises emissions of greenhouse gases related to three source categories as belonging to 2C Metal production:
- 2C1 Iron and steel production: CO_2 emissions: the Netherlands has one integrated iron and steel plant (Tata Steel, previously Corus, cq Hoogovens). During the production of iron and steel, coke and coal are used as reducing agents in the blast and oxygen furnaces,

Table 4.6 Emissions for CF_4 and C_2F_6 from aluminium production (2C3) (Units: Gg CO_2 eq).

Gas	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CF_4	1,803	1,535	1,045	999	1,534	342	88	73	52	86	59	36	50
C_2F_6	444	365	343	328	533	98	19	15	10	16	12	7	8

resulting in the production of the by-products blast furnace gas and oxygen furnace gas. A small part of these gases are emitted (lost) and the rest are subsequently used as fuels for energy purposes. Only the carbon losses are reported in category 2C1. In addition, CO_2 is produced during the conversion from pig iron to steel. These emissions are also reported in this category.
- 2C3 Aluminium production: CO_2 and PFC emissions: in the Netherlands aluminium is produced at two primary aluminium smelters (Zalco, previously Pechiney, and Aldel). CO_2 is produced by the reaction of the carbon anodes with alumina and by the reaction of the anode with other sources of oxygen (especially air). The PFCs (and C2F6) from the Aluminium industry are formed during the phenomenon known as the 'anode effect' (AE), which occurs when the concentration of aluminium oxide in the reduction cell electrolyte drops below a certain level.

There are some small Ferroalloy Production (2C2) companies in the Netherlands. They do not have GHG process emissions. The combustion emissions are included in 1A2. 2C4 Magnesium and aluminium foundries, both of which use SF_6 as a cover gas, do not occur in the Netherlands. No other sources of metal production (2C5) are identified in the inventory.

4.4.2 Key sources

Iron and steel production (carbon inputs) is identified as a key source for CO_2 emissions, Aluminium production as a trend key source for PFC emissions (see Table 4.2).

4.4.3 Overview of shares and trends in emissions

Table 4.2 gives an overview of shares in emissions of the main categories.

Total CO_2 emissions from 2C1 'Iron and steel production' decreased by 1.6 Tg during the period 1990–2010. In 2010, CO_2 emissions slightly decreased compared to 2009.
PFC emissions from primary 'Aluminium industry' (2C3) decreased by 1.8 Tg CO_2 eq between 1995 and 2004. From 2004 onwards the level of the PFC emissions mainly depends on the number of anode effects.
Table 4.6 shows the trend in CF4 and C2F6 emission for aluminium production during the period 1990–2010. The largest company produces approximately two-thirds of the national total production. The emissions decreased by 97% between 1995 and 2010. In 1998, the smallest company switched from side feed to point feed; this switch was followed by the larger company in 2002/2003, thereby explaining the decreased emissions from this year onwards. The higher level of the emissions in 2002 is caused by specific process-related problems during the switching process by the larger producer.

4.4.4 Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocols 12-002, 12-014 and 12-017 on the website www.nlagency.nl/nie.
Activity data are based on the following sources:
- Iron and steel production: data on coke production and coal input, limestone use and the carbon balance are reported by the relevant company (by means of an environmental report);
- Aluminium production: activity data and emissions are based on data reported in the environmental reports of both companies.

Emission factors used in the inventory to estimate greenhouse gas emissions are based on:
- EF (blast furnace gas) = 0.21485 tons CO_2 per GJ (plant specific);
- Aluminium production: EF (consumption of anodes) = 1.45 tons CO_2 per ton aluminium (plant specific; IPCC default = 1.5 t/t aluminium).

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

4.4.5 Methodological issues

The methodologies used to estimate the greenhouse gas emissions for all source categories of metal production are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and emission factors are found in protocols 12-003, 12-014 and 12-017 on the website www.nlagency.nl/nie as indicated in section 4.1.

Iron and steel production (2C1)
CO_2 emissions are estimated using a Tier 2 IPCC method and country-specific value for the carbon contents of the

fuels. Carbon losses are calculated from coke and coal input used as reducing agents in the blast and oxygen furnaces, including other carbon sources such as the carbon contents in the iron ore (corrected for the fraction that ultimately remains in the steel produced):

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

As mentioned above, only the carbon losses are reported in category 2C1. The carbon contained in the blast furnace gas and oxygen furnace gas produced as by-products and subsequently used as fuels for energy purposes is subtracted from the carbon balance and included in the Energy sector (1A1a and 1A2a).
From 2000 onwards data reported in the annual environmental reports of Tata Steel (Corus) are used to calculate the CO_2 emissions from the conversion from pig iron to steel. For the period 1990–2000 the CO_2 emissions have been calculated by multiplying the average IEF (8.3 kg CO_2 per ton of crude steel produced) over the 2000–2003 period by the crude steel production.

Aluminium production (2C3)
A Tier 1a IPCC method (IPCC, 2001) is used to estimate CO_2 emissions from the anodes used in the primary production of aluminium, with aluminium production being as activity data. In order to calculate the IPCC default emission factor, the stoichiometric ratio of carbon needed to reduce the aluminium ore to pure aluminium is based on the reaction: $Al_2O_3 + 3/2C \rightarrow 2Al + 3/2\ CO_2$.
This factor is corrected to include additional CO_2 produced by the reaction of the carbon anode with oxygen in the air. A country-specific emission factor of 0.00145 tons CO_2 per ton of aluminium is used to estimate CO_2 emissions and it has been verified that this value is within the range of the IPCC factor of 0.0015 and the factor of 0.00143 calculated by the World Business Council for Sustainable Development (WBCSD) (WBCSD/WRI, 2004). PFC emissions from primary aluminium production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990–2010. Emission factors are plant-specific and are based on measured data.

4.4.6 Uncertainties and time-series consistency

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

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

4.4.7 Source-specific QA/QC and verification

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

4.4.8 Source-specific recalculations

Recalculations as result of the 2011 in-country review
As a result of the 2011 in-country review, the following recalculations have been made:

- CO_2 emissions from Metal production - Iron and steel production (2C1); there are some differences in the totals in the resubmitted CRF compared to the 2011 v1.3 for the categories 1A2, 1B1b and 2C. These differences are the result of an error correction we made during the analysis of the carbon flows. In this analysis we detected that the emission factor used for blast furnace gas was too low in the v1.3 submission for the years 2005, 2006 and 2009 (category 1A2). Furthermore for the years 2005 to 2009 the correction for the process emissions from limestone use and the steelmaking process was kept constant at 300 kton CO_2 in the calculation of the other emissions. In the recalculation the correct correction terms were used (as reported in 2C11 and 2C151), resulting in changed figures for the carbon loss as reported in 2C152 and the emissions from coke production in 1B1b.
- CO_2 emissions from Metal production - Iron and steel production (2C5); the process emission from anode use during steel production in the electric arc furnace (EAF) is not included in the process-emission calculation. Therefore, this emission (0.3 Gg CO_2-eq in 2009) is added in the resubmission to 2C15 for the entire time-series 1990-2009.

- CO_2 emissions from Metal production - Aluminium production (2C3).
  The ERT noted that for the years 2007-2009 a lower emission factor is used. The Netherlands agreed that this is an error. The lower emission factor leads to lower CO_2 emission estimates for 2007-2009 and an underestimation of CO_2 emissions from aluminium production for this period. The Netherlands has recalculated the CO_2 process-emissions from anode use in the Primary Aluminium Production (2C3) for the whole time-series 1990-2009. For the whole period (also for 2007-2009) the correct country-specific CO_2 emission factor of 1.45 tons CO_2 per ton aluminium is used to estimate CO_2 emissions.

The above-mentioned recalculations were included in the latest official CRF submission from November 2011 and therefore, do not show up in the recalculation sheet of the current CRF.

Other recalculations
No other recalculations have been made in this submission.

4.4.9 Source-specific planned improvements

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

4.5 Food and drink production [2D]

4.5.1 Source category description

This category comprises CO_2 emissions related to food and drink production in the Netherlands. CO_2 emissions in this source category are related to the non-energy use of fuels. Carbon is oxidised during these processes, resulting in CO_2 emissions.

4.5.2 Key sources

Because this is a very small emission source, the key source analysis of this category (2D) is combined with the emissions in category 2G (Other industrial emissions).

4.5.3 Overview of shares and trends in emissions

Emissions vary at around 0.05 Tg and are rounded off to either 0.1 or 0.0 Tg (see Table 4.2).

4.5.4 Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in monitoring protocol 12-003 on the website www.nlagency.nl/nie. The activity data used to estimate CO_2 emissions from this source are based on national energy statistics from Statistics Netherlands (CBS) on Coke consumption. Emission factors are derived from the national default carbon content of coke (Corus/Tata Steel, AER 2000-2010).

4.5.5 Methodological issues

The methodology used to estimate the greenhouse gas emissions complies with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the method used and the emission factors can be found in protocol 12-003 on the website www.nlagency.nl/nie, as indicated in section 4.1. CO_2 emissions are calculated based on the non-energy use of fuels by the food and drink industry as recorded in the national energy statistics, multiplied by an emission factor. The emission factor is based on the national default carbon contents of the fuels (see Annex 2), under the assumption that the carbon is fully oxidised to CO_2.

4.5.6 Uncertainties and time-series consistency

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

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

Table 4.7 Trends in HFC-23 by-product emissions from the Production of HCFC-22 and HFC emissions from Handling activities (2E) (Units: Gg CO_2 eq)

Gas	1990	1995	2000	2005	2006	2007	2008	2009	2010
2E1 HFC-23	4,432	5,759	2,421	196	281	243	212	154	391
2E3 HFCs	NO	12	418	39	37	24	18	109	99
HFC Total	4,432	5,771	2,838	235	318	267	230	263	480

4.5.7 Source-specific QA/QC and verification

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

4.5.8 Source-specific recalculations

Recalculations as result of the 2011 in-country review
No recalculations have been made.

Other recalculations
No recalculations have been made.

4.5.9 Source-specific planned improvements

There are no source-specific improvements planned.

4.6 Production of halocarbons and SF_6 [2E]

4.6.1 Source category description

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

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

4.6.2 Key sources

Production of HCFC-22 (HFC-23 emission) is a trend key source; see Table 4.2.

4.6.3 Overview of shares and trends in emissions

Table 4.2 gives an overview of shares in emissions of the main categories.

Total HFC emissions in category 2E were 5.8 Tg in 1995 and 0.5 Tg CO_2 eq in 2010, with HFC-23 emissions from HCFC-22 production being the major source of HFC emissions. HFC emissions from handling contributed 21% to the total HFC emissions from this category in 2010.

Table 4.7 shows the trend in HFC emissions from the categories HCFC-22 production and HFCs from handling activities for the period 1990–2010. The emissions of HFC-23 increased about by 35% in the period 1995–1998, due to the increased production of HCFC-22. However, in the period 1998–2000, the emissions of HFC-23 decreased by 69% following the installation of a thermal converter (TC) at the plant.

The removal efficiency of the TC (kg HFC-23 processed in TC/kg HFC-23 in untreated flow/year) is the primary, and the production level the secondary factor explaining the variation in emission levels during the 2000–2008 period. Due to the economic crisis, the production level of HCFK22 was much lower in the last quarter of 2008 and in 2009, resulting in lower HFC-23 emissions in both 2008 and 2009. Mainly caused by the economic recovery, the production level of HCFK22 was much higher in 2010, resulting in higher HFC-23 emissions in 2010, compared to 2009.

The significant emission fluctuations in category 2E3 during the period 1992-2010 can be explained by the large variety in handling activities, which depends on the demand of the costumers.

4.6.4 Activity data and (implied) emission factors

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

- Production of HCFC-22:
  - production figures on HCFC-22 are confidential;
  - kg HFC-23 in untreated flow/year is confidential.
- Handling activities (HFCs): activity data used to estimate HFC emissions are confidential.

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

- Production of HCFC-22: removal efficiency of the TC (kg HFC-23 processed in TC/kg HFC-23 in untreated flow/year) is confidential.
- Handling activities (HFCs): the emission factors used are plant-specific and confidential, and they are based on 1999 measurement data. More detailed information on the activity data and emission factors can be found in the monitoring protocols 12-018 and 12-019 on the website www.nlagency.nl/nie.

4.6.5 Methodological issues

The methodologies used to estimate the greenhouse gas emissions included in this category are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the method used and emission factors can be found in the protocols 12-018 and 12-019 on the website www.nlagency.nl/nie as indicated in section 4.1:

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

4.6.6 Uncertainties and time-series consistency

Uncertainties

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

The uncertainty in HFC emissions from HCFC-22 production is estimated to be about 15%. For HFC emissions from handling activities the uncertainty is estimated to be about 20%. The uncertainty in the activity data and the emission factor for handling activities is estimated at 10% and 20%, respectively. These figures are all based on the judgments of experts.

Time-series consistency

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

4.6.7 Source-specific QA/QC and verification

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

4.6.8 Source specific recalculations

4.6.8.1 Recalculations as result of the 2011 in-country review

No recalculations have been made.

4.6.8.2 Other recalculations

No recalculations have been made.

4.6.9 Source-specific planned improvements

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

4.7 Consumption of halocarbons and SF_6 [2F]

4.7.1 Source category description

Halocarbons and SF_6 are released from the use of these compounds in different products. The national inventory of the Netherlands comprises emissions of greenhouse gases related to the following source category: 2F(1-9): Emissions from substitutes for Ozone-depleting substances.

The inventory comprises the following sources in this source category:

- 2F1 Stationary refrigeration: HFC emissions;
- 2F1 Mobile air conditioning: HFC emissions;
- 2F2 Foam Blowing: HFC emissions; (included in 2F9);
- 2F3 Fire Extinguishers (included in 2F9);
- 2F4 Aerosols/Metered dose inhalers: HFC emissions; (included in 2F9);
- 2F5 Solvents (included in 2F9);
- 2F6 Other applications using ODS substitutes
- 2F7 Semiconductor manufacture: PFC emissions (SF_6 emissions included in 2F9);
- 2F8 Electrical equipment: SF_6 emissions (included in 2F9);
- 2F9 Other: SF_6 emissions from Sound-proof windows and Electron microscopes

In the Netherlands, many processes related to the use of HFCs and SF_6 take place in only one or two companies. Because of the sensitivity of data from these companies, only the sum of the HFC emissions of 2F2-2F5 (included in 2F9) and of the SF_6 emissions of 2F7 and 2F8 is reported (included in 2F9).

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

Gas	1990	1995	2000	2005	2006	2007	2008	2009	2010
HFC-134a	NO	46	205	434	471	498	520	540	547
HFC-143a	NO	7	110	294	329	364	394	418	436
HFC-125	NO	8	90	243	272	301	325	342	365
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	0.8	7.0	11.4	12.5	13.3	13.4	13.1	13.3
Other HFCs	NO	187	642	305	325	399	439	464	441
HFC Total	NO	248	1,053	1,288	1,409	1,576	1,693	1,777	1,802
PFC use	18	37	193	178	194	222	180	125	151
SF_6 use	218	287	297	240	199	188	184	170	184
Total HFC/PFC/SF_6	237	572	1,544	1,706	1,803	1,985	2,055	2,072	2,137

4.7.2 Key sources

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

4.7.3 Overview of shares and trends in emissions

The contribution of F-gas emissions from category 2F to the total national inventory of F-gas emissions was 7% in the base year 1995 and 80% in 2010. This corresponds to 2.2 Tg CO_2 eq and accounts for 1.0% of the national total greenhouse gas emissions in 2010.

The level of HFC emissions increased by a factor of 7 in 2010 compared to 1995, mainly due to increased HFC consumption as a substitute for (H)CFC use. PFC emissions increased due to a higher production level of the Semiconductor manufacturing industry. And actual emissions of SF_6 remained rather stable during the period 1995–2010. Table 4.8 gives an overview of the trends in actual emissions from 1990-2010.

4.7.4 Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 12-020 and 12016 on the website www.nlagency.nl/nie.

The activity data used to estimate the emissions of the F-gases are based on the following sources:

- Consumption data of HFCs (Stationary refrigeration, Aerosols and Foams) have been obtained from the annual report from PriceWaterhouseCoopers (PWC, 2011).
- For Mobile air-conditioning the number of cars (per year of construction) and the number of scrapped cars (per year of construction) are obtained from Statistics Netherlands (CBS). The recycled and destroyed amounts of refrigerants are obtained via ARN, a waste processing organisation.
- Activity data on the use of PFCs in Semiconductor manufacturing and SF_6 in Sound-proof windows and electron microscopes are obtained from different individual companies (confidential information).

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

- Stationary refrigeration: annual leak rates are based on surveys (De Baedts et al., 2001).
- Mobile air conditioning: annual leak rates are based on surveys (De Baedts et al., 2001) and other literature. (Minnesota Pollution Control Agency, 2009; YU & CLODIC, 2008).
- Aerosols and Foams: IPCC default EFs are used to calculate the emission from these sources.
- Semiconductor manufacturing: emission factors which are confidential information of the only company.
- Sound-proof windows: EF used for production is 33% (IPCC default); EF (leak rate) used during the lifetime of the windows is 2% per year (IPCC default).
- Electron microscopes: emission factors are confidential information of the only company.

The source Electrical equipment comprises SF_6 emissions of users of high-voltage circuit breakers and the only international test laboratory for power switches. The emissions from the circuit breakers are obtained from EnergieNed, the Federation of Energy Companies in the Netherlands and the emissions from testing in the test laboratory.

4.7.5 Methodological issues

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

Table 4.9 Effects of changes in the use of HFCs and SF_6 (2F) 1990-2009 (Units: Gg CO_2 eq)

		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HFCs	NIR 2011	NO	247	1,048	913	863	1,045	1,183	1,260	1,386	1,553	1,659	1,798
	NIR 2012	NO	248	1,053	922	874	1,060	1,201	1,288	1,409	1,576	1,692	1,777
	Difference	NO	1	6	8	11	15	18	29	23	23	33	-21
SF_6	NIR 2011	217	301	315	317	274	231	252	239	198	192	186	175
	NIR 2012	218	287	297	315	262	225	253	240	199	188	184	170
	Difference	1	-14	-19	-2	-12	-6	1	1	1	-4	-2	-5

The country-specific methods for the sources Sound-proof windows and Electron microscopes are equivalent to IPCC Tier 2 methods. For 2007 and 2008 the country-specific method for the source Electrical equipment is equivalent to the IPCC Tier 3b method and from 2009 onwards to the IPCC Tier 3a method

More detailed descriptions of the methods used and emission factors can be found in the protocols 12-020 and 12016 on the website www.nlagency.nl/nie as indicated in section 4.1.

4.7.6 Uncertainties and time-series consistency

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

The uncertainty in SF_6 emissions from SF_6 consumption was estimated to be 50%. For the activity data and the emission factors for the SF_6 sources the uncertainties were estimated to be about 50% and 25%, respectively. Because for 2007 and 2008 the country-specific method for the source Electrical equipment is equivalent to the IPCC Tier 3b method and from 2009 onwards to the IPCC Tier 3a method, the uncertainty in SF_6 emissions from SF_6 consumption have been changed. The uncertainty in SF_6 emissions from SF_6 consumption is estimated to be 34%. For the activity data and the emission factors for the SF_6 sources the uncertainties are estimated to be about 30% and 15%, respectively.

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

4.7.7 Source-specific QA/QC and verification

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

4.7.8 Source-specific recalculations

4.7.8.1 Recalculations as result of the 2011 in-country review
No recalculations have been made.

4.7.8.2 Other recalculations
Because several new sources of information became available, the emissions of the following sources have been recalculated:

- Stationary refrigeration: from now on it is possible to make a more accurate split on the usage figures into domestic and the seagoing shipping sector for the period 2007-2010.
- Mobile air-conditioning: detailed data about the vehicle fleet per year became available for the period 1999-2009.
- Over 2010, the recycled and destroyed amounts of refrigerant became available via ARN, a waste processing organisation.
- Electrical equipment: In 2011 activity data from previous years became available. Emissions for the intervening years (1995-1998 and 2000-2005) have been recalculated via interpolation.
- Electron microscopes: for the period 1999-2010 new emission figures of the only company became available.

The results of the recalculation and changes were corrected in this submission (see Table 4.9).

4.7.9 Source-specific planned improvements

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

4.8 Other industrial processes [2G]

4.8.1 Source category description

The national inventory of the Netherlands comprises emissions of greenhouse gases related to four source categories in this category:
- Fireworks and candles: CO_2, CH_4 and N_2O emissions;
- Degassing of drinking water: CH_4 emissions;
- Miscellaneous non-energy fossil fuel product uses, (e.g., lubricants and waxes); CO_2 emissions (about 0.2 Tg).

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

4.8.2 Key sources

As already mentioned in 4.5.2, the key source analysis in this category (2G) is combined with the emissions in category 2D (Food and drink production).
There are no key sources identified from these combined source categories (see also Annex 1).

4.8.3 Overview of shares and trends in emissions

The small CO_2 and CH_4 emissions remained rather constant between 1990 and 2010.

4.8.4 Activity data and (implied) emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 12-003 and 12-014 on the website www.nlagency.nl/nie.
The activity data used are based on the following sources:
- Fireworks: data on annual sales from branch organisation;
- Candles: average use of 3.3 kg per person (www.bolsius.com);
- Production of drinking water: Volume Statistics Netherlands (CBS);
- Fuel use: energy statistics obtained from Statistics Netherlands (CBS).

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

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

4.8.5 Methodological issues

The methodologies used to estimate the greenhouse gas emissions included in this category are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and the emission factors can be found in protocols 12-003 and 12-014 on the website www.nlagency.nl/nie as indicated in section 4.1:
- Fireworks and candles: country-specific methods and emission factors are used to estimate emissions of CO_2, CH_4 and N_2O.
- Degassing of drinking water: a country-specific methodology and emission factor are used to estimate the CH_4 emissions, which is the main source of CH_4 emissions in this category.
- Miscellaneous non-energy fossil fuel product uses (i.e., lubricants and waxes): a Tier 1 method is used to estimate emissions from lubricants and waxes using IPCC default emission factors.

4.8.6 Uncertainties and time-series consistency

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

Because the Food and drink production category (2D) is a very small emission source, the uncertainty analysis is combined with the emissions in this category.

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

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

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

4.8.7 Source specific QA/QC and verification

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

4.8.8 Source specific recalculations

Recalculations as result of the 2011 in-country review
No recalculations have been made.

Other recalculations
No recalculations have been made.

4.8.9 Source specific planned improvements

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

5
Solvent and other product use [CRF Sector 3]

Major changes in Sector 3 Solvent and other product use compared to the National Inventory Report 2011

Emissions:	No changes.
Key sources:	There are no key sources in this sector.
Methodologies:	There have been no methodological changes in this sector.

5.1 Overview of sector

Emissions of the greenhouse gases in this sector include indirect emissions of CO_2 related to the release of non-methane volatile organic compounds (NMVOC) with the use of solvents and a wide range of other fossil carbon-containing products (e.g., paints, cosmetics, cleaning agents). In addition, this sector includes N_2O emissions originating from the use of N_2O as anaesthesia and as a propelling agent in aerosol cans (for example, cans with cream).
The Netherlands has three source categories in this IPPC Common Reporting Format (CRF) sector:

- 3A, 3B, 3D 'Solvents and other product use': indirect CO_2 emissions (related to NMVOC)
- 3D 'Anaesthesia': N_2O emissions
- 3D 'Aerosol cans': N_2O emissions.

This sector comprises non-combustion emissions from households, services, hospitals, research- and governmental institutions etc, except for the following emissions:

- Use of F-gases (HFCs, PFCs and SF_6). In accordance with the IPCC Reporting Guidelines F-gases are included in 2 'Industrial processes' (thus including their use in the Residential and Commercial sectors)
- Direct non-energy use of mineral oil products (e.g., lubricants, waxes). These are included in 2G 'Industrial processes'
- Several minor sources of CH_4 emissions from nonindustrial, non-combustion sources. These are included in Sector 2G because the CRF does not permit methane emissions to be included in Sector 3

The following emission from the manufacturing industry is also included in this chapter:

- Indirect CO_2 emissions from 3C 'Chemical products, manufacture and processing'. These NMVOC emissions are included in categories 3A, 3B and 3D.

The following protocol, which can be accessed on www.nlagency.nl/nie, describes the methodologies applied for estimating CO_2 and N_2O emissions from solvent and product use in the Netherlands:

- Protocol 12-014: CO_2, N_2O en CH_4 from Other process emissions and product use.

Overview of shares and trends in emissions
Table 5.1 shows the contribution of the emissions from Solvent and other product use in the Netherlands. Total greenhouse gas emissions from Solvent and product use in the Netherlands were 0.5 Tg CO_2 eq in 1990 and 0.2 Tg CO_2 eq in 2010.
Total emissions of the sector declined by 58% between 1990 and 2003 and decreased further to 68% in 2010. CO_2 emissions from the sector decreased by 59% between 1990 and 2010, mainly due to decreasing indirect emissions from paints that resulted from the implementation of an emission reduction programme for NMVOC (KWS, 2000). N_2O emissions from anaesthesia fell by 89% from 1990 to 2010 due to better dosing in hospitals and other medical institutions. The emissions of N_2O from food aerosol cans decreased by 16% in this period. Total N_2O emissions from this chapter have declined since 1990 by 81%.

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

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

5.2.1 Source category description

CRF source category 3A Paint application includes the indirect CO_2 emissions of solvents from the use of both industrial paints and paints used by households and professional painters. Indirect emissions from the use of solvents in degreasing and dry cleaning are included in CRF source category 3B, which covers the use of solvents for cleaning and degreasing of surfaces, the dry cleaning of clothing and textiles and the degreasing of leather.

5.2.2 Activity data and implied emission factors

Detailed information on the activity data and emission factors of NMVOC estimates can be found in the monitoring protocol 12-014 on the website www.nlagency.nl/nie.
Activity data: consumption data and NMVOC contents of products are mainly provided by trade associations, such as the VVVF (for paints), the NCV (for cosmetics) and the NVZ (for detergents). Consumption of almost all solvent-containing products has increased since 1990. However, the general NMVOC content of products (especially paints) has decreased over the last years, resulting in a steady decline in NMVOC emissions since 1990 (see section 2.4). Due to the increased sales of hairspray and deodorant sprays NMVOC emissions have increased slightly in recent years. It is assumed that the NMVOC contents of these products have remained stable. Emission factors: it is

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

Sector/category	Gas	Key	Emissions base-year	2009	2010	Absolute 2010 - 2009	Contribution to total in 2010 (%)		
			Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq		by sector	% of total gas	% of total CO_2 eq
3 Solvent and other product use	CO_2		0.3	0.1	0.1	0.00		0.1	0.1
	N_2O		0.2	0.1	0.04	-0.03		0.4	0.02
	All		0.5	0.2	0.2	-0.03			0.1
3A Paint application	CO_2		0.2	0.1	0.1	0.00	30	0.03	0.02
3A Paint application	All		0.2	0.1	0.1	0.00	30		0.02
3B Degreasing and drycleaning	CO_2		0.00	0.00	0.00	0.00	1.1	0.00	0.00
3B Degreasing and drycleaning	All		0.00	0.00	0.00	0.00	1.1		0.00
3D Other	CO_2		0.1	0.1	0.1	0.00	44	0.04	0.04
	N_2O		0.2	0.1	0.04	-0.03	25	0.4	0.02
3D1 Anaesthesia	N_2O		0.2	0.03	0.02	0.00	13	0.2	0.01
3D3 Aerosol cans	N_2O		0.02	0.05	0.02	-0.03	11	0.2	0.01
3D Other	All		0.3	0.1	0.1	-0.03			0.1
Total National Emissions	CO_2		159.2	169.9	181.2	11.7		100	
	N_2O		20.2	9.6	9.4	-0.2		100	
National Total GHG emissions (excl. CO_2 LULUCF)	All		213.3	198.9	210.1	11.5			

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

5.2.3 Methodological issues

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

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

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

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

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

5.2.4 Uncertainty and time-series consistency

Uncertainty

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

Time-series consistency

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

5.2.5 Source-specific QA/QC and verification

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

5.2.6 Source-specific recalculations

There were no recalculations in this sector.

5.2.7 Source-specific planned improvements

There are no source-specific improvements planned.

5.3 Miscellaneous N_2O emissions from solvents and product use (3D1 and 3D3])

5.3.1 Source category description

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

5.3.2 Activity data and implied emission factors

Detailed information on the activity data and emission factors of N_2O estimates are found in the monitoring protocol 12-014 on the website www.nlagency.nl/nie.
Activity data: The major hospital supplier of N_2O for aesthetic use reports the consumption data of aesthetic gas in the Netherlands annually. The Dutch Association of Aerosol Producers (NAV) reports data on the annual sales of N_2O-containing spray cans. Missing years are then extrapolated on the basis of this data. Domestic sales of cream in aerosol cans have shown a strong increase since 1990. The increase is reflected in the increased emissions.
Emission factors: the emission factor used for N_2O in anaesthesia is 1 kg/kg. Sales and consumption of N_2O for anaesthesia are assumed to be equal each year. The emission factor for N_2O from aerosol cans is estimated to be 7.6 g/can (based on data provided by one producer) and is assumed to be constant over time.

5.3.3 Methodological issues

Country-specific methodologies are used for the N_2O sources in Sector 3. Since the emissions in this source category are from non-key sources for N_2O, the present methodology complies with the IPCC Good Practice Guidance (IPCC, 2001). A full description of the methodology is provided in the monitoring protocol 12-014 on the website www.nlagency.nl/nie.

5.3.4 Uncertainties and time-series consistency

Uncertainties
These sources do not affect the overall total or trend in the Dutch emissions of direct greenhouse gases. For N_2O emissions, the uncertainty is estimated to be approximately 50% based on the judgment of experts. Uncertainty in the activity data of N_2O use is estimated to be 50% and that of the emission factor to be less than 1% (the assumption is that all gas is released).

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

5.3.5 Source-specific QA/QC and verification

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

5.3.6 Source-specific recalculations

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

5.3.7 Source-specific planned improvements

There are no source-specific improvements planned.

6
Agriculture [CRF Sector 4]

Major changes in sector 4 Agriculture compared to the National Inventory Report 2011

Emissions:	In 2010 methane (CH_4) emissions from agriculture remained almost unchanged compared to the preceding year, while nitrous oxide (N_2O) emissions decreased by 1.0%. Numbers of livestock remained fairly stable, except for poultry where an increase of 4.4% is seen (goats decreased 5.6% but form a relatively small category). The reduction in N_2O is caused by less synthetic fertiliser use, while also considerable amounts of manure have remained in storage leading to smaller emissions from application.
Key sources:	No changes to NIR 2011.
Methodologies:	There have been no methodological changes in this sector.

6.1 Overview of the sector

Emissions of greenhouse gases from 'Agriculture' include all anthropogenic emissions from the agricultural sector, with the exception of emissions from fuel combustion and carbon dioxide (CO_2) emissions by land use in agriculture. These emissions are included in 1A4c 'Agriculture/forestry/fisheries' (section 3.2.9) and in 5 'Land Use, Land Use Change and Forestry' (LULUCF, sections 7.6 and 7.7).

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

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

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

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

The following protocols on www.nlagency.nl/nie describe the methodologies, activity data and emission factors applied in estimating N_2O and CH_4 emissions from the agricultural sector in the Netherlands:
- Protocol 12-027: CH_4 from Enteric fermentation (4A);
- Protocol 12-028: N_2O from Manure management (4B);
- Protocol 12-029: CH_4 from Manure management (4B);
- Protocol 12-030: N_2O from Agricultural soils: indirect emissions (4D);
- Protocol 12-031: N_2O from Agricultural soils: direct emissions and grazing emissions (4D).

Overview of shares and trends in emissions

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

In 2010, CO_2 equivalent emissions from Sector 4 'Agriculture' contributed 8.4% to the total national emissions (without LULUCF) compared to 10.6% in 1990. In 2010, emissions of CH_4 and N_2O from agricultural sources accounted for 57 and 76% of the national total CH_4 and N_2O emissions. Category 4A 'Enteric fermentation' is the main source of CH_4 emissions and category 4D 'Agricultural soils' is the largest source of N_2O emissions included in this sector.

Total greenhouse gas emissions from Agriculture decreased by approximately 26% between 1990 and 2010, from 22.5 Tg CO_2 eq in 1990 to 16.6 Tg CO_2 eq in 2010 (see also Figure 6.1). This decrease was largely the result of decreasing numbers of livestock, a decreased application of animal manure and a decreased use of synthetic fertilisers.

Compared to 2009, CH_4 emissions changed very little as animal numbers remained fairly stable, except for the 4.4% increase in poultry (goats decreased 5.6% but are only a minor category). For cattle CH_4 from enteric fermentation is somewhat higher in 2010, because of higher energy intakes and resulting EFs for mature dairy cattle and white veal calves. Manure production of fattening pigs however was lower, which together with a relatively high emission factor results in lower CH_4 emissions from manure management. N_2O emissions were 1.0% lower, because of reduced synthetic fertiliser usage and approximately 12.8 million kg N from animal manure remaining in storage. Emissions following application will thus occur next year, provided it can then be placed on agricultural soils and is not used otherwise or being exported.

Overview of trends in activity data

Livestock numbers are the primary activity data used in the calculation of CH_4 and N_2O and are taken from the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl, in Annex 8, Table A8.1 and in background documents (e.g., Van der Hoek and Van Schijndel, 2006). Table 6.2 presents an overview.

The number of privately owned horses is estimated to be around 300,000 head by the Product Boards for Livestock, Meat and Eggs (PVE, 2005). As information on activity data is scarce, this estimation is used for the whole time-series. Because no emissions are being reported in Sector 7 Other, this estimation is added to the animal numbers used in the calculations.

For cattle, three categories are distinguished:
- mature dairy cattle: adult cows for milk production;
- mature non-dairy cattle: adult cows for meat production;
- young cattle: mixture of different age categories for breeding and meat production, including adult male cattle.

Table 6.1 Contribution of main categories and key sources in sector 4 Agriculture.

Sector/category	Gas	Key	Emissions base-year Tg CO_2 eq	2009 Tg CO_2 eq	2010 Tg CO_2 eq	Absolute 2010 - 2009 Tg CO_2 eq	Contribution to total in 2010 (%) by sector	of total gas	of total CO_2 eq
4 Agriculture	CH_4		10.7	9.5	9.5	0.00	57	57	4.5
	N_2O		11.8	7.2	7.1	-0.07	43	76	3.4
	All		22.5	16.7	16.6	-0.07			7.9
4A Enteric fermentation	CH_4		7.7	6.6	6.6	0.04	40	40	3.2
4A1 Cattle	CH_4	L,T1	6.8	5.8	5.9	0.04	35	35	2.8
4A8 Swine	CH_4		0.4	0.4	0.4	0.00	2	2	0.2
4A2-7, 10-13 Other animals	CH_4		0.4	0.4	0.4	0.00	2	2	0.2
4B Manure management	CH_4		3.0	2.9	2.9	-0.04	17	17	1.4
	N_2O	L,T2	1.2	1.0	1.0	0.01	6	11	0.5
	All		4.2	3.9	3.9	-0.04	23		1.8
4B1 Cattle	CH_4	L,T	1.6	1.7	1.7	0.02	10	10	0.8
4B8 Swine	CH_4	L	1.1	1.1	1.1	-0.06	6	6	0.5
4B9 Poultry	CH_4	T2	0.3	0.1	0.1	0.00	0	0	0.0
4B2-7, 10-13 Other animals	CH_4		0.0	0.0	0.0	0.00	0	0	0.0
4D Agriculture soils	N_2O		10.7	6.2	6.1	-0.08	37	65	2.9
4D1 Direct soil emissions	N_2O	L,T	4.1	3.4	3.3	-0.07	20	35	1.6
4D2 Animal production on agricultural soils	N_2O	L,T	3.1	1.3	1.3	0.01	8	14	0.6
4D3 Indirect emissions	N_2O	L,T	3.4	1.5	1.5	-0.01	9	16	0.7
National Total GHG emissions (excl. CO_2 LULUCF)	CH_4		25.7	17.1	16.8	-0.27		100	
	N_2O		20.2	9.6	9.4	-0.20		100	
	All	-	213.3	198.9	210.1	11.1			100

Figure 6.1 Category 4 'Agriculture': trend and emission levels of source categories, 1990-2010.

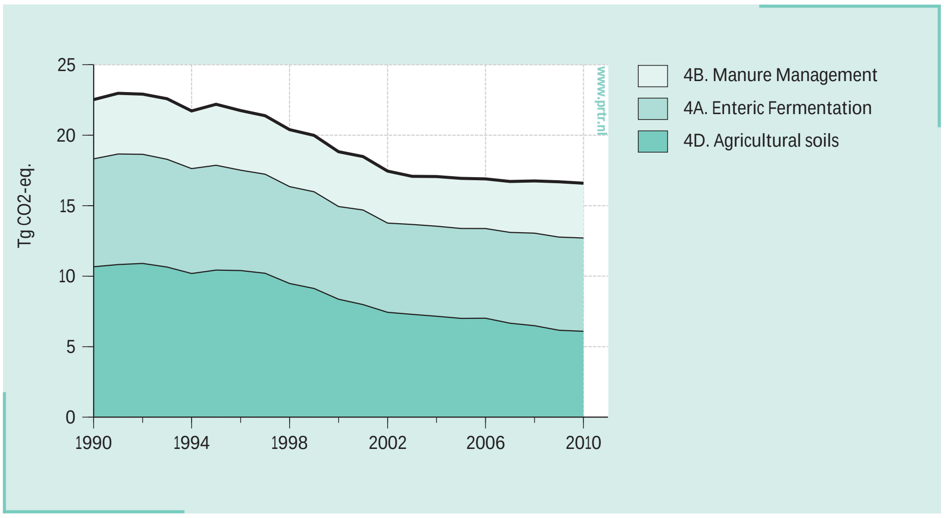


Table 6.2 Numbers of animals in 1990-2010 (1,000 heads) (www.cbs.nl).

Animal type	1990	1995	2000	2005	2007	2008	2009	2010
Cattle	4,926	4,654	4,070	3,799	3,763	3,890	3,968	3,975
- Adult dairy cattle	1,878	1,708	1,504	1,433	1,413	1,466	1,489	1,479
- Adult non-dairy cattle	120	146	163	152	144	127	123	115
- Young Cattle	2,929	2,800	2,403	2,214	2,206	2,297	2,355	2,381
Sheep	1,702	1,674	1,308	1,363	1,369	1,213	1,117	1,130
Goats	61	76	179	292	324	355	374	353
Horses	370	400	418	433	434	444	445	441
Pigs (*1000)	13.9	14.4	13.1	11.3	11.7	12.0	12.2	12.3
Poultry (*1000)	95.6	92.2	107.2	95.9	96.0	99.7	100.0	104.4

Between 1990 and 2010, (dairy) cattle, pig and sheep numbers decreased by 19, 12 and 34% respectively, while poultry numbers increased by 9%. Goat numbers increased by a factor of 5 and horse numbers increased by 19% in this period.

For mature dairy cattle, the decrease in numbers was associated with an increase in milk production per cow between 1990 and 2010. The increased milk production per cow is the a result of both genetic changes (due to breeding programmes for milk yield) as well as the increase in feed intake and the high feeding quality of cattle diets. Total milk production in the Netherlands is determined mainly by European Union (EU) policy on milk quotas, which has remained mostly unchanged. In order to comply with the unchanged milk quota, animal numbers of mature dairy cattle had to decrease to counteract the effect of increased milk production per cow. The last few year's extensions in milk quota have again led to an increase in the number of mature dairy cattle. Between 1990 and 2010 the numbers of young (dairy) cattle follow the same trends as those of adult female cattle – namely, a decrease.

The Netherlands' manure and fertiliser policy also influences livestock numbers. Young cattle, pig and poultry numbers in particular decreased as a result of the introduction of measures such as buying up part of the pig and poultry production rights (ceilings for total phosphate production by animals) by the government and lowering the maximum application standards for manure and synthetic fertiliser. For pigs and young cattle the decreasing trend of the past has levelled off in the last couple of years. In recent years, animal numbers have shown a slight increase.
The increased number of swine in 1997 was a direct result of the outbreak of classical swine fever in that year (see NIR 2009). In areas where this disease was present, the transportation of pigs, sows and piglets to the slaughterhouse was not allowed, so the animals had to remain on the pig farms for a relatively long period (accumulation of pigs).

An increase in the number of poultry is observed between 1990 and 2002. In 2003 however, poultry numbers decreased by almost 30% as a direct result of the avian flu outbreak. In the years afterwards the population recovered, reaching a level only slightly below the 2002 number in 2010.

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

6.2 Enteric fermentation [4A]

6.2.1 Source category description

Methane emissions from enteric fermentation are a by-product of the digestive process, in which organic matter (mainly carbohydrates) is degraded and utilised by micro-organisms under anaerobic conditions. Both ruminant (e.g., cattle, sheep and goats) and non-ruminant animals (e.g., pigs and horses) produce CH_4, but per unit of feed intake ruminants generate much more.
In ruminants, the digestive system is specialised to digest fibrous material and has a strongly expanded chamber (the rumen) at the front. This allows for a selective retention of feed particles and supports intensive microbial fermentation of the feed. Of several nutritional advantages including the capacity to digest fibrous material and the synthesis of microbial protein which can be digested in the intestine, this is also accompanied by a high methane production by methanogens in the rumen. Camels and llamas do not occur in the Netherlands, while emissions from buffalo, mules and donkeys are negligible and not taken up in the inventory. Enteric fermentation methane emission from poultry is not estimated due to the negligible amount of CH_4 emission for this animal category. The IPCC Guidelines also do not provide a default emission factor for this animal category, and other countries do not estimate emissions from poultry either.

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

	1990	1995	2000	2005	2007	2008	2009	2010
Mature dairy cattle	110	116	120	126	129	128	127	129
Mature non-dairy cattle	65	66	67	71	72	73	72	72
Young cattle	37	37	35	34	34	34	34	33

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

	1990	1995	2000	2005	2007	2008	2009	2010
Milk production	6,003	6,596	7,416	7,568	7,878	7,927	7,919	8,075
IEF for methane	110	116	120	126	129	128	127	129

6.2.2 Overview of shares and trends in emissions

In 2010 enteric fermentation accounted for 40% of the total greenhouse gas emissions from the agricultural sector in the Netherlands (see Table 6.1). Cattle accounts for the majority of CH_4 emissions from enteric fermentation (88%) in 2010. The second largest CH_4 emission source in category 4A is swine (6%). 4A Other animals consists of sheep, goats and horses, and accounts for the remaining 6%.

CH_4 emissions from enteric fermentation decreased from 7.7 Tg CO_2 eq to 6.6 Tg (–14%) between 1990 and 2010, which is fully explained by a decrease in CH_4 emission from enteric fermentation in cattle. Although associated emission factors have generally risen during this period, lowering cattle numbers have more than compensated the effect.

6.2.3 Activity data and emission factors

Trends in CH_4 emission from enteric fermentation are explained by a change in animal numbers, a change in emission factor or both. Detailed information on data sources for activity data and emission factors can be found in the following monitoring protocol:

- Protocol 12-027: CH_4 from Enteric fermentation (4A)

All relevant documents concerning methodology, emission factors and activity data are published on the website www.nlagency.nl/nie. Table 6.2 (in section 6.1) presents an overview of animal numbers. In Annex 8, Tables A8.1, A8.2 and A8.3 show the activity data for all animal categories and emission factors for cattle.

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

Trends in cattle IEF

The emission factors for three cattle categories are calculated annually. For mature dairy cattle, a Tier 3 approach is used to calculate the CH_4 production per cow per year on the basis of data on the share of feed components and their chemical nutrient composition (Smink et al., 2005). For mature non-dairy and young cattle, a Tier 2 approach is used to calculate the CH_4 production per animal per year on the basis of data on the feed intake (Smink, 2005). For more information on methods and the calculation used, see section 6.2.4 and 6.2.5. Table 6.3 shows the implied emission factors (IEFs) of the different cattle categories reported. The implied emission factor for young cattle is an average of several subcategories (Annex 8, Table A8.3).

For both mature dairy cattle and mature non-dairy cattle, IEFs increased primarily as a result of an increase in total feed intake during the period 1990–2010. For dairy cattle, a change in the feed nutrient composition partly counteracted this effect (see section 6.2.4). For young cattle the decrease of IEF between 1990 and 2010 can be explained by a decrease in the average total feed intake due to a shift towards relatively more meat calves in the population of young cattle (Annex 8 Table A8.1).

Comparison of cattle IEF with IPCC defaults

Table 6.4 shows that the mature dairy cattle IEF follows the increasing trend in milk production. Compared to the default IPCC IEF of 118 kg CH_4 per cow for mature dairy cattle (at a milk production rate of 6700 kg/cow/year), the IEF used in the Netherlands is slightly lower.
In 1997 for instance, a milk production of about 6800 kg per year per cow led to an emission factor of 117 kg/animal/year, less than 1% lower than the default of 118 kg/animal/year. An explanation of the difference can be found in the data on feed intake, dietary composition and nutrient composition of dietary components as input to an alternative country specific model that predicts the methane emission factor for mature dairy cattle (Bannink, 2010). With increasing milk production per cow a decrease in the amount of CH_4 emission per unit of milk produced

(from 0.018 to 0.016 kg CH_4/kg milk) can be seen.

The higher IEF for mature non-dairy cattle, (compared to the IPCC default value of 48 kg per animal) can be explained by the higher total feed intake per adult non-dairy cow. The relatively large share of meat calves for white and rose veal production explains the relatively low IEF for young cattle compared to the IPCC default value (Annex 8 Table A8.1).

6.2.4 Methodological issues

A detailed description of the method, data sources and emission factors is found in the protocol on www.nlagency.nl/nie, as indicated in section 6.1. In 2009, a recalculation was carried out for the whole time-series (Bannink, 2010 and CBS, 2009).

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

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

Cattle

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

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

The intake of grass silage, maize silage, wet by-products, concentrates and grass products is estimated from national statistics found at www.cbs.nl. More information on the Netherlands VEM system is presented in Smink et al. (2005) and Tamminga et al. (2004).

Mature dairy cattle

The CH_4 emission from enteric fermentation by mature dairy cattle is calculated by a Tier 3 approach using dynamic modelling (Smink et al., 2005). The model of Mills et al. (2001) is employed, including updates (Bannink et al., 2005). This model is based on the mechanistic, dynamic model of rumen fermentation processes developed by Dijkstra et al. (1992). It has been developed for mature cattle and is therefore not suitable for other ruminant categories such as young cattle. The model calculates the gross energy (GE) intake and CH_4 emission factor (kg CH_4/cow/year) and the methane conversion factor (MCF; % of GE intake converted into CH_4) on the basis of data on the share of feed components (grass silage, maize silage, wet by-products and concentrates), their chemical nutrient composition (soluble carbohydrates, starch, NDF, crude protein, ammonia, crude fat and ash) and the intrinsic degradation characteristics of starch, NDF and crude protein in the rumen. Data on the share of feed components in the diet are found at www.cbs.nl. Data on the chemical nutrient composition of individual roughages are provided by Blgg (a leading laboratory in the Dutch agricultural and horticultural sector with roughage sampling, analytical and advisory activities, and able to deliver data that can be taken as representative of the average Dutch farming conditions; www.blgg.com). Data used between 1990 and present are published by Bannink (2010) (via www.prtr.nl).

Young cattle and non-dairy cattle

The methane emission factor (EF) for enteric fermentation by non-dairy and young cattle is calculated by multiplying the GE intake by a methane conversion factor (Smink, 2005). Changes in GE intake are based on changes in the total feed intake and on the share of feed components. Data on the amounts of feed components, expressed as dry matter (DM) intake are found at www.cbs.nl and in Annex 8 Table A8.2 Gross Energy intake can be found. The equation for calculating the EF (in kg per animal per year) is:

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

EF	Emission factor (kg CH_4/animal/year)
MCF	Methane conversion factor; fraction of the gross energy of feed inta ke converted to CH_4
GE intake	Gross energy intake (MJ/animal/day)

With:

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

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

Other livestock

Emission factors for the source categories swine, sheep, horses and goats are based on default IPCC Tier 1 EF (IPCC, 1997). As these factors are averages over all age groups, they have to be multiplied by total number of animals in

that category. This differs from the calculations for 4B manure management, where young animals are included through the manure productions of the mother animals. The share in total CH_4 enteric fermentation emissions by these other livestock categories (sheep, goats, horses and swine) is less than 10% of the total CH_4 enteric fermentation emissions. According to IPCC good practice guidance (GPG), no Tier 2 method is needed if the share of a source category is less than 25–30% of the total emission by a key source category.
As already mentioned in section 6.2.1, enteric fermentation emission from poultry is not estimated due to a lack of data on CH_4 emission factors for this animal category.

6.2.5 Uncertainty and time-series consistency

Uncertainty
The Tier 1 uncertainty analysis shown in Annex 7 provides estimates of uncertainty according to IPCC source categories. The uncertainty of CH_4 emissions from enteric fermentation from cattle sources is based on the judgements of experts and is estimated to be about 16% in annual emissions for mature dairy cattle, using a 5% uncertainty for animal numbers (Olivier et al., 2009) and 15% for the emission factor (Bannink, 2010). For the other cattle categories this is 21% based on 5% uncertainty in activity data and 20% on the EF. The uncertainty in the emission factor for swine and other animals is estimated to be 50% and 30%, respectively (Olivier et al., 2009).

Time-series consistency
A consistent methodology is used throughout the time-series; see also section 6.2.4. Emissions are calculated from animal population data and emission factors. The animal population data are collected in an annual census and published by Statistics Netherlands over a long period of time (several decades). Emission factors are either constant (default IPCC) or are calculated from feed intake data collected by an annual survey published by Statistics Netherlands.

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

However, in order to comply with requirements set forth by the Farm Accountancy Data Network (FADN) of the European Union, from 2010 on a new definition for farms is being used. Before the criterion for inclusion into the agricultural census was three Dutch size units (NGE), this has now changed in 3,000 Standard Output (SO). As influence on the population is very slight, official statistics were not recalculated and therefore the inventory does not reflect this either.

6.2.6 Source-specific QA/QC and verification

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

6.2.7 Source-specific recalculations

Recalculations as result of the 2011 in-country review
Since they are not intended for production, privately owned horses and ponies are not part of the agricultural census. The Product Boards for Livestock, Meat and Eggs (PVE,2005) estimate their number to be 300,000 for the whole time-series. Within the inventory it was decided earlier to include these in the sector Agriculture, since calculation methods were already available.

During the in-country review it was found that due to an error, activity data used for the CH_4 calculations did not reflect this added amount. As a result, emissions in source category 4A Enteric fermentation have increased with 5.4 Gg CH_4 (113.4 Gg CO_2 eq) for each year of the time-series.

The above-mentioned recalculations were included in the latest official CRF submission form November 2011 and therefore, do not show up in the recalculation sheet of the current CRF.

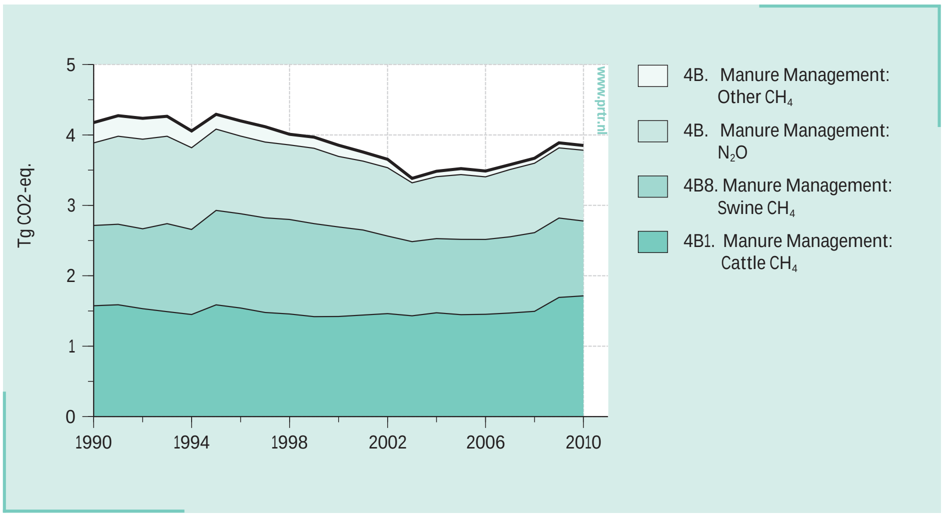
Other recalculations
For 1992 an error was detected in the calculation of the emission factors used within the mature non-dairy and young cattle categories. A wrong set of data on rations fed had been used, leading to underestimations of 1.6 and 0.2 Gg CH_4 (respectively 344.4 and 39.1 Gg CO_2 eq), which is corrected in this submission.

6.2.8 Source-specific planned improvements

Within the calculation of the CH_4 emission factor for mature dairy cattle (Bannink, 2010) a subdivision is made in the NW and SE parts of the country. Until now, CH_4 emissions are not regionalised and thus the weighed mean for the whole of the Netherlands is used. However, it is planned to start making this distinction because rations and thus emissions differ considerably between regions.

On the national scale this could induce slight differences (negligible) due to rounding off numbers.

Figure 6.2 Category 4B Manure management: trend and emission levels of source categories, 1990-2010.



6.3 Manure management [4B]

6.3.1 Source category description

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

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

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

6.3.2 Overview of shares and trends in emissions

In 2010, manure management accounted for 23% (CH_4 and N_2O) of the total greenhouse gas emissions from the agricultural sector (Table 6.1 and Figure 6.2). In the Netherlands, CH_4 emissions from manure management are particularly related to cattle and swine manure management, which in 2010 contributed 10% and 6% respectively, to the total greenhouse gas emissions in the agricultural sector. Poultry is a minor key source for CH_4 emissions by manure management. Furthermore, N_2O emissions from manure management contribute 6% of the total greenhouse gas emissions from the agricultural sector.

Between 1990 and 2010, the emission of CH_4 from manure management decreased by 5%. Emissions from cattle increased by 9% while swine and poultry decreased by 7 and 76% during this period. From 2009 to 2010, the emission of CH_4 from manure management showed a 1.5% decrease.

The emissions of N_2O from manure management decreased 14% between 1990 and 2010, from 1.2 to 1.0 Tg CO_2 eq (Table 6.1). Decreasing animal numbers have been the cause of this trend, from 2007 on it has reversed back into an increase. With the introduction of National Emission Model for Ammonia (NEMA) in 2010, N-flows have shifted giving rise to higher NH_3-emissions and thus lower emissions of N_2O from manure management. Emission factors have also been updated and now follow a Tier 3 approach.

6.3.3 Activity data and (implied) emission factors

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

Table 6.5 CH_4 implied emission factor (kg/head/year) for Manure management as specified by animal category, 1990-2010.

Animal type	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cattle									
- mature dairy cattle	27.70	30.48	33.15	37.50	38.34	39.19	37.50	41.73	42.58
- mature non-dairy cattle	3.23	3.53	3.45	3.45	3.45	3.45	3.45	3.45	3.45
- young cattle	7.70	8.22	7.18	6.63	6.52	6.42	6.86	7.66	7.68
Swine*	3.90	4.43	4.61	4.50	4.46	4.42	4.43	4.40	4.13
Swine excl piglets	6.22	7.25	7.55	7.54	7.55	7.55	7.54	7.54	7.10
- fattening pigs	4.97	6.08	6.32	6.32	6.32	6.32	6.32	6.32	5.79
- breeding swine	11.39	12.24	12.86	12.96	12.99	12.95	13.38	13.26	13.39
Poultry	0.14	0.10	0.06	0.03	0.03	0.03	0.02	0.03	0.02

- Protocol 12-029: CH_4 from Manure management (4B)
- Protocol 12-028: N_2O from Manure management (4B)

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

Activity data on animal numbers can be found on the website www.cbs.nl, in Annex 8, Table A8.1 and in a background document (Van der Hoek and Van Schijndel, 2006). Emission factor data can be found in Annex 8 Tables A8.4 to A8.10.

From the decrease in animal numbers and manure production for swine (Annex 8, Tables A8.1 and A8.8), overall a decrease in CH_4 emission is to be expected. However the decrease is countered by an increase in emission factor (Annex 8, Table A8.7). The emission factor has risen with fraction of manure stored under higher temperatures, i.e., in the stable. For young, mature dairy and non-dairy cattle, emissions do decrease as a result of animal numbers and only a small increase in emission factor. For poultry, the large decrease in CH_4 emissions between 1990 and 2010 can only be explained by the shift towards the solid manure management system with an associated lower IEF.

The slightly decreased N_2O emission from manure management between 1990 and 2010 is explained by a decrease in nitrogen (N) excretion in the stable partly counteracted by an increase in IEF.

CH_4 implied emission factors (IEF) for Manure management

The CH_4 IEF for manure management is calculated annually for all animal categories. A Tier 2 approach is used based on country-specific data on animal manure production per animal, on manure characteristics (such as organic matter (OM) content) and (liquid) manure storage conditions). For more information on methodology, see section 6.3.4 and 6.3.5.

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

Trends in IEF

Mature dairy cattle

The IEF for manure management of mature dairy cattle increased between 1990 and 2010 because the increased milk production in that period (Table 6.4) is accompanied by an increase in manure production per cow and an increase in organic matter content of cattle manure. Both developments result from a higher feed intake. A third development concerns the shift in the proportion of the two dairy manure management systems (liquid manure in the stable and manure production in the meadow). The share of the amount of liquid stable manure increased between 1990 and 2010, while simultaneously the amount of manure produced in the meadow during grazing reduced (Annex 8, Table A8.8). This is a consequence of the increase of the average time period dairy cattle are kept indoors. An explanation for this is the increase in average farm size. Since large herds are difficult to collect for indoor milking, farmers tend to keep the animals indoors for 365 days per year. With stable manure showing a 17-fold higher emission factor for CH_4 emissions, the shift to more stable manure increased the methane emission per cow (Annex 8, Table A8.7; Van der Hoek and Van Schijndel, 2006).

The higher IEF for mature dairy cattle in 2010 can be explained by the volume of manure collected in the animal house (see Annex Table A8.8). Because of less favourable weather, mature dairy cattle spent less time in the meadow than last year and thus, a larger fraction of the manure was excreted at a far higher EF.

Poultry

For poultry, the substantial decrease in CH_4 IEF of manure management between 1990 and 2010 mainly explains the CH_4 emission decrease. This decrease can be explained by a shift in the proportion of the two poultry manure management systems (solid and liquid manure) in this period. The proportion of the solid manure system increased between 1990 and 2010 from approximately 40% to more than 99%. So the liquid manure system was almost completely replaced by the solid manure system. Compared to the liquid manure system the CH_4 emission factor for the solid system is about 15-fold lower (Annex 8, Table A8.7). Overall, this leads to a substantially decreased IEF, which even in combination with a 9% increase in animal numbers fully explains the decrease in CH_4 emissions (Van der Hoek and Van Schijndel, 2006).

Swine
Compared to 1990, the IEF of swine manure management (based on total swine numbers, including piglets), increased in 1993 and 1997 as a result of storage of manure under higher temperature (increased storage capacity below stable) and in 1995 due to increasing volatile solids (Annex 8, Table A8.4 and A8.5). There are interannual changes not explained by this. These changes can be explained by looking at emission factors of underlying swine categories. The calculation method for CH_4 emissions from swine manure management is based on the liquid manure production of adult breeding swine (in which manure production by piglets is accounted for). So presenting the underlying IEFs gives a better understanding of the interannual changes.

For fattening pigs the 22% increase in IEF between 1990 and 1995 is explained by a 4% decrease in manure production per animal combined with a 20% increase in organic matter (OM) content of the manure and a higher storage temperature. The 4% increase in IEF between 1995 and 2000 is explained by an 8% increase due to higher storage temperature counteracted by a 4% decrease in manure production per animal. These manure volume changes are mainly the result of a change in liquid manure handling. In order to decrease the liquid manure volume, the mixing of rinsing water with manure was prevented as much as possible. As a consequence not only manure volume decreased, but also an increase in the OM concentration of manure occurred. A higher OM content results in a higher emission factor.

The interannual changes in the IEF for breeding pigs' manure are explained by interannual changes in the relative amount of different swine categories. Furthermore, between 1999 and 2000 a 2% decrease in manure production per animal occurred as a result of a change in liquid manure handling. In order to decrease the manure volume, the mixing of rinsing water with manure was prevented as much as possible. For more details see Van der Hoek and Van Schijndel (2006) and Annex 8, Tables A8.4 to A8.8.

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

The values of one of the underlying parameters per manure management system, Volatile Solids (VS), also called Organic Matter (OM) per animal type are also not directly comparable. The Netherlands approach differs from the IPCC method in that the Netherlands uses the VS content of the manure (kg VS per kg manure) instead of volatile solids VS produced per animal per day (kg per head per day) in the IPCC calculation equations. By multiplying the VS per kg manure with the manure production per year, the annual VS production in manure in the Netherlands can be compared with the annual VS production underlying the default IPCC emission factors. More details are presented in Annex 8. Compared to the IPCC default MCF values, the Netherlands MCF values for liquid manure systems of swine (1990-1996) and cattle are slightly lower because part of the manure is stored under cooler conditions. For solid manure systems, the Netherlands uses a MCF of 1.5% for all animal categories (see section 6.3.2); for manure production in the meadow, it uses the IPCC default MCF value.

N_2O implied emission factor (IEF) for Manure management
Emissions of N_2O from manure management are calculated within the NEMA-model, where emission factors represent the IPCC default values for liquid, solid manure management systems and liquid poultry manure of 0.001, 0.02 and 0.005 respectively.

Table 6.6 shows that the N_2O emissions from manure management decreased between 1990 and 2010, mainly as a consequence of the decrease in the total N-excretion.

6.3.4 Methodological issues

Methane emissions from animal manure
A Tier 2 approach is followed for CH_4 emission calculations. The amounts of manure (in kg) produced are calculated annually for every manure management system per animal category. The amount of manure produced is calculated by multiplying manure production factors (in kg per head per year) by animal numbers. Detailed descriptions of the methods can be found on the website www.nlagency.nl/nie. More specified data on Manure management are based on statistical information on manure management systems found at www.cbs.nl. These data are also documented in Van der Hoek and Van Schijndel (2006) and in Annex 8, Table A8.8.

Table 6.6 N_2O implied emission factor for Manure management and total N-excretion per animal manure management system, 1990-2010 (Units: mln kg/year and kg N_2O/kg manure).

	1990	1995	2000	2005	2007	2008	2009	2010
Total N-excretion	514.5	516.1	432.6	393.6	406.3	413.0	418.1	423.3
- liquid system	412.4	411.8	337.7	305.2	316.1	319.4	322.9	326.8
- solid storage	102.1	104.3	94.8	88.4	90.2	93.6	95.2	96.5
N_2O emission manure management	3.78	3.72	3.23	2.97	3.08	3.18	3.22	3.24
N_2O IEF manure management	0.0074	0.0072	0.0075	0.0075	0.0076	0.0077	0.0077	0.0077

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

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

In formula: EF = OM *Bo *MCF * 0.662

Where:
0.662 = specific weight of methane, kg per m^3

The Dutch approach differs from the IPCC default in that it uses organic matter (OM) content instead of volatile solids (VS). The reason lies in country-specific Bo values also being expressed in terms of OM content. The outcomes of both methods therefore lead to the same results. Typically, in the Netherlands animal manure is stored in cellars under the slatted floors of animal houses, and when full pumped into outside storage facilities. Given this practice, country-specific MCF values were calculated, as demonstrated in Van der Hoek and Van Schijndel (2006). For solid manure systems and manure produced in the meadow, IPCC default values are used. The IPCC guidelines recommend a MCF value of 0.01 for stored solid cattle manure and MCF = 0.015 for stored solid poultry manure. However, the literature shows that CH_4 emissions from stored solid cattle manure are probably higher. For this reason, the Netherlands set the MCF value for stored solid cattle manure equal to the MCF for stored solid poultry manure (Van der Hoek and Van Schijndel, 2006).

Although the approach of the method applied by the Netherlands for CH_4 calculations differs slightly from the IPCC method, it is in accordance with the IPCC GPG. The Netherlands uses a country-specific emission factor for a specific animal category, which is expressed as the amount of CH_4 emitted per kg animal manure per year, whereas in the IPCC method the emission factor is expressed as the amount of methane (in kg) emitted per animal per year. Since the CH_4 emissions from manure management from cattle, swine and poultry are key sources (see Table 6.1), the present country-specific Tier 2 methodology fully complies with the IPCC Good Practice Guidance (IPCC, 2001).

Nitrous oxide emissions from animal manure

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

6.3.5 Uncertainty and time-series consistency

Uncertainty

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

Time-series consistency

A consistent methodology is used throughout the time-series. The time-series consistency of the activity data is very good due to the continuity in the data provided. However, in order to comply with requirements set forth by the Farm Accountancy Data Network (FADN) of the European Union, from 2010 on a new definition for farms is being used. Before the criterion for inclusion into the agricultural census was three Dutch size units (NGE), this has now changed into 3,000 Standard Output (SO). As influence on the population is very slight, official statistics were not recalculated and therefore the inventory does not reflect this either.

6.3.6 Source-specific QA/QC

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

6.3.7 Source-specific recalculations

Recalculations as result of the 2011 in-country review
Since they are not intended for production, privately owned horses and ponies are not part of the agricultural census. The Product Boards for Livestock, Meat and Eggs (PVE, 2005) estimate their number to be 300,000 for the whole time-series. Within the inventory it was decided earlier to include these in the sector Agriculture, since calculation methods were already available.

During the in-country review it was found that due to an error, activity data used for the CH_4 calculations did not reflect this added amount. As a result, emissions in source category 4B Manure management have increased with around 0.86 Gg CH_4 (18.1 Gg CO_2 eq) for each year of the time-series. There are minor differences over the years because of slight changes in the emission factor associated with grazing.

The above-mentioned recalculations were included in the latest official CRF submission from November 2011 and therefore, do not show up in the recalculation sheet of the current CRF.

Other recalculations
This submission holds separate emission figures for rabbits and fur bearing animals, which were included in the poultry category before. In order to improve transparency and to ensure consistency with other estimates (for ammonia and particulate matter) these are now reported separately.

6.3.8 Source-specific planned improvements

A possible technical measure to prevent methane emissions due to manure management is manure treatment in an anaerobic digester. In 2008, 0.6% of the total liquid stable manure has been treated in an anaerobic digester (www.cbs.nl). The Netherlands is examining future needs and possibilities in this area to include anaerobic treatment in the methodology and to extend calculations. Results of an initial research are expected for 2012.

6.4 Agricultural soils [4D]

6.4.1 Source category description

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

6.4.2 Overview of shares and trends in emissions

In 2010, agricultural soils contributed 36% to the total greenhouse gas emissions in the agricultural sector. Direct and indirect N_2O emissions and emissions from animal production in the meadow contributed 20%, 9% and 8% respectively, to the total greenhouse gas emissions in the agricultural sector.

Total N_2O emissions from Agricultural soils decreased by 43% between 1990 and 2010 (see Figure 6.3). Direct emissions decreased by 21%, while emissions from animal manure produced in the meadow and indirect emissions decreased 59 and 56%, respectively.

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

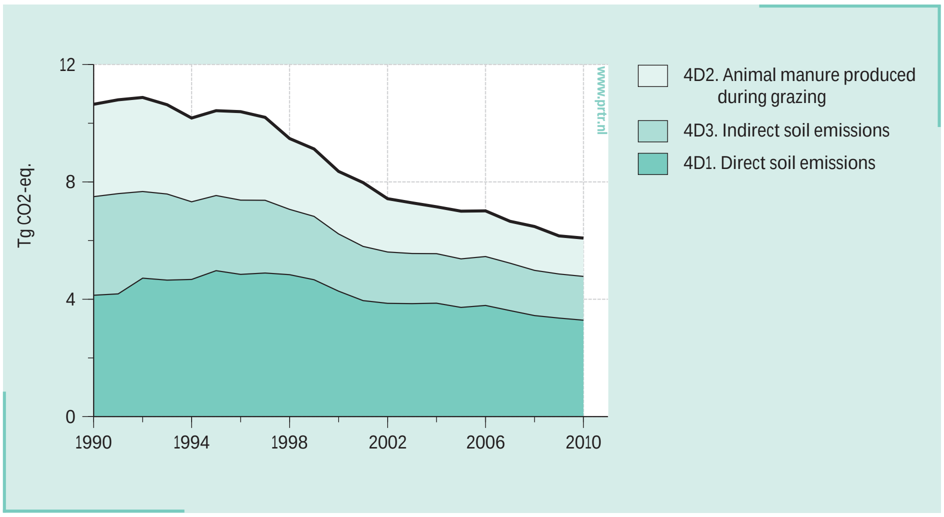
6.4.3 Key sources

Both direct and indirect N_2O soil emissions, as well as animal production on agricultural soils are level and/or trend key sources (see Table 6.1).

6.4.4 Activity data and (implied) emission factors

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

Figure 6.3 Category 4D Agricultural soils: trend and emission levels of source categories, 1990-2010.



- Protocol 12-030: N_2O from Agricultural soils: indirect emissions (4D)
- Protocol 12-031: N_2O from Agricultural soils: direct emissions and grazing emissions (4D).

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

The calculation of N_2O emissions from agricultural soils is based on various activity data, for example, animal numbers (see section 6.1) and nitrogen flows. For an overview of data sources, see the protocols or the background document (Van der Hoek et al., 2007). The activity data and emission factors can also be found in Annex 8, Tables A8.10 and A8.11.

Nitrogen flows

Table 6.7 present the N flows from synthetic fertiliser consumption, animal manure production and application in the Netherlands. 70%-85% of the manure N collected in the stable and in storage is applied to soils. A growing portion of the manure N (from 1% in 1990 to 7% in 2010) is exported; while approximately 10-20% is emitted as ammonia or nitric oxide during storage. The total amount of gross N to soil (total manure production and fertiliser minus net export, including production of animal manure in the meadow) decreased by approximately 38% between 1990 and 2010. The explanation is the Netherlands manure and fertiliser policy, aimed at reducing N leaching and run-off. This policy regulates the amount of manure production and its application by the introduction of measures such as pig and poultry production rights and maximum nutrient application standards for manure and fertiliser.

Of the manure N applied to the soil between 1990 and 2010, the part emitted as ammonia (NH_3) decreased from 45 to 12%, due to a change in the method of animal manure application to agricultural soils. Before 1991 manure was applied to the soil by surface spreading on both grasslands and arable land. Initiated by the Netherlands' policy to reduce ammonia emissions, this practice changed in 1991 into manure incorporation into the soil (e.g., shallow injection or ploughing in), resulting in lower NH_3 emissions. Ultimately, between 1990 and 2010 the part of the N in manure and synthetic fertiliser emitted as NH_3 (in the stable and during storage, grazing and application to the field) decreased from approximately 25% to 12%. In the calculation for 2010, new insights in the N_2O EFs for manure and fertiliser application were adopted, with the first leading to considerably lower N_2O emissions. Part of the total nitrogen flow to the soil is subject to leaching and run-off and until 2009 the default IPCC fracleach factor of 0.3 was used. Now a Tier 3 approach (Velthof and Mosquera, 2011) has been adopted to asses this fraction, while keeping the IPCC default EF of 0.025 in place.

The decrease in indirect N_2O emissions is fully explained by the decrease in N from atmospheric deposition due to lower NH_3-emissions and less leaching and run-off because of lower total N to soil. The decrease in N_2O emissions from animal manure produced in the meadow is also entirely reflected in the decrease in N input to soil by this source. The decrease in direct N_2O emissions can be explained by the decrease in the direct N input to soil by

Table 6.7 Nitrogen flows in relationship to source categories for N_2O (in mln. kg N/year).

	1990	1995	2000	2005	2007	2008	2009	2010	Change 2010 - 1990
Nitrogen fertiliser consumption	412.4	405.8	339.5	279.2	257.5	238.1	225.7	219.5	-47%
Nitrogen excretion by animals	710.4	696.0	565.2	494.9	495.2	506.0	499.0	504.6	-29%
Nitrogen excretion in animals houses	514.5	516.1	432.6	393.7	406.3	413.0	418.1	423.3	-18%
of which in solid form	102.1	104.3	94.8	88.4	90.2	93.6	95.2	96.5	-5%
of which in liquid form	412.4	411.8	337.7	305.2	316.1	319.4	322.9	326.8	-21%
Nitrogen in net manure exported abroad	5.9	22.4	18.0	26.2	31.3	38.3	38.8	36.1	517%
Available manure for application (N-excretion in animal houses – total N-emissions in animal houses – export)	410.5	399.9	336.4	299.0	309.5	301.5	300.3	293.4	-29%
Nitrogen excretion in meadow	195.9	179.9	132.5	101.2	88.8	93.0	80.8	81.3	-59%
Nitrogen in sewage sludge on agric. land	5.0	1.5	1.5	1.2	1.0	1.0	0.9	0.9	-82%
Total nitrogen supply to soil (manure + fertiliser + sewage sludge - export)	1121.9	1080.9	888.2	749.1	722.3	706.9	686.7	688.8	-39%
Nitrogen fixation in arable crops	7.8	4.9	4.7	4.5	4.5	4.2	4.3	4.4	-44%
Nitrogen in crop residues left in field	36.4	34.9	34.1	32.1	29.3	26.7	26.4	25.5	-30%
Nitrogen in histosols	52.4	52.4	52.4	52.4	52.4	52.4	52.4	52.4	0%
NH_3-N emission from synthetic fertilisers	12.0	12.0	10.5	11.4	10.7	9.0	8.6	8.8	-26%
NO-N emission from synthetic fertilisers	4.9	4.9	4.1	3.4	3.1	2.9	2.7	2.6	-47%
NH_3-N emission in animal houses	72.3	70.5	56.3	46.2	46.3	47.3	47.3	45.1	-38%
NO-N emission in animal houses	2.4	2.4	2.1	1.9	2.0	2.0	2.0	2.1	-14%
NH_3-N emission from manure application	182.6	63.7	51.0	44.5	45.9	35.7	35.4	34.5	-81%
NO-N emission from manure application	4.9	4.8	4.0	3.6	3.7	3.6	3.6	3.5	-29%
NH_3-N emission in meadow	15.2	13.7	4.5	3.0	2.1	2.3	1.5	1.8	-88%
NO-N emission in meadow	2.4	2.2	1.6	1.2	1.1	1.1	1.0	1.0	-59%
Atmospheric deposition agr. NH_3-N NO-N	296.7	174.1	134.0	115.1	114.8	103.9	102.3	99.5	-66%
Nitrogen lost through leaching and run off	157.1	140.5	106.6	89.9	86.7	84.8	82.4	82.7	-47%

manure and synthetic fertiliser application, softened by an increase in IEF because of the incorporation into soil.

Implied emission factor

Table 6.8 shows the implied emission factors (IEF) for N_2O emissions from agricultural soils for the application of animal manure. A 132% increase in IEF occurred in the period 1990–2010, which is caused by an ammonia policy driven shift from the surface spreading of manure to the incorporation of manure into the soil. Combined with a 29% decrease in N manure input to soil (see Table 6.7), this explains the 55% increase in N_2O from manure application.

Table 6.8 N_2O implied emission factors from animal manure applied to agricultural soils (Unit: kg N/kg N-input).

Year	IEF
1990	0.004
1991	0.004
1992	0.007
1993	0.007
1994	0.008
1995	0.009
1996	0.009
1997	0.009
1998	0.009
1999	0.009
2000	0.009
2001	0.009
2002	0.009
2003	0.009
2004	0.009
2005	0.009
2006	0.009
2007	0.009
2008	0.009
2009	0.009
2010	0.009

6.4.5 Methodological issues

Direct and indirect N_2O emissions from agricultural soils, as well as N_2O emissions by animal production in the meadow are estimated using country-specific activity data on N-input to soil and NH_3 volatilisation during grazing, manure management (stable and storage) and manure application. Most of these data are estimated at a Tier 2 or Tier 3 level. The present methodologies fully comply with the IPCC Good Practice Guidance (IPCC, 2001). For a description of the methodologies and data sources used, see the monitoring protocols on www.nlagency.nl/nie. A full description of the methodologies is provided in Van der Hoek et al. (2007), with more details in Kroeze (1994). An overview of the emission factors used is presented in Table 6.9. Default IPCC emission factors are included for comparison.

Direct N_2O emissions

An IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions from soil. Emissions from animal manure application are estimated for two types of manure application methods, surface spreading with lower and incorporation into soil with higher emission factor. The higher value for incorporation is explained by two mechanisms. Incorporation of animal manure into the soil produces less ammonia emission and therefore more reactive nitrogen enters the soil. Furthermore, the animal manure is more concentrated (e.g., hot spots) in comparison with surface spreading and hence, the process conditions for nitrification and denitrification can be more suboptimal.

From 2010 calculations are made on gross instead of net nitrogen flows in order to make them more transparent. At the same time, emission factors were updated based on laboratory and field experiments towards the effect of manure application technique on N_2O emission (Velthof et al., 2010; Velthof en Mosquera, 2011; Van Schijndel en Van der Sluis, 2011).

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

Source	Default IPCC	EF used	Reference
Nitrogen fertiliser	0.0125	0.013	4
Animal manure application	0.0125		
Surface spreading		0.004	4
Incorporation into soil		0.009	4
Sewage sludge	0.0125	0.01	2
Biological nitrogen fixation crops	0.0125	0.01	1
Crop residues	0.0125	0.01	2
Cultivation of organic soils (histosols)		0.02	2,3
Animal manure during grazing	0.02	0.033	4

References: 1 = Kroeze, 1994; 2 = Van der Hoek et al., 2007; 3 = Kuikman et al., 2005; 4 = Velthof et al., 2010; Velthof and Mosquira, 2011; Van Schijndel en Van der Sluis, 2011.

Animal production
An IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions from animal production. The method uses total animal production times a country specific emission factor, see also section 6.3.4.

Indirect N_2O emissions
An IPCC Tier 1 method is used to estimate indirect N_2O emissions from atmospheric deposition. Country-specific data on NH_3 and NO emissions (estimated at a Tier 3 level) are multiplied by the IPCC default N_2O emission factor.

Indirect N_2O emissions resulting from leaching and run-off N emissions are estimated using country-specific data on total N-input to soil and leaching fraction (estimated at a Tier 3 level). The difference in 'fracleach' is justified due to specific characteristics of the Netherlands' agricultural soils, with relatively high water tables. A model (STONE) was adopted to assess this fraction as described in Velthof and Mosquera (2011), with IPCC default values used for the N_2O emission factor.

The main reason to use IPCC defaults is that direct and indirect N_2O emissions in the Netherlands partially originate from the same soils and sources. In the Netherlands, no experimental data are available to evaluate the value of the emission factor for indirect emissions.

6.4.6 Uncertainty and time-series consistency

Uncertainty
The Tier 1 uncertainty analysis, shown in Annex 7, provides estimates of uncertainty according to IPCC source categories. The uncertainty in direct N_2O emissions from Agricultural soils is estimated to be approximately 60%. The uncertainty in indirect N_2O emissions from N used in agriculture is estimated to be more than a factor of 2 (Olivier et al., 2009).

Time-series consistency
Consistent methodologies are used throughout the time-series. The time-series consistency of the activity data is very good due to the continuity in the data provided. However, in order to comply with requirements set forth by the Farm Accountancy Data Network (FADN) of the European Union, from 2010 on a new definition for farms is being used. Before the criterion for inclusion into the agricultural census was three Dutch size units (NGE), this has now changed in 3,000 Standard Output (SO). As influence on the population is very slight, official statistics were not recalculated and therefore the inventory does not reflect this either.

6.4.7 Source-specific QA/QC

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

6.4.8 Source-specific recalculations

Recalculations as result of the 2011 in-country review
None.

Other recalculations
In the division of manure over surface spreading and incorporation into the soil, an error was found for the years 1999-2009. Previously, another model was used for ammonia emissions which assumed that from 1999 on surface spreading had zero activity. Last year a new model was adopted, that takes into account the practice in the whole time-series.

However, the amount being surface spread was not subtracted from total manure for application within the N_2O calculations again (and thus also counted towards incorporation in the soil). This double count has been repaired in this submission, reducing emissions by 2.3 to 2.9 Gg (-71.6 to -185.7 Gg CO_2 eq) for these years).

6.4.9 Source-specific planned improvements

None.

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

Major changes in the LULUCF sector compared to the National Inventory Report 2011

Emissions:	The emission data from LULUCF for 2010 are slightly higher than those from 2009. The value for 2009 is about 13% higher than in the previous NIR (2011) due to recalculations
Key sources:	Land converted to Settlements is a key source for the 1st time
Methodologies:	Change to Tier 1 methodology for carbon stock changes in living biomass during land use conversions to/from Croplands and Grasslands to increase completeness of reporting.

7.1 Overview of sector

This chapter describes the 2010 greenhouse gas inventory for the Land Use, Land Use Change and Forestry (LULUCF) sector. It covers both the sources and sinks of CO_2 greenhouse gases from land use, land use change and forestry. The emission of nitrous oxide (N_2O) from land use is included in the 'Agriculture' sector (category 4D) and the emission of methane (CH_4) from wetlands is not estimated due to the lack of data. All other emissions from forestry and land use can be considered to be negligible. Land use in the Netherlands is dominated by agriculture (57%), settlements (13%), forestry (10%, including trees outside forests) and 2% comprises dunes, nature reserves, wildlife areas and heather. The remaining area (19%) in the Netherlands is open water. The soils in the Netherlands are dominated by mineral soils, mainly sandy soils and clay soils (of fluvial or marine origin). Organic soils, used mainly as meadowland or hayfields, cover about 8% of the land area. The Netherlands has an intensive agricultural system with high inputs of nutrients and organic matter. The agricultural land is used as grassland (51%), arable (25%), fodder maize (12%) and the remaining agricultural land is used for horticulture, fallow, fruit trees, etc. Grassland and fodder maize are cultivated in rotation. About 80% of the grasslands are permanent grasslands (of which 5% are high nature value grasslands); the remaining 20% is temporary grassland. Since 1990, the agricultural land area has decreased by about 5%, mainly because of conversion to settlements/infrastructure and nature. The LULUCF sector in the Netherlands is estimated to be a net source, amounting in 2010 to some 2.7 Tg CO_2 equivalents. The fact that the LULUCF sector is a net source is due to the large contribution of carbon emitted from drained peat soils, which exceeds the sequestration of carbon in forestry. The LULUCF sector is responsible for 1.3% of total greenhouse gas emission in the Netherlands. The structure of this section and of the main submission for the National Inventory Report and Common Reporting Format (CRF) tables is based on the categories of the CRF tables, as approved at the 9th Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The Sector 5 Report tables in the CRF format have been submitted using the CRF Reporter.

7.2 Methods

The methodology of the Netherlands to assess the emission from LULUCF is based on the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance: a carbon stock change approach based on inventory data subdivided into appropriate pools and land use types and a wall-to-wall approach for the estimation of area per category of land use. The information on the activities and land use categories used covers the entire territorial (land and water) surface area of the Netherlands. The inventory comprises six classes: Forest Land; Cropland; Grassland; Wetlands; Settlements and Other Land. There is also a category 'Other' which includes emissions from land use related activities such as liming. The changes in land use ('remaining' or 'converted') are presented in a 6 x 6 matrix, which is fully in accordance with the approach described in the IPCC guidelines. To better match available national maps and databases on land use, the category 'Forest Land' is the aggregation of two main subdivisions: Forest (according to the Kyoto definition) and Trees outside Forest, and the category 'Grassland' is the aggregation of two main subdivisions: Grasslands and Nature. The latter subdivision includes heather, peat land and moors. All categories are relevant in the Netherlands. The carbon cycle of a managed forest and wood production system is considered in the calculations of the relevant CO_2 emissions. The carbon stocks in soils from a single stratified measurement campaign for the various types of land use are used to calculate the emissions from land use categories. For the Netherlands, it is assumed that the impact of land use in terms of loss of soil carbon is likely to be relatively small. We have assumed no changes in the soil carbon stocks due to land and soil management and cultivation practices over the period 1990–2010. This is a conservative approach.

The requirement in the Kyoto Protocol to quantify changes in carbon stock for land use conversions to and from Kyoto forest only (at least for countries like the Netherlands that elected no 3.4 activities), led to quantified estimates for these specific land use changes in mineral soils. Afforestation, Reforestation and Deforestation (ARD) together proved to be a sink (see chapter 11 for details). As the Convention allows a more aggregated and complete reporting, the Netherlands for now, until new data becomes available, reports the soils of the Netherlands as one aggregated sink of uncertain magnitude that is conservatively reported as zero (with the exception of the cultivated organic soils, which are reported separately).

7.3 Data

In this NIR, the changes in land use are based on comparing detailed maps that best represent land use in 1990, 2004 and 2009. All three datasets on land use were especially developed to support the temporal and spatial development in land use and especially designed to support policy in the field of nature conservation (MNP, 2008). In the future, updates of the digital land use map will become available regularly and these will suit the future LULUCF process in their aim to present accurate

Table 7.1 Land Use and Land Use Change Matrix aggregated to the six UNFCCC land use categories (in ha) for the period 1990-2004.

				BN 1990			
BN 2004	Forest land	Cropland	Grassland	Wetland	Settlement	Other land	*Total*
Forest land	350,751	14,560	22,540	1,217	2,530	651	*392,248*
Cropland	1,605	739,190	196,595	596	1,623	8	*939,617*
Grassland	17,902	176,797	1,190,740	9,092	10,987	2,547	*1,408,064*
Wetland	1,822	6,821	18,641	776,007	1,390	2,583	*807,265*
Settlement	10,019	81,783	78,259	2,836	392,805	630	*566,332*
Other land	809	201	907	2,791	122	33,144	*37,974*
Total	*382,907*	*1,019,353*	*1,507,682*	*792,539*	*409,457*	*39,563*	*4,151,500*

Table 7.2 Land Use and Land Use Change Matrix aggregated to the six UNFCCC land use categories (in ha) for the period 2004-2009.

				BN 2004			
BN 2009	Forest land	Cropland	Grassland	Wetland	Settlement	Other land	*Total*
Forest land	377,584	2,304	8,827	466	6,155	238	*395,573*
Cropland	487	813,282	106,547	177	4,367	2	*924,863*
Grassland	6,417	108,480	1,243,329	9,633	23,123	506	*1,391,488*
Wetland	829	1,794	10,610	794,785	3,033	890	*811,941*
Settlement	6,694	13,729	37,705	1,441	529,417	137	*589,123*
Other land	238	27	1,047	762	237	36,200	*38,512*
Total	*392,248*	*939,617*	*1,408,064*	*807,265*	*566,332*	*37,974*	*4,151,500*

Table 7.3 Pools for which emissions are reported in the National System per land use (conversion) category in 2012. New variables for the 2012 submission are printed with grey background.

From→ To↓	FL-FAD	FL-TOF	CL	GL	WL	Sett	OL
FL-FAD	BG – BL + DW	BG	BG -BL	BG -BL	BG	BG	BG
FL-TOF	BG – DW - Litt	BG	BG -BL	BG -BL	BG	BG	BG
CL	BG – BL – DW - Litt	BG - BL	Lime appl.	BG -BL	BG	BG	BG
GL	BG – BL – DW - Litt	BG - BL	BG - BL	Cult. of org. soils	BG	BG	BG
WL	– BL – DW - Litt	- BL	-BL	-BL	-	-	-
Sett	– BL – DW - Litt	- BL	-BL	-BL	-	-	-
OL	– BL – DW - Litt	- BL	-BL	-BL	-	-	-

BG: Biomass Gain; BL: Biomass Loss; DW: Dead Wood; Litt: Litter.

information on land use changes. Changes in land use over the period 1990–2004 and 2004-2009 were checked in detail (Kramer et al., 2009; Van den Wyngaert et al., 2012). Omissions due to methodological reasons (e.g., legend, classification and gridding) were manually adjusted in favour of a correct presentation of the changes in land use over the period 1990–2009. The sum of all land use categories is constant over time. It is likely that the updated reference maps will also follow future updates of the land use change matrix. Changes after 2009 have been obtained by linear extrapolation of the land use change rates calculated for the period 2004-2009. The resulting land use matrices are Table 7.1 and 7.2.

Table 7.3 provides an overview of the completeness of reporting of the Netherlands. In response to the 2011 in-country review, the completeness for reporting of biomass was increased to include biomass changes from conversions to and from croplands and grasslands. New pools are carbon stock change due to changes in biomass for all land use conversions involving Croplands and Grasslands, as well as the loss of carbon in dead wood and litter due to conversions from forests to trees outside forests (see also section 7.4 Recalculations).

7.4 Recalculations

This year, there were several changes that led to recalculations.

1. Implementation of a 3rd land use map with map date 1st January 2009. This changed areas and thus, all emissions calculated from area data, from 2004 on, see section 7.3 for the new land use matrix after 2004.
2. Implementation of an updated map of organic soils, leading to updated values for organic soil areas from 1990 on. The areas have decreased slightly, as some of the soils in the Netherlands that were organic soils by now have lost so much of their organic layer that they no longer meet the definition of organic soils.
3. Implementation of Tier 1 method to estimate changes in carbon stock in biomass during land use changes. This resulted in additional sources and sinks in croplands and all conversions that involved Croplands and Grasslands.
4. Emissions from liming of agricultural soils in Other (5G). In the previous NIR fertiliser data were not available for 2009 and therefore the 2009 emission was set equal to the 2008 emission. These fertiliser data have become available and have been used to calculate the 2009 emissions. Furthermore, there was a correction of the 2008 emissions.
5. Update of harvest values led to recalculations for 2009. In the 2011 submission, the value for 2008 was copied for 2009. For this submission, values for 2009 as well as for 2010 were available.
6. Emissions associated with removal of dead wood and litter when Forests are converted to trees outside Forests. This was applied in response to comments on the 2011 review and ensured that no carbon was lost unaccounted for when Forests were first converted to trees outside Forests (which are assumed to have no significant dead wood and litter) and later to any other land use category.

The methodologies applied for estimating CO_2 emissions and removals of the land use change and forestry in the Netherlands are described in the updated background document (van den Wyngaert et al., 2012) and in updates of the two protocols (see also the website www.nlagency.nl/nie):

- Protocol 12-032: CO_2 from forest (5A)
- Protocol 12-033: CO_2 from total land use categories (5B-5G).

Table 7.4 shows the sources and sinks in the LULUCF sector in 1990 and 2010. For 1990 and 2010, the total net emissions are estimated to be approximately 3.0 Tg CO_2 and 3.0 Tg CO_2 respectively, with the major source being CO_2 emissions from the decrease in carbon (C) stored in organic soils and peat lands: 4.2 Tg CO_2, included in 5C1 'Grassland remaining grassland', resulting from agricultural and water management. The major sink is the storage of carbon in forests: -2.7 Tg CO_2, this includes the emissions from 'Forest Land remaining forest land' (5A1) and 'Land converted to Forest Land' (5A2). Sector 5 'Land use, land use change and forestry' (LULUCF) accounted for 1.3% of the total national CO_2 emission in 2010.

7.5 Forest Land [5A]

7.5.1 Source category description

This category includes emissions and sinks of CO_2 caused by changes in forestry and other woody biomass stock. All forests in the Netherlands are classified as temperate forest, with 30% of the forests being coniferous, 22% broad-leaved and the remaining area a mixture of both. The share of mixed and broad-leaved forests has grown in recent decades (Dirkse et al., 2003). In the Netherlands, with its very high population density and strong pressure on land, all forests are managed.

The category includes two subcategories: 5A1 'Forest Land remaining Forest Land' and 5A2 'Land converted to Forest Land'. The first category includes estimates of changes in the carbon stock from different carbon pools in the forest.

The second category includes estimates of the changes in land use from mainly agricultural areas into forest land since 1990 with a 20-year transition period.

Also included in this section (under the heading 'Forest land converted to other land use categories') are the descriptions related to the conversion of Forest land to all other land use categories, which are summed separately under the information items.

7.5.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The methodology of the Netherlands to assess the emission from LULUCF is based on a wall-to-wall approach for the estimation of area per category of land use. For the wall-to-wall map overlay approach were used harmonised and validated digital topographical maps of 1990, 2004 and 2009 (Kramer et al., 2009; Van den Wyngaert et al., 2012). The result was a national scale land-use and land-use change matrix. The information on the activities and land-use categories used covers the entire territorial (land and water) surface area of the Netherlands, see also section 7.3.

Table 7.4 Contribution of main categories and key sources in Sector 5 LULUCF.

Sector/category Key sources	Gas	Key Level, Trend	Emissions base-year Tg CO_2 eq	2009 Tg CO_2 eq	2010 Tg CO_2 eq	Change Absolute 2010 - 2009 Tg CO_2 eq	Contribution to total in 2010 (%) by sector	 of total gas	 of total CO_2 eq
5 Total Land use Categories	CO_2		3.0	2.9	3.0	0.1	100%	1.6%	1.4%
5A Forest land	CO_2		-2.4	-2.8	-2.7	0.1	-90%	-1.5%	-1.3%
5A1 Forest land remaining Forest Land	CO_2	L,T	-2.4	-2.3	-2.1	0.1	-72%	-1.2%	-1.0%
5A2 Land converted to Forest Land	CO_2		0.1	-0.6	-0.5	0.0	-18%	-0.3%	-0.3%
5B Cropland	CO_2		0.1	0.2	0.2	0.0	5%	0.1%	0.1%
5B1 Cropland remaining Cropland	CO_2					0.0	0%	0.0%	0.0%
5B2 Land converted to Cropland	CO_2		0.1	0.2	0.2	0.0	5%	0.1%	0.1%
5C Grassland	CO_2		4.5	4.5	4.5	0.0	150%	2.4%	2.1%
5C1 Grassland remaining Grassland	CO_2	L	4.2	4.2	4.2	0.0	141%	2.3%	2.0%
5C2 Land converted to Grassland	CO_2		0.2	0.3	0.3	0.0	9%	0.1%	0.1%
5D Wetlands	CO_2		0.1	0.1	0.1	0.0	4%	0.1%	0.1%
5D1 Wetlands remaining Wetlands	CO_2		NE	NE	NE				
5D2 Land converted to Wetlands	CO_2		0.1	0.1	0.1	0.0	4%	0.1%	0.1%
5E Settlements	CO_2		0.5	0.8	0.8	0.0	27%	0.4%	0.4%
5E1 Settlements remaining Settlements	CO_2					0.0	0%	0.0%	0.0%
5E2 Land converted to Settlements	CO_2		0.5	0.8	0.8	0.0	27%	0.4%	0.4%
5F Other land	CO_2		0.0	0.0	0.0	0.0	1%	0.0%	0.0%
5F1 Other land remaining other Land	CO_2		0.0	0.0	0.0	0.0	0%	0.0%	0.0%
5F2 Land converted to Other Land	CO_2	L	0.0	0.0	0.0	0.0	1%	0.0%	0.0%
5G Other	CO_2		0.2	0.1	0.1	0.0	2%	0.0%	0.0%
National Total GHG emissions (excl. CO_2 LULUCF)	CO_2		162.2	172.8	184.2	11.4		100%	86%
	All		215.9	201.8	213.1	11.2			100%

7.5.3 Definition

The land use category 'Forest Land' is defined as all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory, sub-divided into managed and unmanaged units and also by ecosystem type as specified in IPCC Guidelines. It also includes systems with vegetation that currently fall below, but are expected to exceed the threshold of the forest land category (IPCC, 2003; 2006).

The Netherlands has chosen to define the land-use category 'Forest Land' as all land with woody vegetation, now or expected in the near future (e.g., clear-cut areas to be replanted, young afforestations). This is further stratified in:

- 'Forest' or 'Forest According to Definition' (FAD) – all forest land which complies with the following (more strict than IPCC) definition chosen by the Netherlands for the Kyoto protocol: forests are patches of land exceeding 0.5 ha with a minimum width of 30 m, with tree crown cover at least 20% and tree height at least 5 m, or, if this is not the case, these thresholds are likely to be achieved at the particular site. Roads in the forest less than 6 m wide are also considered to be forest. This definition conforms to the FAO reporting and was chosen within the ranges set by the Kyoto protocol. It is also consistent with the definition used for the national forest inventories.

- 'Trees outside Forests' (TOF), that is - wooded areas that comply with the previous forest definition except for their surface area (=< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads and fields. These areas comply with the GPG-LULUCF definition of Forest Land (they have woody vegetation) but not to the strict forest definition that the Netherlands applies.

7.5.4 Methodological issues

7.5.4.1 *Forest Land Remaining Forest Land*

Removals and emissions of CO_2 from forestry and changes in woody biomass stock are estimated based on country-specific Tier 2 methodology. The approach chosen follows the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The basis assumption is that the net flux can be derived from converting the change in growing stock volume in the forest into carbon. Detailed descriptions of the methods used and emission factors can be found in the protocol 11-032 on the website www.nlagency.nl/nie, as indicated in section 7.3. The Netherlands' National System follows the carbon cycle of a managed forest and wood products system. The pools are distinguished by above-ground biomass, below-ground biomass, litter, dead wood and soil organic carbon. Changes in the carbon stock are calculated for above-ground biomass, below-ground biomass and dead wood and litter in forests. Calculations for the living biomass carbon balance are carried out at plot level. For Croplands and scaled to national scale (Van den Wyngaert et al., 2011).

Living biomass

The following steps are taken to calculate the net carbon flux in living biomass. First, the age of the stand and the limit of dominant height are calculated, followed by a calculation of the height and expected volume in the next year. Based on the expected volume for the next year and from the number of trees, the average tree volume for the next year is derived. The next step is the calculation of the average diameter of the tree in the next year. The above-ground and below-ground total biomass is derived using the equations from the COST E21 database. The desired net flux is derived from the difference in tree mass between two years, the basic wood density and the carbon content of the dry mass. This last step is represented in the following equation:

$$\Delta C_{FF_G} = \sum_{1}^{n} (A_i \bullet G_{TOTALi}) \bullet CF$$

$$G_{TOTALi} = (\overline{B_{it+1}} - \overline{B_{it}}) \cdot nt_{it}$$

where:

ΔC_{FF_G}	Total net carbon stock change due to biomass increase for Forest land remaining Forest land – FAD in The Netherlands	kg C ha^{-1}
A_i	Area represented per NFI[1] plot	ha
CF	Carbon fraction of living biomass	0.5

and

G_{TOTALi}	Biomass increase for NFI plot I	kg DW[2]
$\overline{B_{it}}$	Average tree biomass of NFI plot i at time t	kg DW
B_{it+1}	Average tree biomass of NFI plot i at time t+1	kg DW
nt_{it}	Living tree density of NFI plot i at time t	ha^{-1}

[1] NFI = National Forest Inventory
[2] DW = Dry Weight

Thinning

Thinning was carried out in all plots that met the criteria for thinning (age > 110 years or growing stock more than 300 m^3 ha^{-1}). The number of trees thinned was based on the volume harvested and the net carbon flux due to thinning is then calculated from the average biomass of a single tree and the carbon content of the dry mass.

Dead wood

The net carbon flux to dead wood is calculated as the remainder of the input of dead wood due to mortality minus the decay of the dead wood. Leaves and roots were not taken into account for the build up of dead wood. The mortality rate was assumed to be a fixed fraction of the standing volume (0.4% year^{-1}), and the current stock of dead wood volume is assumed to be 6.6% of the living wood volume (based on data from Timber Production Statistics and Forecast (HOSP) and the MFV). A net build-up may exist, since Dutch forestry only began to pay attention to dead wood a decade ago. The following equations are used to calculate the net carbon flux to dead wood:

$$\Delta C_{FF\,DW} = \sum (A_i \bullet (B_{DW_{into_i}} - B_{DW_{out_i}})) \bullet CF$$

$$B_{DW_{into_i}} = B_{it} \bullet f_{mort}$$

$$B_{DW_{out_i}} = \left(\frac{V_{SDi}}{L_{SDi}} + \frac{V_{LDi}}{L_{LDi}} \right) \bullet D_{DW} + f_{removal} \bullet D_{DW}$$

$\Delta C_{FF\,DW}$	Total net carbon emission due to change in dead wood for Forest land remaining Forest land – FAD in the Netherlands
$B_{DW_{into_i}}$	Annual mass transfer into dead wood pool of NFI plot i
$B_{DW_{out_i}}$	Annual mass transfer out of dead wood pool of NFI plot i
B_{it}	Stand living biomass of NFI plot i at time t
f_{mort}	Mortality fraction (0.4% year^{-1})
V_{SDi}	Volume of standing dead wood of NFI plot i
V_{LDi}	Volume of lying dead wood of NFI plot i
L_{SDi}	Species specific longevity of standing dead wood
L_{LDi}	Species specific longevity of standing lying wood
D_{DW}	Species specific average wood density of dead wood
$f_{removal}$	Removal fraction of dead wood (was previously set to 0, is now 0.2)

Litter
The carbon stock change from Analysis have shown that there is most probably a build-up in litter in Dutch forest land. However, data from around 1990 are extremely uncertain and thus, this highly uncertain sink is conservatively not reported.

7.5.4.2 Land converted to Forest Land
Removals and emissions of CO_2 from forestry and changes in woody biomass stock are estimated based on country-specific Tier 2 methodology. The approach chosen follows the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The basis assumption is that the net flux can be derived from converting the change in growing stock volume in the forest into carbon, and that young plots (< 20 years) in the national forest inventory are representative for newly re/afforested plots. Detailed descriptions of the methods used and emission factors can be found in the protocol 11-032 on the website www.nlagency.nl/nie, as indicated in section 7.3.

Living biomass
The increase in living biomass in land converted to Forest land is estimated based on the data from the national forest inventories, using the following set of assumptions:
1. At time of regeneration, growth is close to zero.
2. Between regeneration and twenty years of age, the specific growth curve is unknown and is approximated by the simplest function, being a linear curve.
3. The exact height of this linear curve is best approximated by a linear regression on the mean growth rates per age as derived from the NFI. One mean value for each age is taken to avoid confounding effects of the age distribution of the NFI plots (some of which are not afforested but regenerating after a clearcut).
4. The emission factor is calculated for each annual set of afforested plots separately. Thus, the specific age of the re/afforested plots is taken into account and a general mean value is reached only at a constant rate of afforestation for more than twenty years (with varying rates of afforestation, the IEF will vary as well).
5. Between 1990 and 2000, rates are based on the Hosp inventory. From 2000 onwards, rates are based on the MFV inventory.

For Croplands and Grasslands converted to Forest land, biomass loss in year of conversion is calculated using Tier 1 default values.

Dead Organic Matter
The accumulation of dead wood and litter in newly afforested plots is not known, however it is definitely a sink of uncertain magnitude (see also section 11). This sink is conservatively not reported.

7.5.4.3 Forest Land converted to other land use categories

Living biomass
The total emissions from the tree component after deforestation is calculated by multiplying the total area deforested with the average carbon stock in living biomass, above as well as below ground (Nabuurs et al., 2005), as estimated by the calculations for Forest land remaining Forest land. Thus, it is assumed that with

deforestation, all carbon stored above and below ground biomass is lost to the atmosphere. National averages are used as there is no record of the spatial occurrence of specific forest types.

Dead wood

The total emissions from the dead wood component after deforestation is calculated by multiplying the total area deforested with the average carbon stock in dead wood, as estimated by the calculations for Forest land remaining Forest land. Thus, it is assumed that with deforestation, all carbon stored in dead wood is lost to the atmosphere. National averages are used as there is no record of the spatial occurrence of specific forest types.

Litter

The total emissions from the litter component after deforestation is calculated by multiplying the total area deforested with the average carbon stock in litter. Thus, it is assumed that with deforestation all carbon stored above and below ground biomass is lost to the atmosphere. National averages are used as there is no record of the spatial occurrence of specific forest types.

The average carbon stock in the litter layer was estimated at national level (Van den Wyngaert et al., 2011). Data for litter layer thickness and carbon in litter were available from five different datasets. Additional, selected forest stands, on poor and rich sands, were intensively sampled with the explicit purpose to provide conversion factors or functions. None of the available datasets could be used exclusively. Therefore, a stepwise approach was used to estimate the national litter carbon stock in a consistent way. A step-by-step approach was developed to accord mean litter stock values to any of the sampled plots of the available forest inventories (HOSP and MFV).

7.5.5 Activity data

Activity data on land use and land use change are derived from the land use maps and the land use change matrix (see section 7.3).
Activity data on forests are based on forest inventories carried out in 1988–1992 (HOSP data) and in 2001–2002 and 2004–2005 (MFV data). As these most accurately described the state of the Dutch forests, they were applied in the calculations for Forest land remaining Forest land, land converted to Forest land as well as Forest land converted to other land use categories. HOSP data, which includes plot level data (in total 2007 plots, about 400 per year) for growing stock volume, increment, age, tree species, height, tree number and dead wood, was used for the 1990 situation. Forward calculation using this data was applied to the year 1999. Additional data on felling, final cut and thinning was used to complete the data set. MFV plot level data (in total 3622 plots, with same items as HOSP) was applied to the years 2000–2010. In addition, in order to assess the changes in activity data, databases with tree biomass information, with allometric equations to calculate above-ground and below-ground biomass and with forest litter, as well as wood harvest statistics and high-resolution topographical maps of 1990, 2004 and 2009 were used. See the website at www.nlagency.nl/nie for more details on activity data.

7.5.6 Implied emission factors

7.5.6.1 Forest Land remaining Forest Land

The IEF of Forest land remaining Forest land decreases over time from 2.84 Mg C ha^{-1} in 1990 to 2.66 Mg C ha^{-1} in 2010. The decrease in the years 1990-1999 is slightly overestimated, as the new estimated value in 2000 is a bit higher than the calculated value in 1990.

Non CO_2 emissions in forest land

N_2O emissions might occur as a result of using fertiliser in forests or from drainage. Both management practices are rarely applied in forestry in the Netherlands. Thus, it is assumed that N_2O emissions are irrelevant in forests. CH_4 emissions resulting from forest fires are considered to be negligible because fires seldom occur.

7.5.6.2 Land converted to Forest Land

The IEF for biomass increase in land converted to either FAD or TOF increases monotonically, reflecting the age distribution of the re/afforested areas and will attain a constant value 20 years after 1990. The IEF for conversion of Croplands and Grasslands to Forest Land are based on T1 default values and remain constant over time.

7.5.6.3 Forest Land converted to other land use categories

The IEF for carbon stock change from changes in living biomass, i.e., the average carbon stock in living biomass, follows the calculations from the gap filled forest inventory data. The calculated emission factors show a progression over time. The EF for biomass is 60.4 Mg C ha^{-1} in 1990 and increases to 90.35 Mg C ha^{-1} in 2010. The EF for litter is 29.0 Mg C ha^{-1} in 1990 and increases to 35.9 Mg C ha^{-1} in 2010 (this value has been constant since 2003) and the EF for dead wood is 0.45 Mg C ha^{-1} in 1990 and increases to 1.68 Mg C ha^{-1} in 2010. The systematic increase in average standing carbon stock reflects the fact that annual increment exceeds annual harvests in the Netherlands.

Table 7.5 CO_2 emissions/removals from changes in forest and other woody biomass stocks (IPCC category 5A) (Units: Gg CO_2).

	1990	1995	2000	2005	2009	2010
5A Forest Land	-2,356	-2,500	-2,485	-2,575	-2,809	-2,693
5A1 Forest Land remaining Forest Land	-2,412	-2,499	-2,384	-2,357	-2,253	-2,246
Live biomass	-3,754	-3,509	-3,505	-3,309	-3,210	-3,209
Harvest	1,746	1,257	1,247	1,237	1,075	1,074
Trees outside Forest	-212	-180	-160	-135	-121	-121
Dead Wood (including losses when forests are converted to TOF)	-191	-68	60	12	3	2
5A2 Land converted to Forest Land	56	0	-127	-380	-556	-547

7.5.7 Uncertainty and time-series consistency

7.5.7.1 Forest Land remaining Forest Land

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The analysis combines uncertainty estimates of the forest statistics, land use and land use change data (topographical data) and the method used to calculate the yearly growth in carbon increase and removals. The uncertainty in the CO_2 emissions from 5A1 'Forest Land remaining Forest Land' is calculated at 67%. The uncertainty in the CO_2 emission from 5A2 'Land converted to Forest Land' is calculated at 63%. See Olivier et al. (2009) for details.

The uncertainty in implied emission factors of 5A1 'Forest Land remaining Forest Land' concerns forest and trees outside the forest. As the methodology and data sets used are the same for both sources, the uncertainty calculation is performed for forests and the result is considered to be representative for trees outside forests as well. The uncertainty in the implied emission factor of increment in living biomass is calculated at 13% (rounded off to 15% in the calculation spreadsheet). The uncertainty in the implied emission factor of decrease in living biomass is calculated at 30%. The uncertainty in the net carbon flux from dead wood is calculated at 30% (rounded off to 50% in the Tier 1 calculation spreadsheet).

Time-series consistency

The updated time-series for category 5A1 shows an average of about 2,400 Gg CO_2 $year^{-1}$ and with a range from 2,100 Gg CO_2 $year^{-1}$ to 2,700 Gg CO_2 $year^{-1}$ over the period 1990-2010 (see Table 7.5, highest values in years not shown). The figures in category 5A1 show the net result of the sequestration in live trees, in trees outside forest, dead wood and litter and the emission from harvest. The figures for live trees and harvest only change slightly over time, with no clear direction. The figures for afforestation show a steadily decreasing net source in 1990 to quasi neutral in 1995 and further increasing net sink up to 2009, then stabilising as the 20-year transition period is fully covered. They reached a sequestration level of 547 Gg CO_2 $year^{-1}$ in 2010.

7.5.7.2 Land converted to Forest Land

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The analysis combines uncertainty estimates of the forest statistics, land use and land use change data (topographical data) and the method used to calculate the yearly growth in carbon increase and removals. The uncertainty in the CO_2 emission from 5A2 'Land converted to Forest Land' is calculated at 63%. See Olivier et al. (2009) for details.
Uncertainty in implied emission factor of 5A2 'Land converted to Forest Land'
For the increment in living biomass, the same data and calculations are used as for 5A1 'Forest Land remaining Forest Land' and therefore, the same uncertainties are used in the Tier 1 calculation spreadsheet.

Time-series consistency

The updated time series for category 5A2 shows a steadily decreasing net source in 1990, when forests are extremely young and biomass losses from Croplands and Grasslands dominate the values, to quasi neutral in 1995 and further increasing net sink up to 2009, then stabilising as the 20-year transition period is fully covered (Figure 7.2). They reached a sequestration level of 547 Gg CO_2 $year^{-1}$ in 2010.

7.5.7.3 Forest Land converted to other land use categories

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The analysis combines uncertainty estimates of the forest statistics, land use and land use change data (topographical data) and the method used to calculate the yearly growth in carbon increase and removals. The uncertainty in the CO_2 emission from 'Forest Land converted to other land use categories' is calculated at 50%. See Olivier et al. (2009) for details.

Time-series consistency

The updated time series for Forest land converted to other land use categories shows a steadily increasing net source from 666 Gg CO_2 year^{-1} in 1990 to 1242 Gg CO_2 year^{-1} in 2010.

7.5.8 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in chapter 1. The LULUCF QA/QC procedure has shown that there are some very small inconsistencies in the calculation of areas (especially the distribution between land remaining and land converted to a category for land use categories with more than one subcategory). This will be improved in the next submission.

7.5.9 Source-specific recalculations

7.5.9.1 Forest Land remaining Forest

Recalculations that affected Forest land remaining Forest Land were (1) loss of dead wood and litter when forests (according to the definition) were converted to Trees outside Forests from 1990 on and over the whole time series and (2) implementation of the new 2009 land use map and the resulting changes in areas under Forest land remaining Forest land from 2004 on. These recalculations resulted in an additional annual emission of 22 Gg CO_2 in 1990, and 109 Gg CO_2 in 2009 (corresponding to 1% respectively 5% of the total emission from category 5A1 in the previous submission).

7.5.9.2 land converted to Forest Land

Recalculations that affected land converted to Forest Land were (1) implementation of Tier 1 default values for biomass loss from Croplands and Grasslands in the year of conversion from 1990 on and (2) implementation of the new 2009 land use map and the resulting changes in areas under Forest land remaining Forest land from 2004 on. These recalculations resulted in an additional annual emission of 59 Gg CO_2 in 1990 and 149 Gg CO_2 in 2009 (corresponding to 2099% respectively 21% of the total emission from category 5A2 in the previous submission).

7.5.9.3 Forest Land converted to other land use categories

Recalculations that affected Forest land converted to other land use categories were (1) implementation of Tier 1 default values for biomass gain in Croplands and Grasslands in the year of conversion from 1990 on and (2) implementation of the new 2009 land use map and the resulting changes in areas under Forest land remaining Forest land from 2004 on. These recalculations resulted in an additional annual emission of -34 Gg CO_2 in 1990, and 234 Gg CO_2 in 2009 (corresponding to 5% respectively 24% of the total emission from Forest land converted to other land use categories in the previous submission).

7.5.10 Category-specific planned improvements

For this land use category no improvements are planned in the direct future.

7.6 Cropland [5B]

7.6.1 Source category description

The source category 5B 'Cropland' includes only the emissions of CO_2 from 5B2 'Land converted into Cropland'.

The land use category 'Cropland' is defined as all arable and tillage land, including rice-fields and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category (IPCC, 2003).

7.6.2 Activity data and (implied) emission factors

The activity data is derived from the land use maps and the land use change matrix.

7.6.3 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

One consistent approach was used over all land use categories. See sections 7.2 and 7.3.

7.6.4 Definitions

The Netherlands has chosen to define croplands as arable lands and nurseries (including tree nurseries). Intensive grasslands are not included in this category and are reported under Grasslands. For part of the agricultural land, rotation between cropland and grassland is frequent, but data on where exactly this is occurring are as yet lacking. Currently, the situation on the topographical map is leading, with lands under agricultural crops and classified as arable lands at the time of recording reported under Cropland and lands with grass vegetation at the time of recording classified as Grassland.

7.6.5 Methodological issues

The type of land use is determined using digitised and digital topographical maps (scale: 1:10,000), which allows the land-use matrix to be completed according to the recommendations in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The years 1990, 2004 and 2009 are based on observations of land use; the values for the period in between are obtained through linear interpolations and the values for the years after 2009 are obtained by means of extrapolation. For more information on the methodology, see the description on land use and the land use change matrix in chapter 7.2. More detailed descriptions of the methods used and emission factors can be found in the protocols 11-032 and 11-033 on the website www.nlagency.nl/nie.

Carbon emissions from mineral soils are conservatively reported as zero at the national scale as explained in chapter 7.2. The soil organic carbon content of Dutch mineral soils under agriculture is on average not decreasing and is increasing slightly (Hanegraaf et al., 2009; Reijneveld et al., 2009). Based on a large database of soil samples from farmers, the mineral soils show on average a slight increase in soil organic carbon content (Hanegraaf et al., 2009; Reijneveld et al., 2009) and for this reason the Netherlands considers the mineral soils under agriculture as 'not a source'. In fact, they act as very small sinks but their magnitude is unknown.

7.6.6 Uncertainty and time-series consistency

Uncertainties
The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source categories. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The uncertainties in the Dutch analysis of carbon levels depend on the collective factors with which the calculations are implemented (calculation of the organic substances in the soil profile and the conversion to a national level) and data on land use and land use change (topographical data). The uncertainty in the CO_2 emissions from 5B2 'Land converted to Cropland' is calculated at 56%; see Olivier et al. (2009) for details. (rounded off to 50% in the Tier 1 calculation spreadsheet, since it is the order of magnitude that is important).

Uncertainty in activity data
The activity data used is area change, calculated by comparing three topographical maps. The uncertainty of one topographical map is estimated to be 5% (expert judgment).

Time-series consistency
The yearly emission of CO_2 due to the conversion of land converted to cropland shows an annual increase from 122 Gg CO_2 in 1990 to 164 Gg CO_2 in 2010.

7.6.7 Source-specific QA/QC and verification

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

7.6.8 Source-specific recalculations

The recalculations in land converted to cropland are the result of the implementation of the T1 methodologies for biomass loss and gain for Croplands and Grasslands at land use change for the period 1990-2009. Simultaneously, the emissions since 2004 are subject to a recalculation due to an update of the activity data with the implementation of the new land use map (see section 7.4). These recalculations resulted in an additional annual emission of 87 Gg CO_2 in 1990, and 114 Gg CO_2 in 2009 (corresponding to 252% respectively 230% of the total emission from category 5B in the previous submission).

7.6.9 Category-specific planned improvements

For this land use category no improvements are planned in the direct future.

7.7 Grassland [5C]

7.7.1 Source category description

The source category 5C 'Grassland' includes only the emissions of CO_2 from 5C1 'Grassland remaining Grassland' and 5C2 'Land converted into Grassland'. The source category 5C1 is by far the most important source of CO_2 within the sector LULUCF.

7.7.2 Activity data and (implied) emission factors

The activity data is derived from the land use maps and the land use change matrix. The activity data for organic soils is based on soil maps (1:50,000 for the period 1960–1990), recent inventories on organic soils (2001–2003), profile information from LSK and data on field levels in 1990 and 2000.

7.7.3 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

One consistent approach was used over all land use categories. See sections 7.2 and 7.3.

7.7.4 Definition

The land use category 'Grassland' is defined as rangeland and pasture land that is not considered as croplands. It also includes vegetation that falls below the threshold used in the forest land category and is not expected to exceed, without human intervention, the threshold used in the forest land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastoral systems, subdivided into managed and unmanaged, consistent with national definitions (IPCC, 2003). It is stratified in:

- 'Grasslands' – all areas predominantly covered by grass vegetation (whether natural, recreational or cultivated)
- 'Nature' – all natural areas excluding grassland (natural grasslands and grasslands used for recreation purposes). It mainly consists of heath land, peat moors and other nature areas. Many have the occasional tree as part of the typical vegetation structure. This category was a subcategory within Forest land in the previous submissions.

The Netherlands currently reports under grassland any type of terrain which is predominantly covered by grass vegetation. No distinction is made between agricultural intensively and extensively managed grasslands and natural grasslands. However, the potential and the need for this are currently under discussion. Apart from pure grasslands, all orchards (with standard fruit trees, dwarf varieties or shrubs) are included in the category grasslands. They do not conform to the forest definition and while agro-forestry systems are mentioned in the definition of Croplands, this is motivated by the cultivation of soil under trees. However, in the Netherlands the main undergrowth of orchards is grass. We therefore chose to report them as grasslands. As for grasslands, no change in above-ground biomass is reported, the carbon stored in these orchard trees is not reported.

7.7.5 Methodological issues

For information on the methodology to assess land use and land use change see sections 7.2 and 7.3. A country-specific Tier 2 method is used to estimate CO_2 emissions from the drainage of organic soils (Grassland remaining Grassland). For grassland, CO_2 emissions resulting from soil subsidence of peat land by oxidation of peat due to managed drainage are added. The CO_2 emission of 5C1 'Grassland remaining Grassland' is calculated and based on observations on yearly subsidence rates for various types of peat and available information on the extent of drainage and subsequent soil carbon losses through oxidation for each peat type and drainage level (Kuikman et al., 2005). The country-specific method used is based on the recommendations given in the IPCC 2003 Good Practice Guidance (IPCC, 2003). Uncertainty in the decrease in the area of organic soils in past decades – in particular, the estimate for 1990 – has led to the conclusion that the area can be considered to be relatively constant yet likely to be still decreasing at a slow rate since 1990 (223,000 ha is the observed area of organic soils and thus a conservative estimate). The 2003 stated area of organic soils with the relevant water management conditions and measures and calculated loss of organic matter calculates an implied emission factor of on average 19.04 tons CO_2/ha (Kuikman et al., 2005). For the period 1990-2010 the emissions from organic soils under grassland are based on the fixed area and implied emission factor value. Both are the result of analysis of the developments in a range of different peat lands (including water and soil management). The area used so far conflicts to some extent with the results for grassland on organics soils of the land use change matrix.

The matrix shows a 4% smaller area and over time a very slight decrease in area. As long as the loss of carbon cannot be verified and calculated on an annual basis (based on accurate condition data, e.g., temperature and water management) the use of year specific area figures of the matrix introduces a pseudo accuracy. Therefore, we have decided not to change the calculation methodology as outlined in Kuikman et al. 2005. More detailed descriptions of the methods used and emission factors can be found in protocols 11-032 and 11-033 on the website www.nlagency.nl/nie.

7.7.6 Uncertainty and time-series consistency

Uncertainties

The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to the IPCC source category. The uncertainty for the CO_2 emissions in categories 5C1 Grassland remaining Grassland and 5C2 Land converted to Grassland is calculated to be 56%; see Olivier et al. (2009) for details.

Uncertainty in the implied emission factor of 5C1 Grassland remaining Grassland

The uncertainty for the oxidation of organic soils in category 5C1 is calculated at 55% (50% used in the Tier 1 calculation spreadsheet).

Uncertainty in the implied emission factor of 5C2 Land converted to grassland

For the uncertainty of 5C2 'Land converted to Grassland', reference is made to the description of 5B2 'Land converted to Cropland' (section 7.6.6). The calculation for 'Land converted to Grassland' is based on the same assumptions as those made for 5B2 'Land converted to Cropland' and are, therefore, identical. The uncertainty is estimated to be 56% (50% used in the Tier 1 calculation spreadsheet).

Uncertainty in activity data of categories 5C1 and 5C2

The activity data used is area change, calculated by comparing three topographic maps. The uncertainty of one topographic map is estimated to be 5% (expert judgment).

Time-series consistency

The yearly source of CO_2 that results from the drainage of organic soils is 4,246 Gg CO_2. The yearly emission of CO_2 due to the conversion of land to grassland shows a steady increase from 245 Gg CO_2 in 1990 to 259 Gg CO_2 in 2010.

7.7.7 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in chapter 1. The LULUCF QA/QC procedure has shown that there are some very small inconsistencies in the calculation of areas (especially the distribution between land remaining and land converted to a category for land use categories with more than one subcategory). This will be improved in the next submission.

7.7.8 Source-specific recalculations

The recalculations in land converted to grassland are the result of the implementation of the T1 methodologies for biomass loss and gain for Croplands and Grasslands at land use change for the period 1990-2009. Simultaneously, the emissions since 2004 are subject to a recalculation due to an update of the activity data with the implementation of the new land use map (see section 7.4). These recalculations resulted in an additional annual emission of -149 Gg CO_2 in 1990, and -305 Gg CO_2 in 2009 (corresponding to 38% respectively 54% of the total emission from category 5C in the previous submission).

7.7.9 Category-specific planned improvements

For this land use category no improvements are planned in the direct future.

7.8 Wetland [5D]

7.8.1 Source category description

The source category 5D 'Wetland' includes only CO_2 emissions from 5D1 'Wetland remaining Wetland' and 5D2 'Land converted to Wetland'.

7.8.2 Activity data and (implied) emission factors

The activity data is derived from the land use maps and the land use change matrix (see sections 7.2 and 7.3.).

7.8.3 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

One consistent approach was used over all land use categories. See sections 7.2 and 7.3.

7.8.4 Definition

The land use category 'Wetland' includes land that is covered or saturated with water for all or part of the year and does not fall into the forest land, cropland, grassland or settlements categories. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged sub-divisions (IPCC, 2003). Though the Netherlands is a country with many wet areas by nature, many of these are covered by a grassy vegetation and those are included under grasslands. Some wetlands are covered by a more rough vegetation of wild grasses or shrubby vegetation, which is reported in the subcategory 'Nature' of Grassland. Forested wetlands like willow coppice are reported in the subcategories FAD or TOF of Forest Land, depending on their surface area.

In the Netherlands, only reed marshes and open water bodies are included in the Wetland land use category. This includes natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes. It includes bare areas which are under water only part of the time as a result of tidal influences and very wet areas without vegetation. It also includes 'wet' infrastructure for boats, i.e., waterways but also the water in harbours and docks.

7.8.5 Methodological issues

For information on the methodology to assess land use and land use change see chapter 7.2. The emission of CH_4 from wetlands is not estimated due to the lack of data. More detailed descriptions of the methods used and the emission factors can be found in protocols 11-032 and 11-033 on the website www.nlagency.nl/nie.

7.8.6 Uncertainty and time-series consistency

Uncertainties
For information on the uncertainty estimates, the reader is referred to section 7.6.6, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency
The time-series shows a consistent small increase from 82 Gg CO_2 in 1990 to 134 Gg CO_2 in 2010.

7.8.7 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in chapter 1. The LULUCF QA/QC procedure has shown that there are some very small inconsistencies in the calculation of areas (especially the distribution between land remaining and land converted to a category for land use categories with more than one subcategory). This will be improved in the next submission.

7.8.8 Source-specific recalculations

The recalculations in land converted to wetlands from 2004 on are the result of an update of the activity data with the implementation of the new land use map from 2004 on, as well as the implementation of Tier 1 defaults for conversion of Croplands and Grasslands (see section 7.4). These recalculations resulted in an additional annual emission of 42 Gg CO_2 in 1990, and 76 Gg CO_2 in 2009 (corresponding to 105% respectively 132% of the total emission from category 5D in the previous submission).

7.8.9 Category-specific planned improvements

For this land use category no improvements are planned in the direct future.

7.9 Settlement [5E]

7.9.1 Source category description

This source category 5E 'Settlement' includes only those CO_2 emissions from 5E1 'Settlements remaining Settlements' and 5E2 'Land converted to Settlements'.

7.9.2 Activity data and (implied) emission factors

The activity data are derived from the land use maps and the land use change matrix.

7.9.3 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

One consistent approach was used over all land use categories. See sections 7.2 and 7.3.

7.9.4 Definition

The land use category 'Settlements' includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories (IPCC, 2003). In the Netherlands, the main classes included are urban areas and transportation infrastructure and built-up areas. Built-up areas include any constructed item, independent of the type of construction material, which is (expected to be) permanent, fixed to the soil surface and serves as place for residence, trade, traffic and/or labour. Thus, it includes houses, blocks of houses and apartments, office buildings, shops and warehouses but also fuel stations and greenhouses. Urban areas and transportation infrastructure include all roads, whether paved or not, and are included in the land use category Settlements with the exception of forest roads, which are included in the official forest definition. It also includes train tracks, (paved) open spaces in urban areas, parking lots and graveyards. Though some of the last classes are actually covered by grass, the distinction cannot be made based on maps. As even the grass graveyards are not managed as grasslands, inclusion in the land use category 'Settlements' conforms better to the rationale of the land use classification.

7.9.5 Methodological issues

For information on the methodology to assess land use and land use change see chapter 7.2. More detailed descriptions of the methods used and the emission factors can be found in the protocols 12-032 and 12-033 on the website www.nlagency.nl/nie, as indicated in section 7.4.

7.9.6 Uncertainty and time-series consistency

Uncertainties
Uncertainty estimates are provided in section 7.6.6, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency
The time-series shows a consistent increase from 459 Gg CO_2 in 1990 to 808 Gg CO_2 in 2010.

7.9.7 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in chapter 1. The LULUCF QA/QC procedure has shown that there are some very small inconsistencies in the calculation of areas (especially the distribution between land remaining and land converted to a category for land use categories with more than one subcategory). This will be improved in the next submission.

7.9.8 Source-specific recalculations

The recalculations in land converted to settlements are the result an update of the activity data with the implementation of the new land use map from 2004 on, as well as the implementation of Tier 1 defaults for conversion of Croplands and Grasslands (see section 7.4). These recalculations resulted in an additional annual emission of 246 Gg CO_2 in 1990, and 498 Gg CO_2 in 2009 (corresponding to 116% respectively 86.6% of the total emission from category 5E in the previous submission).

7.9.9 Category-specific planned improvements

For this land use category no improvements are planned in the direct future

7.10 Other Land [5F]

7.10.1 Source category description

This source category 5F 'Other Land' includes only CO_2 emissions from 5F1 'Other Land remaining Other Land' and 5F2 'Land converted to Other Land'.

7.10.2 Activity data and (implied) emission factors

The activity data are derived from the land use maps and the land use change matrix (see sections 7.2 and 7.3).

7.10.3 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

One consistent approach was used over all land use categories. See sections 7.2 and 7.3.

7.10.4 Definition

The land use category 'Other Land' was included to allow the total of identified land to match the national area where data are available. It includes bare soil, rock, ice and all unmanaged land areas that do not fall into any of the other five categories. (IPCC, 2003).

In general, Other Land does not have a substantial amount of carbon. The Netherlands uses this land use category to report the surfaces of bare soil, which are not included in any other category. In the Netherlands, this refers mostly to almost bare sands and the earliest stages of succession from sand in the coastal areas (beaches, dunes and sandy roads) or uncultivated land alongside rivers. It does not include bare areas that emerge from shrinking and expanding water surfaces (these 'emerging surfaces' are included in wetlands).

7.10.5 Methodological issues

For information on the methodology to assess land use and land use change see chapter 7.2. The land use category Other Land is introduced to allow wall-to-wall reporting of land areas even if not all land could be allocated to a land use category. The carbon stored in land allocated to Other Land need not be reported (as it is assumed that Other Land has no carbon). More detailed descriptions of the methods used and the emission factors can be found in protocols 12-032 and 12-033 on the website www.nlagency.nl/nie, as indicated in section 7.4.

7.10.6 Uncertainty and time-series consistency

Uncertainties
For information on the uncertainty estimation, the reader is referred to section 7.6.6, which discusses the uncertainty of soil carbon and changes in land use.

Time-series consistency
The time-series shows a consistent small increase from 20 Gg CO_2 in 1990 to 27 Gg CO_2 in 2010.

7.10.7 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures, as discussed in chapter 1. The LULUCF QA/QC procedure has shown that there are some very small inconsistencies in the calculation of areas (especially the distribution between land remaining and land converted to a category for land use categories with more than one subcategory). This will be improved in the next submission.

7.10.8 Source-specific recalculations

The recalculations in land converted to other lands are the result an update of the activity data with the implementation of the new land use map from 2004 on, as

Table 7.6 CO_2 emissions from using limestone and dolomite in agriculture (Units: Gg CO_2).

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
5G Other (liming of agricultural soils)	183	98	98	80	85	86	79	75	81	71	71	60	60

well as the implementation of Tier 1 defaults for conversion of Croplands and Grasslands (see section 7.4). These recalculations together resulted in an additional annual emission of 2 Gg CO_2 in 1990, and -1 Gg CO_2 in 2009 (corresponding to 0% respectively 17.0% of the total emission from category 5F in the previous submission).

7.10.9 Category-specific planned improvements

For this land use category no improvements are planned in the direct future.

7.11 Other [5G]

7.11.1 Source category description

The source category 5G 'Other' includes only the emissions of CO_2 from the liming of agricultural land with limestone and dolomite. Limestone and dolomite are used in the agricultural sector to increase the chalk content of the soil in order to maintain a pH range suitable for crop and grass production.

Activity data and (implied) emission factors
The activity data is derived from agricultural statistics for total lime fertilisers (period 1990–2010). Data available on the application of limestone and dolomite does not address its use on grassland and cropland separately.

7.11.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Information on liming was derived from national, yearly updated, statistics on fertiliser use. The yearly amount of limestone and dolomite are converted into carbon dioxide emissions in line with the calculations in the guidelines.

7.11.3 Methodological issues

The reporting is considered to be at the Tier 2 level (see protocol 12-033). Limestone ('lime marl') and dolomite ('carbonic magnesium lime') amounts, reported in CaO equivalents, are multiplied with the emission factors for limestone (440 kg CO_2/ton pure limestone) and for dolomite (477 kg CO_2/ton pure dolomite). More detailed descriptions of the methods used and the emission factors can be found in protocols 12-032 and 12-033 on the website www.nlagency.nl/nie, as indicated in section 7.4.

7.11.4 Uncertainty and time-series consistency

Uncertainties
The Tier 1 analysis in Annex 7 shown in Table A7.1 provides estimates of uncertainties according to IPCC source category. The uncertainty in the CO_2 emissions from 5G 'Liming of soils' is calculated to be 25%. The uncertainty in the activity data is estimated to be 25%, and the uncertainty in emission factors is 1%. When considered over a longer time span, all carbon that is applied through liming is emitted.

Time-series consistency
The methodology used to calculate CO_2 emissions from limestone and dolomite for the period 1990–2010 is consistent over time. The use of chalk containing fertiliser in the Netherlands decreased from 265 million kg in 1990 to 102 million kg in 2009. Over that period the proportion of limestone doubled, from about 12% in 1990 up to about 24% in 2009 and the proportion of dolomite decreased from about 38% in 1990 to levels between 25-30% in following years and reached 26% in 2009 (the remaining is earth foam). The CO_2 emissions related to these fertilisers is 60 Gg CO_2 (2009), which is 11 Gg CO_2 less than in 2008 (see Table 7.6). This difference is explained by different amounts of limestone and dolomite in both years. Due to lack of fertiliser statistics, the 2010 emission is set equal to the previous year.

7.11.5 Source-specific QA/QC and verification

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

7.11.6 Source-specific recalculations

The 2008 emission has been recalculated to incorporate an error correction in the attribution to limestone and dolomite.

The 2009 emission has been recalculated because fertiliser data for 2009 has become available. In the previous NIR the 2009 emission had been set equal to the 2008 emission.

7.11.7 Category-specific planned improvements

A recalculation over 2010 will be carried out when fertiliser data become available.

8
Waste [CRF Sector 6]

Major changes in Waste sector compared to the National Inventory Report 2011

Emissions:	In 2010, the total greenhouse gas emissions in this sector decreased further.
Key sources:	No changes in key sources in this category.
Methodologies:	Based on new research, the EF for the GHG from organic waste composting activities and waste incineration were updated.

8.1 Overview of sector

The national inventory of the Netherlands comprises four source categories in the Waste sector:
- 6A Solid waste disposal: CH_4 (methane) emissions
- 6B Wastewater handling: CH_4 and N_2O emissions
- 6C Waste incineration: CO_2 and N_2O emissions (included in [1A1a])
- 6D Other waste: CH_4 and N_2O emissions

Carbon dioxide emissions from the anaerobic decay of waste in landfill sites are not included, since this is considered to be part of the carbon cycle and is not a net source. The Netherlands does not report emissions from waste incineration facilities in the Waste sector because these facilities also produce electricity or heat used for energy purposes and, as such, these emissions are included in category 1A1a (to comply with IPCC reporting guidelines). Methodological issues concerning this source category are briefly discussed in section 8.4.

The following protocols, which can be found on the website www.nlagency.nl/nie, describe the methodologies applied for estimating CO_2, CH_4 and N_2O emissions of the Waste sector in the Netherlands (see also Annex 6):
- Protocol 12-034: CH_4 from Waste disposal (6A1)
- Protocol 12-035: CH_4, N_2O from Wastewater treatment (6B)
- Protocol 12-036: CH_4, N_2O from Industrial composting (6D)
- Protocol 12-038: CO_2 CH_4 N_2O from Biomass (1A)

The Waste sector accounted for 2% of total national emissions (without LULUCF) in 2010 compared with 6% in 1990, with the emissions of CH_4 and N_2O accounting for 90% and 10% of CO_2 equivalent emissions from the sector, respectively. Emissions of CH_4 from waste – almost all (86%) from Landfills (6A) – accounted for 26% of the national total CH_4 emissions in 2010. The N_2O emissions from the Waste sector stem from domestic and commercial wastewater. The fossil-fuel related emissions from waste incineration, mainly CO_2, are included in the fuel combustion emissions from the Energy Sector (1A1a), since all large-scale incinerators also produce electricity and/or heat for energy purposes.

Emissions from the Waste sector decreased by 61% between 1990 and 2010 (see Figure 8.1), mainly due to a 64% reduction in CH_4 from Landfills (6A1 'Managed waste disposal on land). Between 2009 and 2010 the CH_4 emissions from landfills decreased by about 7%. The decreased methane emission from 'Landfills' since 1990 is the result of:
- increasing recycling of waste
- a considerable reduction in the amount of municipal solid waste (MSW) disposal at landfills
- a decreasing organic waste fraction in the waste disposed
- increasing methane recovery from the landfills (from 5% in 1990 to 17% in 2009) (Agentschap NL, 2011a).

Table 8.1 shows the contribution of the emissions from the Waste sector to the total greenhouse gas emissions in the Netherlands and also presents the key sources in this sector specified by level, trend or both. The list of all (key- and non-key) sources in the Netherlands is shown in Annex 1. Total greenhouse gas emissions from the Waste sector decreased from 12.8 Tg CO_2 eq in 1990 to 5.0 Tg CO_2 eq in 2010. This decrease is mainly due to (SenterNovem, 2008b):
- Increased recovery and recycling, resulting in a decreasing amount of solid waste disposed of at landfills;
- A decreasing amount of organic waste disposed of at landfills;
- Increasing CH_4 recovery from landfills.

CH_4 emissions from landfills contribute the largest share to the greenhouse gas emissions of this sector. Category 6A1 Solid waste disposal sites (SWDS) is a key source specified by both level and trend, category 6B N_2O emissions from waste water handling is a minor key source (L2) when uncertainties are taken into account (see Annex 1).

8.2 Solid waste disposal on land [6A]

8.2.1 Source category description

In 2010 there were 22 operating landfill sites as well as a few thousand older sites that are still reactive. CH_4 recovery takes place at 53 sites in the Netherlands. As a result of anaerobic degradation of the organic material within the landfill body, all of these landfills produce CH_4 and CO_2. Landfill gas comprises about 60% (vol.) CH_4 and 40% (vol.) CO_2. Due to a light overpressure, the landfill gas migrates into the atmosphere. On several landfill sites the gas is extracted before it is released into the atmosphere and subsequently used as an energy source or flared off. In both of these cases the CH_4 in the extracted gas is not released into the atmosphere. The CH_4 may be degraded (oxidised) to some extent by bacteria when it passes through the landfill cover; this results in a lower CH_4 emission.

Anaerobic degradation of organic matter in landfills is a time-dependent process and may take many decades. Some of the factors influencing this process are known; some are not. Each landfill site has its own unique characteristics: concentration and type of organic matter, moisture and temperature, among others. The major

Figure 8.1 Sector 6 'Waste': trend and emission levels of source categories, 1990-2010.

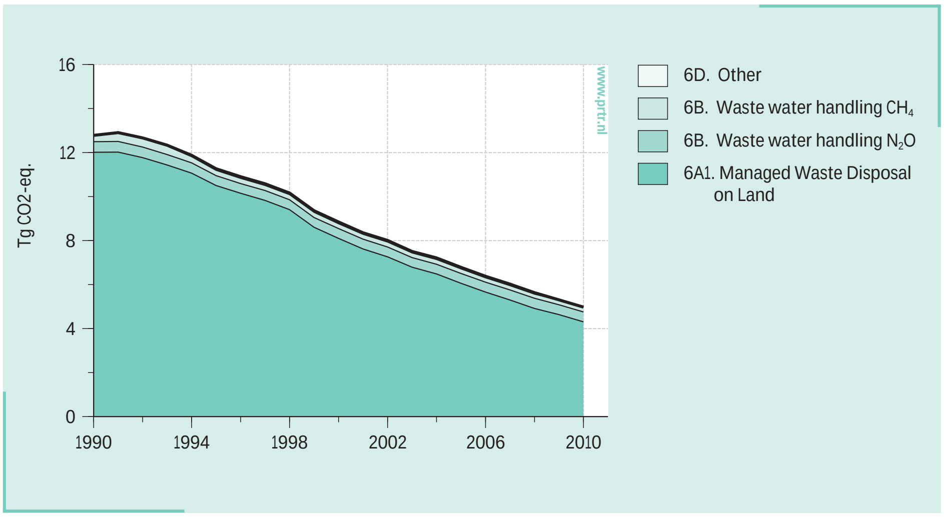


Table 8.1 Contribution of main categories and key sources in Sector 6 Waste.

Sector/category	Gas	Key	Emissions base-year Gg	Emissions base-year Tg CO_2 eq	Emissions 2009 Gg	Emissions 2009 Tg CO_2 eq	Emissions 2010 Gg	Emissions 2010 Tg CO_2 eq	Change 2010 - 2009 Gg	Contribution to total in 2010 (%) by sector	of total gas	of total CO_2 eq
6 Waste	CH_4		585.8	12.3	231.3	4.9	215.5	4.5	-0.3	90	27	2
	N_2O		1.6	0.5	1.6	0.5	1.6	0.5	0.00	10	5	0.2
	All			12.8		5.3		5.0	-0.3	100	0.00	2
6A Solid Waste Disposal on Land	CH_4		572.0	12.0	220.8	4.6	205.1	4.3	-0.3	86	26	2
6A1 Managed Waste Disposal on Land	CH_4	L,T	572.0	12.0	220.8	4.6	205.1	4.3	-0.3	86	26	2
6B Waste water handling	N_2O	L2	1.6	0.5	1.4	0.4	1.4	0.4	0.00	9	5	0.2
	CH_4		13.8	0.3	9.6	0.2	9.4	0.2	0.00	4	1	0.1
	All			0.8		0.6		0.6	0.00	13		0.3
6D Other	CH_4		0.1	0.00	1.0	0.02	1.0	0.02	0.00	0.4	0.1	0.01
Total National Emissions	CH_4		1,223.5	25.7	812.7	17.1	798.3	16.8	-0.3		100	
	N_2O		65.0	20.2	30.9	9.6	30.3	9.4	-0.2		100	
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.3		198.9		210.1	11.5			100

factors determining the decreased net CH_4 emissions are lower quantities of organic carbon deposited into landfills (organic carbon content × total amount of land-filled waste) and higher methane recovery rates from landfills (see sections 8.2.2 and 8.2.3).
The share of CH_4 emissions from landfills in the total national inventory of greenhouse gas emissions was 6% in 1990 and 2% in 2010. Between 1990 and 2010 CH_4 emissions have decreased by 64%. This decrease is due to the increase in recovered CH_4 – from about 5% in 1990 to 17% in 2010 – but also to the decrease in methane produced in solid waste disposal sites.
In 2010 solid waste disposal on land accounted for 86% of the total emissions in the Waste sector and 2% of the total national CO_2 equivalent emissions (see Table 8.1).

The policy that has been implemented in the Netherlands is one directly aimed at reducing the amount of waste

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

Parameter	1990	1995	2000	2005	2006	2007	2008	2009	2010
Waste generation rate (kg/cap/day)	1.52	1.50	1.69	1.75	1.74	1.77	1.74	1.70	1.66
Fraction MSW disposed to SWDS	0.38	0.29	0.09	0.01	0.01	0.01	0.01	0.01	0.01
Fraction DOC in MSW	0.13	0.13	0.11	0.10	0.11	0.07	0.05	0.05	0.05
CH_4 generation rate constant (k)	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Number of SWDS recovering CH_4	45	50	55	50	54	51	52	53	51
Fraction CH_4 in landfill gas	0.6	0.6	0.6	0.52	0.55	0.52	0.51	0.50	0.51

used in land fill sites. This policy requires enhanced prevention of waste production and the increased recycling of waste, followed by incineration. As early as the 1990s the government introduced bans on the use of certain categories of waste for land-filling; for example, the organic fraction of household waste. Another method implemented to reduce land-filling was to raise the landfill tax to comply with the increased costs of incinerating waste. Depending on the capacity of incineration, the government can grant exemption from these 'obligations'. Due to this policy the amount of waste used at landfill has decreased from more than 14 million tonnes in 1990 to 2 million tonnes in 2010, thereby reducing emissions from this source category.

Methodological issues

A more detailed description of the method used and emission factors can be found in the protocol 12-034 on the website www.nlagency.nl/nie as indicated in section 8.1.

Activity data on the amount of waste disposed of at landfill sites are mainly based on the annual survey performed by the Working Group on Waste Registration at all the landfill sites in the Netherlands. This data can be found on the website www.agentschapnl.nl/nie and are documented in Agentschap NL, 2011a. This document also contains the amount of CH_4 recovered from landfill sites yearly. The implied emission factors correspond with the IPCC default values.

In order to calculate the CH_4 emissions from all the landfill sites in the Netherlands, the simplifying assumption was made that all the wastes are assumed to be disposed of at one landfill site, an action that started in 1945. However, as stated above, characteristics of individual sites vary substantially. CH_4 emissions from this 'national landfill' are then calculated using a first-order decomposition model (first-order decay function) with an annual input of the total amounts deposited and the characteristics of the land-filled waste and the amount of landfill gas extracted. This is equivalent to the IPCC Tier 2 methodology. Since the CH_4 emissions from landfills are a key source, the present methodology is in line with the IPCC Good Practice Guidance (IPCC, 2001).

Parameters used in the landfill emissions model are as follows:

- total amount of land-filled waste;
- fraction of degradable organic carbon (DOC) (see Table 8.2 for a detailed time-series);
- CH_4 generation (decomposition) rate constant (k): 0.094 up to and including 1989, decreasing to 0.0693 in 1995 and constant thereafter; this corresponds to half-life times of 7.4 and 10.0 years respectively (see Table 8.2 for a detailed time-series);
- CH_4 oxidation factor: 10%;
- fraction of DOC actually dissimilated (DOCF): 0.58; (see also (Oonk et al., 1994));
- CH_4 conversion factor (IPCC parameter): 1.0;
- The fraction of methane in landfill gas is determined yearly from 2002 onwards, based on the composition of landfill gas at all sites with CH_4 recovery. For the years until 2001, the fraction of methane in landfill gas is set at 60%.

Trend information on IPCC Tier 2 method parameters that change over time is provided in Table 8.2. The change in DOC values is due to such factors as the prohibition of land filling of combustible wastes, whereas the change in k-values (CH_4 generation rate constant) is caused by a sharp increase in the recycling of vegetable, fruit and garden waste in the early 1990s. The integration time for the emission calculation is defined as the period from 1945 to the year for which the calculation is made.

8.2.2 Uncertainty and time-series consistency

Uncertainty

The Tier 1 uncertainty analysis shown in Tables A7.1 and A7.2 of Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in CH_4 emissions of solid waste disposal sites is estimated to be approximately 35% in annual emissions. The uncertainty in the activity data and the emission factor are estimated to be 30% and 15%, respectively. For a more detailed analysis of these uncertainties, see Olivier et al. (2009).

Time-series consistency

The estimates for all years are calculated from the same model, which means that the methodology is consistent throughout the time-series. The time-series consistency of the activity data is very good, due to the continuity in the data provided. Since 2002 the fraction of CH_4 in landfill gas is determined yearly based on the composition of the landfill gas of the sites recovering CH_4. It is expected that this will reflect the average fraction of CH_4 in the landfill gas better than the default used in previous inventories and slightly reduces uncertainties in the emission estimations of the post-2001 period. This 'new' CH_4 fraction is only used to estimate methane in the recovered biogas and not for the generation of methane within the landfill site.

8.2.3 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures as discussed in chapter 1. And the specific QA/QC as described in the document for QA/QC of outside agencies 2011 (Wever et al., 2011).

8.2.4 Source-specific recalculations

As a result of the 2011 in-country review, the Netherlands has (re)generated the historical land filled data (1945 – 1990) and used this data for the estimation of CH_4 emissions. The reported amounts of land filled waste for 1950, 1955, 1960, 1965 and 1970 (Van Amstel, 1994) are linearly interpolated for the years in between. Furthermore it is assumed that in 1945 0.1 Mton of waste was land filled. Emissions changed by less than 0.5 Gg CO_2 eq over the total time-series.

This recalculation was not included in the latest official CRF submission from November 2011 and therefore, does now show up in the recalculation sheet of the current CRF.

8.2.5 Source specific planned improvements

During the review of the NIR 2006 by the ERT it was recommended to investigate the composition of soils in order to verify the fraction of organic carbon present and to include this fraction in the estimation of CH_4 emissions. In 2009 a project started studying, among other things, contaminated soils at landfill sites. In the first half of 2012 the results will be available and will be incorporated in the estimation method.

8.3 Wastewater handling [6B]

8.3.1 Source category description

This source category covers emissions released from wastewater handling and includes emissions from industrial, commercial and domestic wastewater and septic tanks.

The treatment of domestic and commercial wastewaters and the resulting wastewater sludge is accomplished using aerobic and/or anaerobic processes in public Wastewater Treatment Plants (WWTP). During the treatment, the biological breakdown of Degradable Organic Compounds (DOC) and nitrogen compounds can result in CH_4 and N_2O emissions, respectively. The discharge of effluents subsequently results in indirect N_2O emissions from surface waters due to the natural breakdown of residual nitrogen compounds. The source category also includes the CH_4 emissions from anaerobic industrial wastewater treatment plants (IWWTP) and the CH_4 and N_2O emissions from septic tanks, but these are small compared to public WWTP.

N_2O emissions from waste water treatment (see Table 8.1) contributed about 5% to total N_2O emissions in 2010 and 0.2% in total CO_2 eq. N_2O emissions from waste water handling and effluents decreased by 9% during the period 1990–2010. This small decrease is the result of two counteracting trends. Improved biological breakdown of nitrogen compounds at public WWTPs (see Table 8.4) leads to a gradual increase of N_2O emissions. However, this improved nitrogen removal results in lower effluent loads (see Table 8.4) and a subsequent decrease in the (indirect) N_2O emissions from human sewage.

The contribution of wastewater handling to the national total of CH_4 emissions in 2010 was 1.2%. Since 1994, CH_4 emissions from public WWTPs have decreased due to the introduction in 1990 of a new sludge stabilisation system in one of the largest wastewater treatment plants. As the operation of the plant took a few years to optimise, venting emissions were higher in the introductory period (1991–1994) than under normal operating conditions. CH_4 emissions from waste water handling decreased by 32% during the period 1990–2010. 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. It should be noted that non-CO_2 emissions from the combustion of biogas at wastewater treatment facilities are allocated to category 1A4 'Fuel combustion – Other sectors' because this combustion is partly used for heat or power generation at the treatment plants.

Table 8.3 shows the trend in greenhouse gas emissions from the different sources of wastewater handling.

8.3.2 Methodological issues

Activity data and (implied) emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 12-035 on the website www.nlagency.nl/nie.

Table 8.3 Wastewater handling emissions of CH_4 and N_2O (Units: Gg/year).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
CH_4 industrial wastewater	0.25	0.33	0.34	0.36	0.33	0.32	0.33	0.32	0.32
CH_4 domestic & commercial wastewater	9.07	7.90	7.96	8.20	8.12	8.37	8.23	8.75	8. 60
CH_4 septic tanks	4.47	3.25	2.20	1.47	1.10	0.74	0.49	0.50	0.50
Net CH_4 emissions	13.79	11.48	10.50	10.03	9.56	9.44	9.05	9.57	9.42
CH_4 recovered and/or flared	33.0	39.2	40.4	41.9	43.8	42.6	43.7	44.2	45.0
Recovery/flared (% gross emission)	70.5	77.4	79.4	80.6	82.1	81.9	82.8	82.2	82.7
N_2O domestic & commercial wastewater	0.66	0.75	0.88	0.99	1.05	1.10	1.14	1.12	1.12
N_2O from human sewage	0.85	0.65	0.53	0.43	0.38	0.37	0.34	0.31	0.32
N_2O septic tanks	0.052	0.043	0.029	0.019	0.014	0.009	0.006	0.006	0.006
Total N_2O emissions	1.55	1.45	1.44	1.45	1.45	1.48	1.49	1.44	1.45

Table 8.4 Activity data of domestic and commercial wastewater handling (WWTP), Industrial anaerobic wastewater handling (IWWTP) and septic tanks.

	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010
Wastewater DOC [1] WWTP	Gg/year	933	921	921	943	938	942	946	938	953
Sludge DOC [1] WWTP	Gg/year	254	269	281	298	318	294	316	320	320
Nitrogen removed in urban WWTP	Gg/year	42.0	47.7	55.8	63.1	66.8	70.0	72.5	71.5	71.3
Treated volume WWTP	Mm^3/y	1,711	1,908	2,034	1,841	1,872	2,090	1,948	1,818	1,934
Wastewater DOC [2] IWWTP	Gg/year	181	233	244	261	238	231.5	232.5	232.1	232.1
Nitrogen in effluents [3]	Gg/year	53.8	41.5	33.8	27.8	24.3	23.6	23.2	19.7	20.5
% Inhabitants with septic tanks	%	4.0	2.8	1.9	1.2	0.9	0.6	0.4	0.4	0.4
Annual per capita protein uptake	kg	34.86	39.97	38.69	38.03	38.69	38.22	37.81	37.81	37.81

1) DOC, Degradable organic component, in terms of Chemical Oxygen Demand (COD)
2) For anaerobic industrial wastewater treatment plants; this is reflected by the design capacity in terms of the Chemical Oxygen Demand (COD).
3) Total of industrial, domestic and commercial effluents.

Most of the activity data on wastewater treatment are collected by Statistics Netherlands (CBS, 2011) in yearly questionnaires which cover all public WWTPs as well as all anaerobic industrial WWTPs; see also www.statline.nl for detailed statistics on wastewater treatment. Table 8.4 shows the development in the key activity data with respect to domestic and commercial wastewater treatment as well as industrial wastewater treatment and septic tanks. Due to varying weather conditions, the volumes of treated wastewater and of the total load of DOC of domestic and commercial wastewater can fluctuate from year to year, depending on how much run-off rainwater enters the sewer systems. In the method developed for calculating methane emissions, the Degradable Organic Component (DOC) is based on an organic load in terms of the Chemical Oxygen Demand (COD).

From Table 8.4 it can be concluded that the DOC of treated wastewater and sludge does not significantly change over time. Therefore, the interannual changes in CH_4 emissions can be explained by varying fractions of CH_4 being vented instead of flared or used for energy purposes. The source Septic Tanks has steadily decreased from 1990 onwards. This can be explained by the increased number of households connected to the sewer system in the Netherlands (and therefore no longer using septic tanks; see Table 8.4).

A full description of the methodology is provided in the monitoring protocol 12-035 (see the website www.nlagency.nl/nie) and in the background document (Oonk et al., 2004). In general, the emissions are calculated according to the IPCC guidelines, with country-specific parameters and emission factors being used for CH_4 emissions from wastewater handling (including sludge). The calculation methods are equivalent to the IPCC Tier 2 methods.

CH_4 emissions from industrial waste water treatment

For anaerobic industrial WWTPs, the CH_4 emission factor is expressed as 0.176 t/t DOC, assuming a CH_4-producing potential (Bo) of 0.22 t/t DOC (Doorn et al, 1997; Oonk et al, 2004) and a removal efficiency of 80%.
Since monitoring data of DOC in the influents of anaerobic WWTP are not available, the DOC is calculated on basis of the design capacity and a utilisation rate of 80% (Oonk et al., 2004). The design capacity is available in terms of Pollution Equivalents (also named Inhabitant Equivalents, see protocol 12-135), with 1 p.e is equal to 40 kg COD per year.
Assuming a methane recovery (MR) of 99% (Oonk et al., 2004) and taking into account all aforementioned factors and parameters, the overall emission factor can be calculated as 0.056 t/t DOC design capacity expressed in Population Equivalents.

Table 8.4 provides the times-series of total DOC design capacity for industrial waste water treatment plants, based on the design capacity. In 2010, 68% of the anaerobic capacity was installed within the food- and beverage industry. Other branches with anaerobic wastewater treatment are the waste-processing facilities (14%), chemical industry (13%) and paper- and cardboard industry (4%) Currently, Statistics Netherlands publishes only the total number of biological treatment facilities per economic activity and the total design capacity for anaerobic as well as anaerobic WWTP. (CBS, 2011). It is recognised that further detail is needed in the statline tables to improve the transparency of the data. Hence, the breakdown of the data on design capacity per economic activity, solely for anaerobic treatment, will be published on statline from April 2012 on.

Data from the questionnaire among industrial wastewater treatment plants, performed by Statistics Netherlands (CBS), show that only 2 out of a total of 160 industrial wastewater plants are equipped with anaerobic sludge digestion reactors. These data are not published on www.cbs.statline.nl for reasons of confidentiality. Forthcoming CH_4 emissions are not estimated (NE) because it is not known what sludge treatment capacity these plants have and how much sludge is digested.
Most of the industrial companies discharge their wastewater into the sewer system, subsequently connected to public WWTP. Emissions of wastewater- and sludge handling are thus included elsewhere, namely within the category domestic and commercial wastewater handling.

CH_4 emissions from domestic and commercial waste water treatment

For public WWTPs and related anaerobic sludge handling, the combined emission factor is defined as 0.0085 tons CH_4 per ton DOCinfluent. DOC is measured and calculated as the Chemical Oxygen Demand (COD). The following parameters are underlying the calculation of this emission factor (for further details, see also background document Oonk et al., 2004).

- Methane formation Bo = 0.25 t CH_4/t DOC converted (IPCC, 1997)
- MCFstp = Methane Correction Factor of Sewage Treatment Plants = 3.5% (Doorn et al, 1997, as referred to in IPCC-GPG, 2001)
- 37% of the DOCinfluent remains in the sludge (Country Specific Long Term Annual Average)
- MCF of anaerobic sludge treatment = 54% (Country Specific LTAA)
- In anaerobic sludge treatment 42% of the incoming DOC is digested (Country Specific LTAA)
- CH_4 recovery (MR) from anaerobic sludge treatment = 94% (Hobson and Palfrey, 1996, as referred to in IPCC-GPG, 2001).

Incidental venting of biogas at public WWTPs is recorded by the plant operators and subsequently reported to Statistics Netherlands. In 2010, the amount of CH_4 emitted via venting of biogas was 0.5 Gg CH_4, equalling 5% of total CH_4 emissions of the category Domestic and commercial wastewater. During the last decade this value usually varied between 2 and 10%.

CH_4 emissions from septic tanks

For septic tanks, the overall emission factor for CH_4 is expressed as 0.0075 tons per year per person connected to a septic tank, assuming a methane correction factor (MCF) of 0.5 (Doorn and Liles, 1999), a CH_4-producing potential (Bo) of 0.25 (IPCC, 1997) and a DOC of 60 kg per person per year. The time-series of the percentage of population connected to septic tanks is given in Table 8.4. According to new data, published by Rioned (2009) and RWS-Waterdienst (2011), it is estimated that in 2010 only 0.4% of the population was connected to a septic tank (see also section 8.3.5.2).

N_2O emissions

N_2O emissions from the biological N removal processes in domestic and commercial (or public) WWTP and in septic tanks, as well as indirect N_2O emission from effluents, are calculated using the IPCC default emission factor of 0.01 kg N_2O-N per kg N (IPCC, 1997). Since N_2O emissions from wastewater handling are identified in earlier NIRs as a key source, the present Tier 2 methodology complies with the IPCC Good Practice Guidance (IPCC, 2001).

The N_2O emissions from domestic and commercial wastewater handling are determined on basis of country specific activity data on the total nitrogen loads removed in public WWTPs (see also Table 8.4). Influent and effluent loads of public WWTPs are monitored systematically by all of the Dutch Regional Water Authorities in accordance with the rules of the EU Urban Wastewater Treatment Directive. Waste water treated at public WWTP is a mixture of household waste water, run-off rainwater and waste water from industries and services, so the forthcoming N_2O emissions are reported under the category 6B2 'Domestic and commercial wastewater'. Because of their insignificance compared to N_2O from public wastewater treatment, no N_2O emissions were estimated for separate industrial wastewater treatment.

As a result of the 2011 in-country review, in the NIR2012 the N_2O emissions from septic tanks are calculated for the first time. This is done according to the default method provided in the IPCC 1996 revised Guidelines (IPCC,1997). For detailed information, see section 8.3.5. For the calculation of the annual per capita protein uptake (see Table 8.4), data from FAO Statistics were used. For data on the % of people connected to septic tanks, the same time-series is used as in the calculation of CH_4 emissions from septic tanks.

8.3.3 Uncertainties and time-series consistency

Uncertainties
The Tier 1 uncertainty analysis in Tables A7.1 and A7.2 in Annex 7 provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in annual CH_4 and N_2O emissions from wastewater handling are estimated to be 32% and 54%, respectively. The uncertainty in activity data is based on the judgments of experts and estimated to be 20%. The uncertainty in emission factors for CH_4 and N_2O are estimated to be 25% and 50% respectively.

Time-series consistency
The same methodology has been used to estimate emissions for all years, thereby providing a good time-series consistency. The time-series consistency of activity data is very good, due to the continuity in the data provided by Statistics Netherlands.

8.3.4 Source-specific QA/QC and verification

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

8.3.5 Source-specific recalculations

Recalculations as result of the 2011 in-country review
As a result of the 2011 in-country review in the NIR2012 a time-series of N_2O emissions from septic tanks is calculated for the first time. These data are calculated using the default emission factor and standard calculation method according to the 1996 IPCC revised Guidelines (IPCC, 1997).

$$N_2O_{\text{septic tanks}} = n_{st} * \text{Protein} * F_{NPR} * EF_{st} * 44/28$$

$N_2O_{\text{septic tanks}}$	laughing gas emissions from septic tanks in kg N_2O year^{-1}
n_{st}	number of persons not connected to the sewer system ≈ number connected to septic tanks
Protein	annual per capita protein consumption, kg/person/yr
F_{NPR}	fraction of nitrogen in protein, default = 0.16 kg N/kg protein.
EF_{st}	emission factor of septic tank = 0.01 kg N_2O-N/kg N (IPCC default).
44/28	conversion of kg N_2O-N to kg N_2O.

The amount of nitrogen in the wastewater is determined on basis of the annual per capita protein uptake – as published each year by the FAO – and a default fraction of nitrogen in protein. Regarding the parameter; 'number of inhabitants connected to septic tanks', the same data is used as in the calculation of methane emissions from septic tanks (see also section 8.3.5.2).
The above-mentioned recalculation was included in the latest official CRF submission from November 2011 and therefore, does not show up in the recalculation sheet of the current CRF.

Other recalculations
For the calculation of CH_4 emissions from septic tanks, more recent and corrected data were used on the '% of population connected to septic tanks' for 2005 and 2007-2009. These data were published by Rioned, 2009 and RWS-Waterdienst, 2011. The value for 2005 was adjusted from 1.1% to 1.2%. The values of 2007-2009 were adjusted from 0.8%, 0.7% and 0.7% to 0.6%, 0.4% and 0.4% respectively. The new data caused for 2005 an increase in CH_4 emissions from 1.22 to 1.47 Gg CH_4 and for 2009 a decrease from 0.81 to 0.50 Gg CH_4. The new time-series of % of population connected to septic tanks was also used for the recalculation of the N_2O emissions from septic tanks (as described in section 8.3.5.1).

8.3.6 Source-specific planned improvements

There are no source specific planned improvements compared to the previous submission.

Table 8.5 Composition of incinerated waste.

	1990	1995	2000	2005	2007	2008	2009	2010
Total waste incinerated (Gg)	2,780	2,913	4,896	5,503	5,790	6,053	6,333	6,459
of which household waste (Gg)	2,310	2,083	3,115	4,413	3,738	3,681	2,763	3,727
of which								
paper/cardboard (weight %)	26%	33%	32%	25%	25%	26%	20%	21%
wood (weight %)	1%	2%	2%	3%	3%	3%	4%	4%
other organic (weight %)	51%	37%	35%	35%	34%	33%	33%	33%
plastics (weight %)	8%	11%	13%	19%	20%	19%	20%	18%
other combustible (weight %)	3%	5%	5%	6%	6%	6%	10%	10%
non-combustible (weight %)	11%	13%	13%	13%	12%	12%	14%	14%
Total waste incinerated (TJ)	22,746	27,903	51,904	55,058	59,678	62,341	63,609	63,818
Energy content (MJ/kg)	8.2	9.6	10.6	10.0	10.3	10.3	10.0	9.9
Fraction organic (energy %)	58.2%	55.2%	50.4%	47.8%	47.9%	48.8%	51.2%	53.1%
Amount of fossil carbon (Gg)	164	221	433	561	596	611	690	675
Amount of organic carbon (Gg)	544	561	938	909	988	1,046	1,143	1,172

8.4 Waste incineration [6C]

8.4.1 Source category description

The source category 'Waste incineration' is included in category 1A1 (Energy industries) as part of the source 1A1a Public electricity and heat production, since all waste incineration facilities in the Netherlands also produce electricity and/or heat used for energy purposes. According to the IPCC Guidelines (IPCC, 2001), these are included in category 1A1a: Public electricity and heat production: other fuels (see section 3.2.6).

8.4.2 Methodological issues

Activity data and emission factors

The activity data for the amount of waste incinerated are mainly based on the annual survey performed by the Working Group on Waste Registration at all 14 waste incinerators in the Netherlands. Data can be found on the website www.agentschapnl.nl/nie and in a background document (Agentschap NL, 2011a).

A more detailed description of the method used and the emission factors can be found in the protocol 12-038 on the website www.nlagency.nl/nie, as indicated in section 8.1 and in a background document (Agentschap NL, 2010b).

Total CO_2 emissions – i.e., the sum of organic and fossil carbon – from waste incineration are reported per facility in the annual environmental reports and included in the ER-I data set. The fossil-based and organic CO_2 and N_2O emissions from Waste incineration are calculated from the total amount of waste incinerated. The composition of the waste is determined per waste stream (household waste and several others). An assumption is made for each of the six types of waste composition with respect to the specific carbon and fossil carbon fractions, which will subsequently yield the CO_2 emissions. Table 8.5 shows the total amounts of waste incinerated, the fractions of the different waste components used for calculating the amounts of fossil and organic carbon in the waste (from their fossil and organic carbon fraction) and the corresponding amounts of fossil and organic carbon in total waste incinerated. The method is described in detail in Agentschap NL, 2010b and in the monitoring protocol. Based on measurement data (Spoelstra, 1993), an emission factor of 20 g/ton waste is applied for N_2O from incineration with SCR. For Incineration with SNCR an emission of 100 g/ton is applied. The percentage SCR increased from 6% in 1990 to 40% in 2010.

In 2009 the carbon fraction of the household waste fractions and the percentage fossil of these fractions were determined. These values are still used for the calculation of the fossil and non-fossil emissions from household waste. For the other fraction, the older values are still used (Agentschap NL, 2010b). A survey of emission factors for CH_4 used in other countries and analysis of emissions from Waste incinerators in the Netherlands made clear that the CH_4 concentration in the flue gasses from of Waste incinerators are below the background CH_4 concentration in ambient air. Therefore the Netherlands uses a emission factor of 0 g/GJ and reports no methane emissions from waste incineration for the whole time series. As the CRF holds problems to handle such value, the notation key NO is used. More information is in Agentschap NL, 2011b.

Open burning of waste does not occur in the Netherlands. This is prohibited by law.

8.4.3 Uncertainties and time-series consistency

Uncertainties

The Tier 1 uncertainty analysis is shown in Tables A7.1 and A7.2 in Annex 7 and provides estimates of uncertainties according to IPCC source category and gas. The uncertainty in annual CO2 emissions from Waste incineration is estimated at 11%. The main factors influencing these emissions are the total amount being incinerated. The fractions of different waste components used for calculating the amounts of fossil and organic carbon in the waste (from their fossil and organic carbon fraction) and the corresponding amounts of fossil and organic carbon in the total waste incinerated. The uncertainty in the amounts of incinerated fossil waste and the uncertainty in the corresponding emission factor are estimated to be 10% and 5% respectively.

Time-series consistency

The time-series are based on consistent methodologies for this source category. The time-series consistency of the activity data is considered to be very good, due to the continuity of the data provided by Working Group on Waste Registration.

8.4.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures that are discussed in chapter 1 and the specific QA/QC as described in the document for QA/QC of outside agencies 2011 (Wever et al., 2011).

8.4.5 Source-specific recalculations

There are no source-specific recalculations done for this category.

8.4.6 Source-specific planned improvements

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

8.5 Other waste handling [6D]

8.5.1 Source category description

This source category, which consists of the CH_4 and N_2O emissions from composting and digesting separately collected organic waste from households, is not considered to be a key source. Emissions from small-scale composting of garden waste and food waste by households are not estimated, as these are assumed to be negligible.

The amount of composted organic waste from households increased from nearly 0 million tons up to 1.3 million tons in 2010. In 2010 there were 23 industrial composting sites in operation; these accounted for less than 1% of the emissions in the Waste sector in that year (see Table 8.1).

8.5.2 Methodological issues

Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocol 12-036 on the website www.nlagency.nl/nie. The activity data for the amount of organic waste composted at industrial composting facilities are mainly based on the annual survey performed by the Working Group on Waste Registration at all industrial composting sites in the Netherlands. Data can be found on the website www.agentschapnl.nl/nie and in a background document (Agentschap NL, 2011a). This document also contains the amount of compost produced on a yearly basis.
A more detailed description of the method used and the emission factors can be found in protocol 12-036 on the website www.nlagency.nl/nie as indicated in section 8.1.
A country-specific methodology is used for estimating the industrial composting of organic food and garden waste from households. Since this source is not considered to be a key source, the present methodology level complies with the general IPCC Good Practice Guidance (IPCC, 2001). No mention is made of a method for estimating the industrial composting of organic waste in the Good Practice Guidance.

8.5.3 Uncertainties and time-series consistency

Uncertainty

The emissions of this source category are calculated using an average emission factor that has been obtained from the literature. Given the large scatter in reported emission factors, the uncertainty is estimated to be more than 100% (Olivier et al., 2009).

Time-series consistency

The time-series consistency of the activity data is very good, due to the continuity in the data provided.

8.5.4 Source-specific QA/QC and verification

The source categories are covered by the general QA/QC procedures that are discussed in chapter 1 and the specific QA/QC as described in the document for QA/QC of outside agencies 2011 (Wever et al., 2011).

8.5.5 Source-specific recalculations

Compared to the previous submission, no recalculations took place for this submission.

8.5.6 Source-specific planned improvements

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

9
Other [CRF Sector 7]

The Netherlands allocates all emissions to Sectors 1 to 6; there are no sources of greenhouse gas emissions included in Sector 7.

10 Recalculations and improvements

Major changes compared to the National Inventory Report 2010

For the NIR 2012, the data for the most recent year (2010) were added to the corresponding Common Reporting Format (CRF).
This submission includes emission estimates for charcoal production and use, CNG fuelled cars, CO_2 from gas transport, CH_4 from enteric fermentation and manure management of horses, anode consumption in iron and steel plants and N_2O from septic tanks. Those emissions were added to the inventory as a response to the in-country review 2011. These changes compared to the previous NIR were already included in the resubmission from November 2011. Since then, no major changes in the emission data were introduced in the inventory.

During the compilation of this NIR some errors from previous submissions were detected and corrected. These result in minor changes in emissions over the total period 1990-2009.

For more details on the effect and justification for the recalculations, see chapters 3–8.

10.1 Explanation and justification for the recalculations

10.1.1 GHG inventory

For this submission (NIR 2012), the Netherlands uses the CRF reporter software 3.5.2. The present CRF tables are based on improved methodologies after the UNFCCC in-country review in 2011. These improved methodologies are also described in the (updated) monitoring protocols 2012 (see Annex 6).

This chapter summarises the relevant changes in emission figures compared to the NIR 2011 and the resubmitted CRFs from 14 November 2011 (NETHERLANDS-2011-v2.3) as result of the in country review 2011.
A distinction is made between:
- Methodological changes: new emission data are reported resulting from revised or new estimation methods; improved emission factors or activity data are also captured in recalculations as a result of methodological changes;
- Allocation: changes in the allocation of emissions to different sectors (only affecting the totals per category or sector);
- Error corrections: correction of incorrect data.

Due to the methodical changes and error corrections mentioned in the following sections, the national emissions in 1990 increased by 0.04 Tg CO_2 eq compared to the resubmission from November 2011. For 1995 the corrections led to an increase in emissions of 0.01 Tg CO_2 eq and for 2000 to a decrease of 0.04 Tg CO_2 eq. For 2009 an increase of emissions amounting to 0.04 Tg CO_2 eq is calculated (all figures including LULUCF).

All relevant changes in previous data (methodological, allocation and error correction) are explained in the sector chapters of this NIR and in the CRF.

2011 in-country review
As a result of the in-country review of September 2011 and encouraged by the ERT report 2010 and the Saturday paper of the 2011 review, this submission includes the following changes compared to the NIR 2011:
1. Inclusion of missing estimates for the sources:
   - CO_2, CH_4 and N_2O from CNG fuelled vehicles;
   - CO_2 from gas transmission;
   - CH_4 from charcoal production;
   - CH_4 from charcoal consumption;
   - CO_2 from anode consumption in Iron and steel;
   - N_2O from septic tanks.
2. Error corrections:
   - CO_2 emission from Iron and Steel;
   - CO_2 emission from Aluminium production;
   - CH_4 from enteric fermentation and manure management, horses.

Please note that the changes in emissions due to these improvements were already reported in the resubmitted CRFs from 14 November 2011 (NETHERLANDS-2011-v2.3).

Methodological changes
The improvements of the QA/QC activities in the Netherlands as implemented in past years (process of assessing and documenting methodological changes) are still in place. This process (using a brief checklist for timely discussion with involved experts and users of information on likely changes) improves the peer review of and timely documentation on the background and justification of changes.

For the sources, which were improved in the resubmission from November 2011, this submission only holds new emission estimates for the years 2005 to 2010 for septic tanks. After the resubmission in November 2011 new data on the % of population connected to septic tanks became available and these are used for this submission (N_2O changed -0.2 Gg CO_2 eq in 2005 and 5.1 Gg CO_2 eq in 2009, CH_4 changed 5.1 Gg CO_2 eq in 2005 and -6.4 Gg CO_2 eq in 2009).

Other recalculations in this submission (compared to the resubmitted data) are:
- Changed GHG emissions from transport for the years 1990 to 2009 due to implementation of improved calculation of fuel use for mobile machinery and improved activity data (including military, 2007-2009) (-2.0 Gg CO_2 eq in 1990 and -33.6 Gg CO_2 eq in 2009);
- Changed CH_4 emissions from Manure Management for the years 1990 to 2009 due to the definition of rabbits and fur bearing animals as a separate emission source. In earlier submissions this category was included in the poultry category (17.6 Gg CO_2 eq in 1990 and 19.8 Gg CO_2 eq in 2009);
- Implementation of a new land use change map for 2009, leading to changed emissions from 2004 on in LULUCF and improvement of completeness by implementation of Tier 1 methods to estimate biomass gain and loss for grasslands and croplands at land use conversion (288 Gg CO_2 eq in 1990 and 168 Gg CO_2 eq in 2009);
- Minor changes in the CH_4 emissions from Solid Waste Disposal as a result of recommendations from the 2011 review (0.4 Gg CO_2 eq in 1990 and 0.07 Gg CO_2 eq in 2009);

- Changed HFC emissions for the years 1995 to 2009 due to new activity data (0.8 Gg CO_2 eq in 1995 and -21.0 Gg CO_2 eq in 2009);
- Changed SF_6 emissions for the years 1990 to 2009 due to new activity data 1 Gg CO_2 eq in 1990 and -4.8 Gg CO_2 eq in 2009).

As a result of some of the above-mentioned methodical changes (and others) the emissions for the precursor gases changed over the whole time-series. The explanation of the recalculations can be found in the IRR report 2012.

Source allocation
As a result of one recommendation from the 2010 review (which was not implemented in the NIR 2011), emissions from limestone use in Iron and Steel Production are now included in category 2A3 compared to 2C15 in earlier submissions.

The GHG emissions within the sector 1.A.4 'Other sectors' for gaseous fuel for the years 2002 to 2009 were reallocated due to the implementation of improved activity data from a survey in the agricultural sector (only minor adjustments in emissions of N_2O; less than 0.01 Gg CO_2 eq in 2002). Emissions changed during this reallocation because the fuel use is reallocated to sectors with different emission factors.

For the precursor gases the allocation of the sources was streamlined with the allocation as used in the IIR reports. This results in a shift of emissions in nearly all sectors.

Error correction
In general, the 2009 figures were updated whenever improved statistical data became available after the 2011 submission. Besides these the following error corrections were performed:
- Inclusion of missing N_2O emissions in 1990 from biomass in category 1A2E (0.02 Gg CO_2 eq in 1990);
- Changes in N_2O emissions from Agricultural Soils for the years 1999 to 2009 due to an error correction (-71.6 Gg CO_2 eq in 1999 and -185.7 Gg CO_2 eq in 2009);
- Error correction in 2009 for N_2O emissions from Nitric acid production (+45.5 Gg CO_2 eq)
- Error correction in 1992 in the calculation of CH_4 emission from enteric fermentation for cattle (+383.5 Gg CO_2 eq)

As a result of the internal QA/QC procedures, minor errors (in activity data and emission figures) were detected and corrected. These error corrections amount to max ± 0.01 Gg CO_2 eq per source category and are not explained in more detail.

10.1.2 KP-LULUCF inventory

The implementation of a new land use map for 2009 changed the areas both subject to re/afforestation and deforestation. This resulted in a decreased sink strength of 62 Gg CO_2 in 2009 for re/afforested land and 42 Gg CO_2 for deforested land.

To increase completeness, Tier 1 defaults were used to estimate changes in biomass in the conversion of cropland and grassland. For re/afforested land the additional emission of carbon when croplands and grasslands were converted to forests amounted to 33.2 Gg CO_2. For deforested land, the additional emission in biomass from conversion to cropland and grassland was -27.3 Gg CO_2.

For deforestation to trees outside forests, loss of carbon in litter and dead wood were accounted for and amounted to 22.7 Gg CO_2 for litter and 1.0 Gg CO_2 for dead wood.

An update of the liming statistics decreased the estimated CO_2 emissions from liming of deforested land now used as croplands by 0.09 Gg C (or 0.32 Gg CO_2).

10.2 Implications for emission levels

10.2.1 GHG inventory

This chapter outlines and summarises the implications of the changes described in section 10.1, for the emission levels over time. Table 10.1 elaborates the differences between the submissions from last year and the current NIR with respect to the level of the different greenhouse gases. More detailed explanations are elaborated in the relevant chapters 3-8.

10.2.1.1 Effect of recalculations on base year and 2009 emission levels

Table 10.1 gives the changes due to the recalculations for the base year 1990, 1995, 2000 and 2005 to 2009 (compared to the NIR 2010). From the table it emerges that the recalculations changed the national emissions only to a small extent.

Table 10.1 Differences between NIR 2011 (including resubmitted data after the review) and the NIR 2012 for the period 1990–2009 due to recalculations (Units: Tg CO_2 eq; for F-gases: Gg CO_2 eq).

Gas	Source	1990	1995	2000	2005	2006	2007	2008	2009
CO_2 (Tg)	NIR 2012	**162.2**	173.6	172.9	179.0	175.4	175.3	178.2	172.8
Incl. LULUCF	NIR 2011	**162.0**	173.3	172.5	178.7	175.0	174.9	177.9	172.4
	Difference	*0.2%*	*0.2%*	*0.2%*	*0.2%*	*0.2%*	*0.2%*	*0.2%*	*0.2%*
CO_2 (Tg)	NIR 2012	**159.3**	170.7	169.9	175.9	172.3	172.4	175.2	169.9
Excl. LULUCF	NIR 2011	**159.3**	170.8	170.0	176.0	172.3	172.4	175.2	169.9
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
CH_4 (Tg)	NIR 2012	**25.7**	24.3	19.9	17.4	17.0	17.0	17.2	17.1
	NIR 2011	**25.7**	24.3	19.9	17.3	16.9	17.0	17.2	17.1
	Difference	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.1%*	*0.0%*	*0.1%*
N_2O (Tg)	NIR 2012	**20.2**	20.1	17.6	15.6	15.5	13.8	9.9	9.6
	NIR 2011	**20.1**	20.1	17.7	15.7	15.6	13.8	9.9	9.7
	Difference	*0.1%*	*0.0%*	*-0.5%*	*-0.5%*	*-0.5%*	*-0.6%*	*-0.9%*	*-1.4%*
PFCs (Gg)	NIR 2012	2,264	**1,938**	1,582	266	257	323	251	168
	NIR 2011	2,264	**1,938**	1,582	266	257	323	251	168
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
HFCs (Gg)	NIR 2012	4,432	**6,019**	3,892	1,515	1,727	1,843	1,922	2,040
	NIR 2011	4,432	**6,018**	3,886	1,494	1,704	1,820	1,889	2,061
	Difference	*0.0%*	*0.0%*	*0.1%*	*1.9%*	*1.4%*	*1.3%*	*1.7%*	*-1.0%*
SF_6 (Gg)	NIR 2012	218	**287**	297	240	199	188	184	170
	NIR 2011	217	**301**	315	239	198	192	186	175
	Difference	*0.4%*	*-4.8%*	*-5.9%*	*0.5%*	*0.3%*	*-2.3%*	*-1.1%*	*-2.7%*
Total	NIR 2012	215.0	226.2	297	214.0	210.0	208.4	207.6	201.8
(Tg CO_2 eq.)	NIR 2011	214.7	225.9	315	213.7	209.7	208.1	207.3	201.5
Incl. LULUCF	*Difference*	*0.2%*	*0.1%*	*-5.9%*	*0.1%*	*0.1%*	*0.2%*	*0.1%*	*0.1%*
Total	NIR 2012	212.0	223.4	297	211.0	207.0	205.5	204.6	198.9
(Tg CO_2 eq.)	NIR 2011	212.0	223.4	315	211.0	207.0	205.6	204.7	199.1
Excl. LULUCF	*Difference*	*0.0%*	*0.0%*	*-5.9%*	*0.0%*	*0.0%*	*0.0%*	*-0.1%*	*-0.1%*

10.2.2 KP-LULUCF inventory

Due to the changes described in section 10.1.2, the data for 2008 and 2009 were recalculated. In Table 10.2 the differences for the reported values in the NIR 2011 and 2012 are presented. The table shows that the recalculations increased the cumulative emission for KP-LULUCF over 2008 and 2009 by approximately 7% and 16%.

10.3 Implications for emission trends, including time-series consistency

10.3.1 GHG inventory

In general, the recalculations improve both the accuracy and time-series consistency of the estimated emissions. Table 10.3 presents the changed trends in the greenhouse gas emissions during this period due to the recalculations carried out.

10.3.2 KP-LULUCF inventory

Not applicable, the Netherlands reports the KP data only for the third time in the NIR 2012.

10.4 Recalculations, response to the review process and planned improvements

10.4.1 GHG inventory

10.4.1.1 Recalculations

No recalculations are anticipated in the next submission of the CRF.

10.4.1.2 Response to the review process

Public and peer review

Drafts of the NIR are subject to an annual process of general public review and a peer review. No remarks were received from the public on the draft NIR of January 2012.

Table 10.2 Differences between NIR 2011 and NIR 2012 for 2009 due to recalculations for KP-LULUCF.

	2008		2009	
	NIR 2011	NIR 2012	NIR 2011	NIR 2012
AR	-484,61	-404,69	-537,09	-442,19
D	821,57	763,01	833,20	787,56
Total	336,96	358,32	296,12	345,38

Table 10.3 Differences between NIR 2011 and NIR 2012 with respect to emission trends during the period 1990–2009 (Units: Gg CO_2 eq, rounded)

Gas	Trend (absolute)			Trend (percentage)		
CO_2 eq (Gg) [1)]	NIR 2011	NIR 2012	Difference	NIR 2011	NIR 2012	Difference
CO_2	10,618	10,646	28	6.7%	6.7%	0.0%
CH_4	-8,619	-8,628	-8	-33.6%	-33.6%	0.0%
N_2O	-10,421	-10,570	-149	-51.7%	-52.4%	-0.7%
HFCs	-2,371	-2,392	-21	-53.5%	-54.0%	-0.5%
PFCs	-2,097	-2,097	0	-92.6%	-92.6%	0.0%
SF_6	-42	-48	-6	-19.4%	-21.9%	-2.5%
Total	-12,932	-13,089	-156	-6.1%	-6.1%	-0.1%

[1)] Excluding LULUCF.

The peer review includes a general check on all chapters. In addition, a special focus is given to a specific sector or topic each year. This year, a separate study (Somogyi, 2012) focused on the LULUCF sector. In the report the conclusion is drawn that the estimations for emissions and removals as well as the documentation for LULUCF and KP LULUCF are of good quality. Furthermore, recommendations were formulated on the following issues: improvement of the transparency, complete the documentation boxes in the CRF table series 5, improvement of consistency between the NIR and the protocols and ensure completeness of the description of the methodology in both documents together. A recommendation to assess the (maybe unnecessarily complicated) methodology of estimating carbon stock changes in forest biomass will be researched. For KP LULUCF the peer review pointed to the importance of a new round of the Dutch NFI during the KP commitment period or as an alternative, to develop an improved extrapolation including validation. Several recommendations are incorporated in the present NIR while other recommendations will be taken into consideration for future submissions and improvement actions.

Peer reviews in the past years were performed on the following sectors: waste (Oonk, 2011), transport (Hanschke, 2010), combustion and process emissions in industry (Neelis et al., 2009) and agriculture (Monteny, 2008). In general, the conclusion of these peer reviews is that the Dutch NIR adequately describes the way that the Netherlands calculates the emissions of greenhouse gases. The major recommendations refer to readability and transparency of the NIR and suggestions for textual improvement.

UNFCCC reviews

In September 2011 an in-country review of the NIR 2011 took place. An intensive process of presentations, discussions, questions and answers was part of this process. On October 1st 2011 the ERT sent the Saturday paper with potential problems and further questions. After the response by the Netherlands, the ERT sent a message indicating that all potential problems are resolved. However, the draft report by the ERT was not received until 28 February 2012. Therefore, the Netherlands could not use the recommendations in the ERT report for further improvements in this NIR. Table 10.4 contains the improvements made in response to the UNFCCC Saturday paper of the 2011 review and the remaining issues from the 2010 review report.

Table 10.4 Improvements made in response to UNFCCC reviews 2011 and 2010.

Source [1)]	Category	ERT comment	Netherlands' Response	Reference (section of NIR)
S.P. 2011 #1	Energy	Missing emission estimates for CNG vehicles	Estimates included in the resubmitted CRF 2011.v2.3	3.2.8.2
S.P. 2011 #2	Energy	Missing emission estimates for CO_2 from gas transmission	Estimates included in the resubmitted CRF 2011.v2.3	3.3.2.5
S.P. 2011 #3	Energy	Missing emission estimates for CH_4 from charcoal production	Estimates included in the resubmitted CRF 2011.v2.3	3.3.1.1.
S.P. 2011 #4	Energy/IP	Improve transparency of emissions in Iron & Steel	Confidential carbon balance provided to the ERT	1.6.3 and 3.2.7.5
S.P. 2011 #5	Energy	Missing emission estimates for charcoal use	Estimates included in the resubmitted CRF 2011.v2.3	3.2.9.5
S.P. 2011 #6	Energy	Improve transparency on emissions from civil aviation	Provided to the ERT	3.2.8.1.
S.P. 2011 #7	IP	Missing estimates of emissions from lime production in paper industry	This source is proved to be not occurring in the Netherlands	4.2.1.
S.P. 2011 #8	Energy/IP	Missing emission estimates for CO_2 from anode consumption in Iron & Steel	Estimates included in the resubmitted CRF 2011.v2.3	4.4.5
S.P. 2011 #9	IP	Error in emission estimate for Aluminium Production	Error corrected in the resubmitted CRF 2011.v2.3	4.4.8.1.
S.P. 2011 #10 & 11	Agriculture	Error in emission estimates for Horses	Error corrected in the resubmitted CRF 2011.v2.3	6.2.7.1. and 6.3.7.1
S.P. 2011 #12	Waste	Improve transparency on emissions from landfills	Provided to the ERT and included in this NIR	8.2.4
S.P. 2011 #13	Waste	Missing emission estimates for N_2O from septic tanks	Estimates included in the resubmitted CRF 2011.v2.3 and improved in the CRF 2012	8.3.2
ARR 2010 Par 15	Institutional arrangements	Update institutional arrangements to the current state and use the correct names	This has been corrected in relevant chapters	1
ARR 2010 Par 19 to 21	Key categories	Improve transparency and include LULUCF in Table 7 of CRF	Documentation in Table 7 improved	CRFs 1990 and 2010
ARR 2010 Par 23 to 24	Uncertainties	Improve description and implement Ecofys proposals	Current uncertainty estimates are included in the inventory database. Sectoral specialist can now update estimates which will (can) be incorporated in next submissions	
ARR 2010 Par 26	Recalculations	Improve consistency and cross-check with sectoral chapters	Improved	10
ARR 2010 Par 28	QAQC	Improve Tier 2 QC documentation	Improved	f.i. 1.6.1
ARR 2010 Par 29, 35 and 105	QAQC	Improve internal consistency NIR CRF and protocols	Improved	Based on changes in methodologies protocols are improved (i.e. waste water, F-gases)
ARR 2010 Par 30 and 65	Transparency	Inclusion of more detail of protocols in NIR	This recommendation is not followed. All protocols are publicly available and referenced as part of the NIR	

Source [1)]	Category	ERT comment	Netherlands' Response	Reference (section of NIR)
ARR 2010 Par 31	Transparency	Improve transparency in NIR and CRF on reporting for the agricultural sector	Missing data in CRF were included and NIR text was improved	CRFs Tables 4A and 4B and Annex 8 of the NIR
ARR 2010 Par 32 and 64	Transparency	Justify the use of 'C' in IP	Included in the sectoral chapters and intensively discussed in the 2011 review	1.6.3 and 3
ARR 2010 Par 33	Inventory management	Describe archiving system for all information used for preparation of the inventory	Implemented	1.3.3 and 1.6.1
ARR 2010 Par 45	Energy	Describe how time-series consistency for plant specific data is maintained	Implemented	1.3.2.1 and 1.6.1
ARR 2010 Par 46	Energy	Use ETS data for QA/QC	Implemented in QA/QC procedures	1.6.1
ARR 2010 Par 51	Energy	Improve accounting oxidation losses	No improvement made until now due to lack of resources	
ARR 2010 Par 56	Energy	See S.P. 2011 #5	Estimates are included in the resubmission of the CRF (November 2011) and in NIR 2012.	3.2.9.5
ARR 2010 Par 57	Energy	See S.P. 2011 #3	Estimates are included in the resubmission of the CRF (November 2011) and in NIR 2012.	3.3.1
ARR 2010 Par 58	Energy	Include fugitive emissions from (oil) transport in the inventory	Estimates are included in the resubmission of the CRF (October 2010) and in NIR 2011.	3.3.2.5
ARR 2010 Par 61	IP	Include emissions from asphalt roofing and road paving in the inventory	Not implemented because no AD are available and the resources needed are not available	
ARR 2010 Par 71	IP	Report on emission reduction and abatement technologies	Already implemented in the NIR 2011	4.3.3
ARR 2010 Par 73	IP	Reallocate limestone use in Iron and steel to limestone and dolomite use	Implemented in the CRF reallocation from 2.C.1.5. to 2.A.3	4.2.8.1
ARR 2010 Par 74	IP	Improve use of notation keys	Improved	CRF
ARR 2010 Par 75 and 76	IP	Explain the use of different emission calculation methods and raw materials	Already implemented in the NIR 2011	4
ARR 2010 Par 79 and 80	Agriculture	Improve transparency on CS emission factors and notation keys	Implemented	6.2.3, Annex 8 and CRFs
ARR 2010 Par 86	Agriculture	Include anaerobic digestion in the CRF	Not yet implemented, research is ongoing	
ARR 2010 Par 92 and 98	LULUCF	Include missing categories in the submission	Implemented for biomass at land use conversion where T1 is available	7.4 recalculations
ARR 2010 Par 94	LULUCF	Improve QA/QC	QA/QC procedure has been adapted to specifically include LULUCF	1.1.2.
ARR 2010 Par 95	LULUCF	Improve inventory and reduce uncertainties	Uncertainties are subject of ongoing research, this year completeness was improved	7.4
ARR 2010 Par 96 and 97	LULUCF	Report Carbon stock changes in organic and mineral soils	For mineral soils it was already implemented in the Dutch method on a national level. For organic soils not implemented due to lack of data and resources.	7.6.5

Source [1]	Category	ERT comment	Netherlands' Response	Reference (section of NIR)
ARR 2010 Par 96 and 97	LULUCF	Report Carbon stock changes in organic and mineral soils	For mineral soils it was already implemented in the Dutch method on a national level. For organic soils not implemented due to lack of data and resources.	7.6.5
ARR 2010 Par 98	LULUCF	Improve transparency	Implemented: inclusion of land use change matrices in NIR, additional information for category 5A	7.3; 7.5
ARR 2010 Par 104	Waste	Explain drivers for time-series of waste composition	Implemented	8.2.1
ARR 2010 Par 109	Waste	Improve transparency and estimates of industrial WWTP	Notation key in CRF and text in the NIR are now improved.	8.3.2
ARR 2010 Par 118	KP LULUCF	Include N_2O emission estimates	Already implemented in the NIR 2011	
ARR 2010 Par 119	KP LULUCF	Include emission estimates from wildfires	Data for wildfires are lacking	11.3.1.2

[1] S.P.: Saturday Paper after in-country review 2011.

10.4.1.3 Completeness of sources

The Netherlands' greenhouse gas emission inventory includes all sources identified by the Revised Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 1997) with the exception of the following, very minor, sources:

- CO_2 from asphalt roofing (2A5), due to missing activity data;
- CO_2 from road paving (2A6), due to missing activity data;
- CH_4 from enteric fermentation of poultry (4A9), due to missing emission factors;
- N_2O from industrial waste water (6B1), due to negligible amounts;
- part of CH_4 from industrial waste water (6B1b Sludge), due to negligible amounts;
- Precursor emissions (i.e., carbon monoxide (CO), nitrogen oxide (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2) from Memo item 'International bunkers' (international transport) have not been included.

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

10.4.1.4 Completeness of the CRF files

For the years 1991–1994, energy data are less detailed for all industrial source categories than in both the preceding and following years, but they adequately cover all sectors and source categories. All emissions are specified per fuel type (solid, liquid and gaseous fossil fuels). Coal-derived gases (coke oven gas, blast furnace gas, etc.) are included in Solid fuels and refinery gases and residual chemical gases are included in Liquid fuels (also LPG, except for Transport). The fuel category Other Fuels is used to report emissions from fossil waste in waste incineration (included in 1A1a).

Since the Industrial processes source categories in the Netherlands often comprise only a few companies, it is generally not possible to report detailed and disaggregated data. Activity data are confidential and not reported when a source category comprises three (or fewer) companies.

Potential emissions (total consumption data) for PFCs and SF_6 are not reported due to the confidentiality of the consumption data. A limited number of companies report emissions or consumption data and actual estimates are made on the basis of these figures. Data to estimate potential emissions, however, are confidential (Confidential Business Information).

10.4.1.5 Planned improvements

The Netherlands National System was established by the end of 2005, in line with the requirements under the Kyoto Protocol and under the EU Monitoring Mechanism. The establishment of the National System was a result of the implementation of a monitoring improvement programme (see section 1.6). In 2007, the system was reviewed during the initial review. The review team concluded that the Netherlands' National System has been established in accordance with the guidelines for national systems under Article 5, section 1, of the Kyoto Protocol (decision 19/CMP.1) and that it meets the requirements for implementation of the general functions of the National System as well the specific functions of inventory planning, inventory preparation and inventory management.

Monitoring improvement

The National System includes an annual evaluation and improvement process. The evaluation is based on experience in previous years and results of UN reviews, peer reviews and audits. Where needed, improvements are included in the annual update of the QA/QC programme (NL Agency 2011).

One of the improvement actions relates to the emission factor (EF) for natural gas. This EF has been calculated on a yearly basis for a number of years, using detailed data from the gas supply companies. The annual EF was established in this way for the NIR 2006, for 2004 and the base year 1990. For both years, the emission factor proved to be 56.8. Given the time constraints, the EF for intermediate years was assumed to be constant. In 2009, a study analysed this further using two further sample years and the conclusion was that annual fluctuations in intermediate years were very minor. It was therefore decided not to carry out more detailed assessment for further intermediate years and to maintain the EF for these intermediate years at 56.8, especially since these years are neither base years nor commitment period years. Since 2007, the EF has been assessed annually. The value in both 2007 and 2008 was 56.7 (Zijlema, 2008 and Zijlema, 2009), the value in 2009 and 2010 was 56.6 (see Annex 2, Zijlema, 2010a and Zijlema, 2010b).

In 2012 a research project must show if the fuel sales figures for military aviation (that will then be reported by Statistics Netherlands) can be used to calculate emissions from military aviation.

Monitoring protocol and QAQC programme

The Netherlands uses monitoring protocols that describe the methodology, data sources (and the rationale for their selection). These protocols are available on the website www.nlagency.nl/nie. The protocols were given a legal basis in December 2005. The monitoring protocols are assessed annually and – when needed – updated. The initial review recommended that some of the protocols should include more details (inclusion of some additional information that is now only included in background documents). For 2009, the Netherlands has included this recommendation in its QAQC programme and to improve the ‘balance’ between NIR, protocols and background reports. This process started in 2009 and was finalised in 2010.

The QA/QC programme for this year (NL Agency, 2011) continues the assessment of improvement options in the longer term, partly based on the consequences of the new 2006 IPCC guidelines. This will provide a basis for a possible improvement programme for the longer term. As a consequence of the slow progress in international negotiations, this process has not been finalised and will be continued in 2012. Another issue for the Expert Review Team was the recommendation of further centralisation of the archiving of intermediate calculations by task forces. Since 2011, the RIVM database holds storage space where the task forces can store the crucial data for their emission calculations. Finally, the improvement of uncertainties will be continued in 2012.

10.4.2 KP-LULUCF inventory

The Netherlands received comments on the completeness of reporting for grasslands and croplands (biomass). These carbon stock changes have been included in the NIR 2012.

Part II
Supplementary Information required under Article 7, Paragraph 1

11 KP-LULUCF

11.1 General information

11.1.1 Definition of forest and any other criteria

The Netherlands identified in its Initial Report the single minimum values under Article 3.3 of the Kyoto Protocol. The complete forest definition the Netherlands uses for Kyoto reporting is: Forest is land with woody vegetation and with tree crown cover of more than 20% and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m. at maturity *in situ*. They may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground, or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 20%. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 20% or tree height of 5 m are included under forest, as areas normally forming part of the forest area which are temporally unstocked as a result of human intervention or natural causes but which are expected to revert to forest. Forest Land also includes:

- forest nurseries and seed orchards that constitute an integral part of the forest;
- forest road, cleared tracts, firebreaks and other small open areas, all narrower than 6 m, within the forest;
- forest in national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural or spiritual interest, with an area of more than 0.5 ha and a width of more than 30m;
- windbreaks and shelter belts of trees with an area of more than 0.5 ha and a width of more than 30 m.

This excludes tree stands in agricultural production systems, for example, in fruit plantations and agro forestry systems.

This definition is in line with the FAO reporting since 1984 and was chosen within the ranges set by the Kyoto Protocol. The definition matches the subcategory 'Forests according to the Kyoto definition' (abbreviated as FAD) of Forest Land in the inventory under the Convention on Climate Change.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

The Netherlands has not elected any activities to include under Article 3, paragraph 4, of the Kyoto Protocol.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

Units of land subject to Article 3.3 afforestation and reforestation are reported jointly and are defined as units of land that did not comply with the forest definition on 1

January 1990 and do so at any time (that can be measured) before 31 December 2012. Land is classified as re/afforested as long as it complies with the forest definition.

Units of land subject to Article 3.3 deforestation are defined as units of land that did comply with the forest definition at a time on or after 1 January 1990, and again ceased to comply with this forest definition at any moment in time (that can be measured) after 1 January 1990. Once land is classified as deforested, it remains in this category, even if it is reforested and thus complies with the forest definition again later in time.

For each individual pixel, the map overlay gives all mapped land use changes over time since 1990. All of these are taken into account to ensure that AR land remains AR land unless it is deforested and that D land remains D land, even when it is later again converted to forest. The categories in the CRF table 2 show the land use is converted to after it is deforested for the first time, so even though there is no category 'D land converted to forest', this is included in the other subcategories of Table 2.

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities and how they have been consistently applied in determining how land was classified.

This is not applicable as no article 3.4 activities have been elected. `

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

The Netherlands has complete and spatially explicit land use mapping that allows for geographical stratification at 25 m x 25 m (0.0625 ha) pixel resolution (Kramer et al., 2009). This corresponds with the wall-to-wall approach used for reporting under the Convention (approach 3 in GPG-LULUCF chapter 2) and is described as reporting method 2 in GPG-LULUCF for Kyoto (par. 4.2.2.2). ARD activities are recorded on a pixel basis. For each pixel individually, it is known whether it is part of a patch that complies with the forest definition or not.

Any pixel changing from non-compliance to compliance with the forest definition is treated as re/afforestation. This may be the result of a group of clustered pixels that together cover at least 0.5 ha of non-forest land changing land use into forest land. It may also occur when one or more pixels adjacent to a forest patch change land use. Similarly, any pixel changing from compliance with the Kyoto forest definition to non-compliance is treated as deforestation, whether it involves the whole group of clustered pixels or just a subgroup of them. Thus, the assessment unit of land subject to ARD is 25 m x 25 m (0.0625 ha).

11.2.2 Methodology used to develop the land transition matrix

The Netherlands has complete and spatially explicit land-use mapping with map dates on 1 January 1990 and 1 January 2004 (Kramer et al., 2009) and on 1 January 2009 (Van den Wyngaert et al., 2012). An overlay was made between those three maps, a map with mineral soil types and a map with organic soil locations (Van den Wyngaert et al., 2012). This resulted in a land-use change matrix between January 1990 and January 2004 and one between January 2004 and January 2009. Mean annual rates of change for all land-use transitions between those years was calculated by linear interpolation, and after 2009 by extrapolation of the 2004-2009 values. The values based on extrapolation after 1 January 2009 will be subject to recalculation when a new land-use map of later date has been created. Our aim is to make a final land-use map for 1 January 2013, ensuring that we are able to capture all land-use changes before 2012 (IPCC, 2003). Though a land use map with map date of 1st January 2008 would have allowed exact land use changes during the CP, this was practically not feasible. As emissions of all land changing between 1990 and 2012 are part of the KP, this was not considered a major problem.
Thus, in Table NIR-2 the transitions from 'other land' to either AR or D activities during the reporting years 2009 and 2010 (last rows in respective tables for NIR-2) are extrapolated values based on the mean annual rate of land use change between 2004 and 2009, and will be subject to recalculation when updates of the land-use map become available. The reported values for 2008 can be considered as final. Land subject to AR or D between 1990 and 2010 is based on the sum of:

- the cumulative area under AR respectively under D for the (reporting) years 1990 to 2003, as derived from a land-use map overlay (these values can be considered as final) and
- the cumulative area under AR respectively under D for the (reporting) years 2004 to 2008, as derived from a land-use map overlay (these values can be considered as final) and
- the cumulative area under AR respectively under D for the (reporting) years 2009 to 2010, based on an extrapolation of the mean annual rate of land use change between 2004 and 2009 (these values will be subject to recalculation when updates of the land use maps become available).

Table 11.1 Results of the calculations of the area change (in kha) of re/afforestation (AR) and deforestation (D) in the period 1990-2010.

Year	AR land remaining AR land	Land converted to AR land	AR land converted to D land	D land remaining D land	Land converted to D land	Other (not in KP article 3.3)	Land in KP article 3.3 ARD
1990	0.00	2.56	0.00	0.00	1.99	4,146.95	4.55
1991	2.56	2.56	0.00	1.99	1.99	4,142.40	9.10
1992	5.12	2.56	0.00	3.98	1.99	4,137.85	13.65
1993	7.68	2.56	0.00	5.98	1.99	4,133.29	18.21
1994	10.24	2.56	0.00	7.97	1.99	4,128.74	22.76
1995	12.80	2.56	0.00	9.96	1.99	4,124.19	27.31
1996	15.36	2.56	0.00	11.95	1.99	4,119.64	31.86
1997	17.92	2.56	0.00	13.94	1.99	4,115.09	36.41
1998	20.47	2.56	0.00	15.94	1.99	4,110.54	40.96
1999	23.03	2.56	0.00	17.93	1.99	4,105.99	45.51
2000	25.59	2.56	0.00	19.92	1.99	4,101.43	50.07
2001	28.15	2.56	0.00	21.91	1.99	4,096.88	54.62
2002	30.71	2.56	0.00	23.91	1.99	4,092.33	59.17
2003	33.27	2.56	0.00	25.90	1.99	4,087.78	63.72
2004	34.96	2.53	0.88	27.89	1.64	4,083.61	67.89
2005	36.61	2.53	0.88	30.40	1.64	4,079.45	72.05
2006	38.26	2.53	0.88	32.92	1.64	4,075.28	76.22
2007	39.91	2.53	0.88	35.43	1.64	4,071.12	80.38
2008	41.57	2.53	0.88	37.94	1.64	4,066.95	84.55
2009	43.22	2.53	0.88	40.46	1.64	4,062.79	88.71
2010	44.87	2.53	0.88	42.97	1.64	4,058.62	92.88

Table 11.1 gives the annual values from 1990 on for the article 3.3 related cells in Table NIR-2. Due to the use of extrapolation in the current submission, the values from 2009 on can be considered preliminary, with updates foreseen in the 2014 submission.

The summed values in Table 11.1 for AR (AR land remaining AR land + Other land converted to AR land) match with the sum of values reported under the Convention sector 5.A.2 land converted to Forest Land subcategory Forests according to the Kyoto definition (FAD), and Forest Land – Trees outside Forest converted to Kyoto Forest (included in Forest land – Kyoto Forest) for the respective years until 2009. From 2010 on, land in the Convention sector 5.A.2, land converted to Forest Land subcategory Forests according to the Kyoto definition (FAD) converted in 1990 is moved to the Convention sector 5.A.1 Forest land remaining Forest Land subcategory Forests according to the Kyoto definition (FAD), as the 20-year transition period is reached.

The annual values for deforestation (Other land converted to D land) match with the sum of the values reported in sectors 5.B.2.1 Forest Land – FAD to 5.F.2.1 Forest Land – FAD, and Forest Land – Kyoto forest converted to Trees outside Forest (included in Forest land – Trees outside Forest) for the respective years.

It should be noted here that during the QA/QC procedure for the land areas under the Convention, numerically small inconsistencies were discovered, which could not be resolved for this submission but will be for the next (2013). These were related to the 20-year transition period and the combination of several map categories in one LULUCF category. However, these problems did not occur for the KP-LULUCF calculations, which have no transition period and where changes between other land use categories are not important.

11.2.3 Maps and/or database to identify the geographical locations and the system of identification codes for the geographical locations

The land use information reported under both the Convention (see also par. 7.1.2) and the Kyoto Protocol is based on three maps for monitoring nature development in the Netherlands, 'Basiskaart Natuur' (BN) for 1990, 2004 and 2009.

The source material for BN1990 consists of the paper topographic map 1:25,000 (Top25) and digital topographical map 1:10,000 (Top10Vector). Map sheets with exploration years in the period 1986-1994 were used. The source material for BN 2004 consists of the digital topographic map 1:10,000 (Top10Vector). All topographic maps have been explored in the period 1999-2003. For the BN 2004 as well as the BN 2009, information from the Top

Table 11.2 Characteristics of BN 1990 and BN 2004.

Characteristics	BN 1990	BN 2004
Name	Historical Land use Netherlands 1990	Base map Nature 2004
Aim	Historical land use map for 1990	Base map for monitoring nature development
Resolution	25 m	25 m
Coverage	Netherlands	Netherlands
Base year source data	1986-1994	1999-2003
Source data	Hard copy topographical maps at 1:25,000 scale and digital topographical maps at 1:10,000	Digital topographical maps at 1:10,000 and additional sources to distinguish specific nature types
Number of classes	10	10
Distinguished classes	Grassland, Arable land, Heath land/peat moor, Forest, Buildings, Water, Reed marsh, Sand, Built-up area, Greenhouses	Grassland, Nature grassland, Arable land, Heath land, Forest, Built-up area and Infrastructure, Water, Reed marsh, Drifting sands, Dunes and Beaches

10 vector is combined with four other sources, that is information from two subsidy regulations (information from 2004 respectively 2009), a map with the geophysical regions of the Netherlands (Fysisch Geografische Regio's) and a map with the land use in 2000 (Bestand BodemGebruik, 2000; Kramer et al., 2007). Table 11.2 summarises the characteristics of the 1990 and 2004 maps (taken from Kramer et al., 2009). The 2009 map has basically the same properties as the 2004 map and was based on the years 2004-2008.
In 2008, a series of improvements were made to the methodology for digitalisation, classification and aggregation of the then existing 1990 and 2004 maps. One of the main improvements for the 1990 map is a better distinction between built-up areas and agricultural lands. This was based on manual checking of all areas. If the source information was a paper map, it was converted to a digital high-resolution raster map. Then both Top10 Vector files and digitised Top25 maps were (re)classified to match the requirements set by UNFCCC reporting. In this process additional data sets were used and the forest definition was applied to distinguish forests that comply with the minimum area and width chosen for the Kyoto Protocol (see section 11.1.1) from other wooded areas ('Trees outside forests').
Simultaneously, harmonisation between the different source materials was applied to allow a sufficiently reliable overlay. Harmonisation included the use of road maps to check the representation of linear features and correct for any artefact movement of roads due to differences in source material.
The final step in the creation of the land use maps was the aggregation to 25 m × 25 m raster maps. For the 1990 map (which to a large extent was based on information derived from paper maps), an additional validation step was applied to check on the digitising and classifying processes.

To distinguish between mineral soils and peat soils, an overlay was made between the two BN maps and the Dutch Soil Map (De Vries et al., 2003). The result is a map with national coverage that identifies for each pixel whether it was subject to AR or D between 1990 and 2004, and whether it is located on a mineral or an organic soil. Following this procedure, the status as re/afforested area or deforested area is certain for each of the individual locations on the map that were subject to ARD between 1990 and 2004 and 2009. However, it is unknown for each individual location when exactly this occurred. A mean annual rate for the Netherlands as a whole is derived from this by interpolating. For ARD occurring after 1 January 2009 until the reporting year, the mean annual rate for ARD activities is derived by extrapolating the mean annual rates between 2004 and 2009. As such, the exact location of ARD activities after 2008 is not known. The location will be specified in the 2014 submission, when the map dated 1st January 2013 will be available. All ARD will be recalculated for the years where extrapolated data have been used.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 *Description of the methodologies and the underlying assumptions used*

The linkage between AR the reporting based on land use (sub-)categories for the Convention is as follows:
- 5.A.2.1 Cropland converted to Forest Land – Forests according to the Kyoto definition;
- 5.A.2.2 Grassland converted to Forest Land – Forests according to the Kyoto definition;

Table 11.3 Emissions (in Gg C) of re/afforestation activities during the commitment period.

Year	CSC in AG biomass	CSC in BG biomass	CSC in litter	CSC in DW	CSC in mineral soil	CSC in organic soil
2008	90.56	33.65	NE	NE	7.63	-21.46
2009	97.85	36.88	NE	NE	7.86	-22.00
2010	100.88	36.91	NE	NE	7.70	-22.53

Table 11.4 Emissions (in Gg C) of deforestation activities during the commitment period.

Year	CSC in AG biomass	CSC in BG biomass	CSC in litter	CSC in DW	CSC in mineral soil	CSC in organic soil
2008	-109.36	-18.83	-58.90	-2.54	-5.65	-12.50
2009	-112.91	-20.03	-58.90	-2.59	-6.84	-13.21
2010	-116.67	-21.26	-58.90	-2.64	-8.09	-13.91

CSC : carbon stock change
AR : afforestation and reforestation
AG : above ground
D : deforestation
BG : below ground

- 5.A.2.3 Wetland converted to Forest Land – Forests according to the Kyoto definition;
- 5.A.2.4 Settlement converted to Forest Land – Forests according to the Kyoto definition;
- 5.A.2.5 Other Land converted to Forest Land – Forests according to the Kyoto definition as well as the conversion from 5.1.1. Trees outside Forest to Forests according to the Kyoto definition, included in 5.1.1. Forests according to the Kyoto definition.

The methodologies used to calculate carbon stock changes in biomass due to AR activities are in accordance with those under the Convention as presented in section 7.2. The carbon stock changes due to changes in biomass were attributed to above- respectively below-ground biomass, using one average R value derived from the plots 0-20 years old (Van den Wyngaert et al., 2009). Carbon stock changes in dead wood and litter are not reported (see section 11.3.1.2). Carbon stock changes in mineral and organic soils are reported in this submission for the first time, and a recalculation was made for 2008. The methods are presented below and results for carbon stock changes for all pools are given for the full time-series since 1990 in Table 11.3.

The linkage between D and the reporting based on land use (sub)categories for the Convention is as follows:

- 5.B.2.1 Forest Land – Forests according to the Kyoto definition converted to Cropland
- 5.C.2.1 Forest Land – Forests according to the Kyoto definition converted to Grassland
- 5.D.2.1 Forest Land – Forests according to the Kyoto definition converted to Wetland
- 5.E.2.1 Forest Land – Forests according to the Kyoto definition converted to Settlement
- 5.F.2.1 Forest Land – Forests according to the Kyoto definition converted to Other Land as well as the conversion from Forests according to the Kyoto definition to Trees outside Forest, included in 5.1.1. Trees outside Forest.

The methodologies used to calculate carbon stock changes in biomass due to D activities are generally in accordance with those under the Convention as presented in section 7.2.4. The carbon stock changes due to changes in biomass change were differentiated in above- respectively below-ground biomass using data available from the simple bookkeeping model used (Van den Wyngaert et al., 2009). All biomass emissions were attributed to the year of deforestation, and no biomass emissions were reported for any other years. Carbon stock changes in mineral soils are reported using a 20-year transition period, while carbon stock changes in organic soils are reported for all organic soils under article 3.3 activities. The methods are presented below.
Deforestation of re/afforested land involved an emission of all carbon stocks that had been calculated to have accumulated following the methodologies for re/afforestation.

Method to estimate carbon stock change in ARD land in mineral soils

Carbon stock changes in mineral and organic soils are reported for all soils changing land use under article 3.3. The carbon stock change in mineral soils was calculated from base data from the LSK survey (de Groot et al., 2005; Lesschen et al., in prep.) The LSK database contains quantified soil properties, including soil organic matter, for about 1,400 locations at five different depths. The soil

types for each of the sample points were reclassified to eleven main soil types, which represent the main variation in carbon stocks within the Netherlands. Combined with the land use at the time of sampling, this led to a new soil-land use based classification of all points.
The LSK data set only contains data on soil carbon stocks for the land uses grassland, cropland and forest. For the remaining land use categories separate estimates were made. For settlements (about 25% of deforested land becomes settlements) the estimates make use of information in the IPCC 2006 guidelines. An average soil carbon stock under settlement that is 0.9 times the carbon stock of the previous land use is assumed based on the following assumptions:

(i) 50% of the area classified as settlement is paved and has a soil carbon stock of 0.8 times the corresponding carbon stock of the previous land use. Considering the high resolution of the land use change maps in the Netherlands (25x25 m grid cells), it can be assumed that in reality a large portion of that grid cell is indeed paved.
(ii) The remaining 50% consists mainly of grassland and wooded land for which the reference soil carbon stock from the previous land use, i.e., forest is assumed.

For the land use categories wetland and trees outside forest (TOF) no change in carbon stocks in mineral soils is assumed upon conversion to or from forest. For the category Other land a carbon stock of zero is assumed. This is a conservative estimate, yet in many cases very realistic (other land in the Netherlands are sandy beaches and inland (drifting) sandy areas).

The estimated annual C flux associated with re/afforestation or deforestation is then estimated from the difference between land use classes divided by twenty years (IPCC default):

$$E_{\min\_xy} = \sum_{1}^{i} \left(\frac{C_{yi} - C_{xi}}{T} \cdot A_{\min\_xyi} \right)$$

$E_{\min\_xy}$ Annual emission for land converted from land use x to land use y on soil type I (Gg C yr^{-1})

$A_{\min\_xy}$ Area of land converted from land use x to land use y on soil type I in years more recent than the length of the transition period (= less than 20 years ago) (ha)

C_{yi}, C_{xi} Carbon stocks of land use x respectively y on soil type I (Gg C.ha^{-1})

T length of transition period (= 20 years)

For units of land subject to land use change during the transition period (e.g., changing from forest to grassland and then to cropland), the estimated carbon stock at time of land use change was calculated based on

$$C_{\Delta yi_t} = C_{xi} + t \cdot \frac{C_{yi} - C_{xi}}{T}$$

With symbols as above and

$C_{\Delta yi_t}$ Carbon stock of land converted from land use x to land use y on soil type i at time t years after conversion (Gg C ha-1)

t years since land use change to land use y

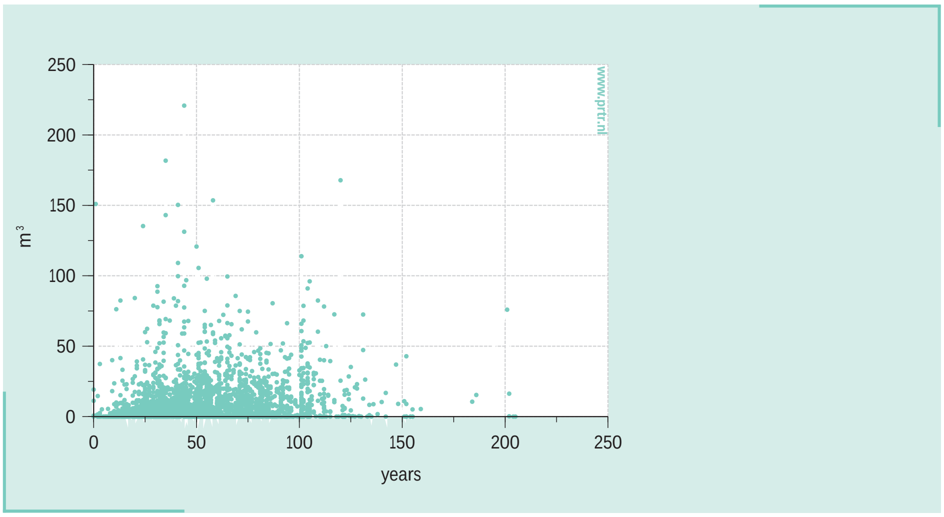
And this carbon stock was filled in the first formula to calculate the mineral soil emissions involved in another land use change.

This results in net sources of 20.9 (2008), 25.0 (2009) and 29.7 (2010) kton CO_2 per year for deforestation and a net sink of 27.9 (2008), 28.3 (2009) and 28.6 (2010) kton CO_2 per year for re/afforestation.

Method to estimate carbon stock change in ARD land in organic soils

The area of organic soils under forests is very small: 11,539 ha (4.0% of total peat area), based on the land use map of 2004. The area of re/afforested land on organic soils is 2,912 ha (8% of re/afforested area) and of deforested land 1,536 ha (5% of deforested area), based on the land use change between 1990 and 2004 (Kramer et al., 2009). The majority of this is a conversion between Kyoto forest and agricultural land (cropland or grassland). Drainage of organic soils to sustain forestry is not part of the land management nor actively done. However, indirectly also organic soils under forest are affected by drainage from the nearby cultivated and drained agricultural land.
Based on the land use maps of 1990 and 2004 the locations of deforestation and re/afforestation were determined in the ongoing study by Van den Wyngaert et al. (in prep) and overlaid with the ground surface lowering map of peat areas. The emissions from organic soils are then calculated using the ground surface lowering rate, the bulk density of the peat, the organic matter fraction and the carbon fraction in organic matter (see Kuikman et al., 2005). For organic soils under deforestation the assumption that emissions are equal to the emissions of cultivated organic soils is realistic. For re/afforestation this assumption is rather conservative, as active drainage in forests is not common practice. For this reason and since no data is available about emissions from peat soils under

Figure 11.1 Volume of dead wood (standing and lying) in Dutch NFI plots in relation to tree age.



forest or about the water management of forests, we have assumed that emissions remain equal to the emissions on cultivated organic soils before re/afforestation.
The result of the overlay of the ground surface lowering map of peat soils with the locations of re/afforestation and deforestation (land use changes from 1990 – 2004) results in area (ha) and emissions (kton CO_2). The average CO_2 emission from organic soils under re/afforestation is 23.7 ton CO_2 per ha per year and under deforestation 23.9 ton CO_2 per ha per year.

Method to estimate nitrous oxide emissions associated with disturbance of soils when deforested areas are converted to cropland
Nitrous oxide emissions associated with disturbance of soils when deforested areas are converted to cropland are calculated using equations 3.3.14 and 3.3.15 of Good Practice Guidance for LULUCF (IPCC, 2003) for each aggregated soil type (see mineral soils above). The default EF1 of 0.0125 kg N_2O-N/kg N was used. For three aggregated soil types average C:N ratios, based on measurements, were available and used. For all other aggregated soil types we used the default C:N ratio of 15 (GPG p. 3.94, IPCC, 2003). For aggregated soil types where conversion to cropland led to a net gain of carbon, the nitrous oxide emission was set to zero.

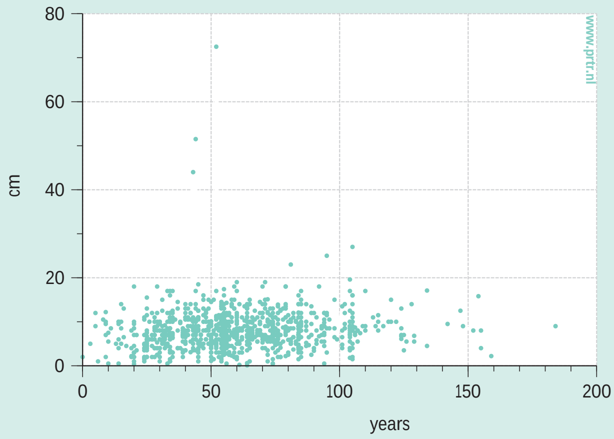
Method to estimate carbon stock change in ARD land due to liming
Liming of forest in the Netherlands might occur occasionally but no statistics are available. All liming based on quantities of product sold is attributed to agricultural land (Cropland, Grassland) which is the main sector where liming occurs. Liming is thus reported only for deforested land that is converted to any of these categories. The total amount of liming is reported in sector 5G of the Convention and described in section 7.8. There is no information how much of the total amount of lime is applied on croplands and grasslands that are reported under deforestation (as opposed to other croplands and grasslands). A mean per ha lime application was calculated based on the total amount of lime applied and the total area under grassland and cropland. This was multiplied with the total area of grassland and cropland reported under article 3.3 deforestation to calculate the amount of CO_2 emission due to liming.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Carbon stock change due to changes in dead wood and litter in units of land subject to article 3.3 AR
The national forest inventory provides an estimate for the average amount of litter (in plots on sandy soils only) and the amount of dead wood (all plots) for plots in permanent forests. The data do provide the age of the trees and assume that the plots are no older than the trees. However, it is possible that several cycles of forest have been grown and harvested on the same spot. The age of the plot does not take into account this history or any effect it may have on litter accumulation from previous forests in the same location. Thus, age does not necessarily represent time since re/afforestation. This is reflected in a very weak relation between tree age and carbon in litter (Figure 11.2), and a large variation in dead wood even for plots with young trees (Figure 11.1).

Apart from forests, no land use has a similar carbon stock in litter (in Dutch grasslands, management prevents the

Figure 11.2 Thickness of litter layer (LFH) in Dutch NFI plots in relation to tree age. LFH measurements were conducted only in plots on sandy soils.



built-up of a significant litter layer). Thus, the conversion of non-forest to forest always involves a build-up of carbon in litter. However, as good data are lacking to quantify this sink, we report the accumulation of carbon in litter for re/afforestation conservatively as zero.

Similarly, no other land use has carbon in dead wood. Thus, the conversion of non-forest to forest involves a build-up of carbon in dead wood. However, as it is unlikely that much dead wood will accumulate in very young forests (having regeneration years in 1990 or later), accumulation of carbon in dead wood in re/afforested plots is most likely a very tiny sink that is too uncertain to quantify reliably. Thus, we report this carbon sink conservatively as zero.

N_2O emission due to nitrogen fertilisation in units of land subject to article 3.3 AR

Forest fertilisation does not occur in the Netherlands. Therefore, fertilisation in re/afforested areas is reported NO.

GHG emission due to biomass burning in units of land subject to article 3.3 ARD

Greenhouse gas emissions (CO_2, CH_4 and N_2O) related to biomass burning are not estimated because biomass burning has not been monitored since 1996. Wildfire statistics indicated that forest fires rarely occurred in the two decades before 1996 (Wijdeven et al., 2006).

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

For all article 3.3 AR activities, forests were created only after 1990 and factoring out of effects on age structure of practices and activities before 1990 is not relevant. For article 3.3 D activities, the increase in mean carbon stock since 1990 may be an effect of changes in management as well as a change in age structure resulting from activities and practices before 1990. However, it is not known which factor contributes to what extent. There has been no factoring out of indirect GHG emissions and removals due to effects of elevated carbon dioxide concentrations or nitrogen deposition. To our knowledge, there is no internationally agreed methodology to factor out the effects of these that could be applied to our data.
This increase in mean carbon stock results in a higher carbon emission due to deforestation. Thus, not factoring out the effect of age structure dynamics since 1990 results in a more conservative estimate of emissions due to article 3.3 D activities.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

All emissions and activity data for 2008 and 2009 have changed since the previous submission due to:

1. Implementation of a 3rd land use map with map date 1st January 2009, resulting in a new set of activity data. From 2004 on land use change rates and ARD locations have been updated to measured values (2004-2008) or to extrapolations (2009-2010). Due to the change of the activity data, all emissions have changed as well. The new land use map and the implementation of a 2nd land use matrix also involved the introduction of a new series of transitions (e.g., deforestation of AR land).

2. Implementation of Tier 1 emission factors for biomass for land use conversions to or from Cropland and Grassland
3. Explicit calculation of loss of dead wood and litter associated with deforestation to Trees outside Forest. For Trees outside Forest, no explicit dead wood or litter is assumed and as a consequence, land use conversion to another category does not involve carbon loss from these pools. To be consistent, land use conversion of forests (that do have an explicit dead wood and litter pool) to trees outside Forest need to involve an explicit removal of the carbon stored in these pools.
4. Update of the 2009 harvest value has a small effect on the emission factor for biomass loss associated with deforestation.

These correspond with part of the recalculations described in par. 7.4 for the submission under the Convention (recalculations 1,3,5,6).

Another change, without effect on the emission values, involved the definite delay of a new round of the Dutch NFI until beyond the KP commitment period. Thus, the extrapolation method that is now used and proposed as temporary until a new NFI is carried out, will be the definite method used for the final accounting for KP.

11.3.1.5 Uncertainty estimates

The Tier 1 analysis in Annex 7, Table A7.3 provides estimates of uncertainties of LULUCF categories. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the sector LULUCF. The analysis combines uncertainty estimates of the forest statistics, land use and land use change data (topographical data) and the method used to calculate the yearly growth in carbon increase and removals (Olivier et al., 2009). The uncertainty analysis is performed for Forests according to the Kyoto definition (par. 7.2.5) and is based on the same data and calculations as used for KP article 3.3 categories.
Thus, the uncertainty for total net emissions from units of land under article 3.3 afforestation/reforestation is estimated at 63%, equal to the uncertainty in Land converted to Forest Land. Similarly, the uncertainty for total net emissions from units of land under article 3.3 deforestation is estimated at 66%, equal to the uncertainty in Land converted to Grassland (which includes for the sake of the uncertainty analysis all Forest land converted to any other type of land use (see Olivier et al., 2009). As a result of recent improvements in both maps and calculations (see NIR 2009), it is likely that the current estimate is an overestimate of the actual uncertainty. It is foreseen that new uncertainty estimates will be calculated before the final accounting for the KP commitment period.

11.3.1.6 Information on other methodological issues

There is no additional information on other methodological issues.

11.3.1.7 The year of the onset of an activity, if after 2008

The forestry activities under Article 3, paragraph 3 are reported from the beginning of the commitment period.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are directly human-induced

The land use map is dated on 1 January 1990. Only ARD activities relative to this map, that is after this date, are taken into account.

In the Netherlands, forests are protected under the Forest Law (1961), which stipulates that 'The owner of ground on which a forest stand, other than through pruning, has been harvested or otherwise destroyed, is obliged to replant the forest stand within a period of three years after the harvest or destruction of the stand (...)'. A system of permits is applied for deforestation, and compensation forests need to be planted at other locations. This has in the past created problems for (local) nature agencies that wanted to restore the more highly valued heather and peat areas in the Netherlands and as a result, will not allow forest regeneration on areas where it is not intended.

With the historic and current scarcity of land in the Netherlands (which has the highest population density of Europe), any land use is the result of deliberate human decisions.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Following the forest definition and the mapping practice applied in the Netherlands, areas subject to harvesting or forest disturbance are still classified as forests and as such will not result in a change in land use in the overlay of the land use maps (Kramer et al., 2009).

11.4.3 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Following the forest definition and the mapping practice applied in the Netherlands, areas subject to harvesting or forest disturbance are still classified as forests and as such will not result in a change in land use in the overlay of the land use maps (Kramer et al., 2009).

11.4.4 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

The land use maps do not provide information on forest areas that have lost forest cover if they are not classified as deforested. However, from the national forest inventory it can be estimated that about 0.3% of the forests was classified as clear cut area, that is, without tree cover.

11.5 Article 3.4

This is not applicable as no article 3.4 activities have been elected.

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

Under the Convention, conversion to Forest Land (5A2) is a key category. Despite differences in definition between forests under the Convention and under the Kyoto Protocol, 5A2 is a corresponding category and as such re/afforestation is considered a key category under the KP. Under the Convention, conversion of Forest Land to Settlements (5E2) is a key category. Despite differences in definition between forests under the Convention and under the Kyoto Protocol, 5C2 is a corresponding category and as such deforestation is considered a key category under the KP.
The smallest key category based on level for Tier 1 level analysis including LULUCF is 574 Gg CO_2 (2A3 Limestone and dolomite use, see Annex 1). With 450.88 Gg CO_2 the annual contribution of re/afforestation under the KP is just below the smallest key category (Tier 1 level analysis including LULUCF). Deforestation under the KP in 2009 causes an emission of 788.40 Gg CO_2, which is more than the smallest key category (Tier 1 level analysis including LULUCF).

11.7 Information relating to Article 6

The Netherlands is not buying or selling emission rights from JI projects related to land subject to a project under Article 6 of the Kyoto protocol.

12 Information on accounting of Kyoto units

12.1 Background information

The Netherlands' Standard Electronic Format report for 2011 containing the information required in paragraph 11 of the annex to decision 15/CMP.1 and adhering to the guidelines of the SEF has been submitted to the UNFCCC Secretariat electronically - SEF_NL_2012_1_16-20-3 4-1-2012.xls.

12.2 Summary of information reported in the SEF tables

There were 1,057,489,053 AAUs in the Netherlands' National Emission Trading Registry at the end of the year 2011, of which 533,219,656 AAUs were in the Party holding account; 151,872,020 AAU's in the entity holding accounts; 3,979 AAUs in the other cancellation accounts and 372,393,398 AAUs in the retirement account.

There were 41,608,817 CERs in the registry at the end of 2011: 23,172,040 CERs were held in the Party holding account, 18,375,603 CERs were held in the entity holding accounts, 61,174 CERs in the other cancellation accounts and no CERs were held in the retirement account.

There were 6,912,193 ERUs in the registry at the end of 2011: 4,866,337 ERUs were held in the Party holding account, 2,045,856 ERUs were held in the entity holding accounts and no ERUs in the other cancellation accounts or the retirement account.

The registry did not contain any RMUs, t-CERs or l-CERs. There were no units in the Article 6 issuance and conversion accounts; no units in the Article 3.3 and Article 3.4 issuance or cancellation accounts and no units in the Article 12 afforestation and reforestation accounts.

The total amount of the units in the registry corresponded to
1,106,010,063 tonnes CO_2 eq.

The Netherlands' assigned amount is 1,001,262,141 tonnes CO_2 eq.

Annual Submission Item	Submission
15/CMP.1 annex I.E paragraph 11: Standard electronic format (SEF)	The Standard Electronic Format report for 2010 has been submitted to the UNFCCC Secretariat electronically (SEF_NL_2012_1_16-20-3 4-1-2012.xls). The contents of the report (R1) can also be found in Annex A6.6 of this document.

12.3 Discrepancies and notifications

Annual Submission Item	Submission
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	No discrepant transactions occurred in 2011.
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2011.
15/CMP.1 annex I.E paragraph 15: List of non-replacements	No non-replacements occurred in 2011.
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as of 31 December 2011.
15/CMP.1 annex I.E paragraph 17: Actions and changes to address discrepancies	No actions were taken or changes made to address discrepancies for the period under review.

12.4 Publicly accessible information

Annual Submission Item	Submission
15/CMP.1 annex I.E Publicly accessible information	The information as described in 13/CMP.1 annex II.E paragraphs 44-48 is publicly available at the following internet address (URL); http://www.emissieautoriteit.nl/english/public-information-kyoto All required information for a Party with an active Kyoto registry is provided with the following exceptions;
	paragraph 46 Article 6 Project Information. The Netherlands does not host JI projects as laid down in National legislation. This fact is stated on the mentioned Internet address. That the Netherlands does not host JI projects is implied by article 16.46c of the Environment Act (Wet milieubeheer) and explicitly stated in the explanatory memorandum to the act implementing the EC linking Directive (Directive 2004/101/EC, the Directive that links the ETS to the project based activities under the Kyoto Protocol). As is explained in the memorandum, the government decided not to allow JI projects in the Netherlands since it would only increase the existing shortage of emission allowances/assigned amount units.
	paragraph 47a/d/f/l in/out/current Holding and transaction information is provided on a holding type level, due to more detailed information being declared confidential by EU regulation. This follows from article 10 of EU Regulation 2216/2004/EC, that states that 'All information, including the holdings of all accounts and all transactions made, held in the registries and the Community independent transaction log shall be considered confidential for any purpose other than the implementation of the requirements of this Regulation, Directive 2003/87/EC or national law.'
	paragraph 47c The Netherlands does not host JI projects as laid down in National legislation (ref. submission paragraph 46 above).
	paragraph 47e The Netherlands does not perform LULUCF activities and therefore does not issue RMUs.
	paragraph 47g No ERUs, CERs, AAUs and RMUs have been cancelled on the basis of activities under Article 3, paragraphs 3 and 4 to date.
	paragraph 47h No ERUs, CERs, AAUs and RMUs have been cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1 to date.
	paragraph 47i The number of other ERUs, CERs, AAUs and RMUs that have been cancelled is published by means of the SEF report.
	paragraph 47j The number of other ERUs, CERs, AAUs and RMUs that have been retired is published by means of the SEF report.
	paragraph 47k There is no previous commitment period to carry ERUs, CERs, and AAUs over from.

12.5 Calculation of the commitment period reserve (CPR)

In April 2008 the Netherlands became eligible under the Kyoto Protocol. Its assigned amount was fixed at 1,001,262,141 tonnes CO_2 equivalent. The CPR was calculated at that point in time at 901,135,927 tonnes CO_2 equivalent. The CPR has not been changed.

12.6 KP-LULUCF accounting

Not applicable, because the Netherlands has opted for end-of-period accounting for KP-LULUCF.

13 Information on changes in national system

Extensive information on the national inventory system is described in this National Inventory Report under the appropriate sections as required by the UNFCCC guidelines. More extensive background information on the National System is also included in the Netherlands 5th National Communication and in the Initial Report. The Initial Review in 2007 concluded that the Netherlands National System has been established in accordance with the guidelines.

There have been no changes in the National System since the last submission and since the initial report, with the exception of the following issues:

- The co-ordination of the Emission Registration Project, in which emissions of about 350 substances are annually calculated, was performed until 1 January 2010 by PBL. As of 1 January 2010, co-ordination has been assigned to RIVM. Processes, protocols and methods remain unchanged. Many of the former experts from PBL have also shifted to RIVM.
- The name of SenterNovem (single national entity/NIE) has changed as of 1 January 2010 to NL Agency.
- The name of the Ministry of Housing, Spatial Planning and the Environment (VROM) has changed as of October 2010 to the Ministry of Infrastructure and the Environment (IenM), as a result of a merger with the Ministry of Transport, Public Works and Water Management.
- The name of the Ministry of Agriculture, Nature and Food Quality (LNV) has changed as of October 2010 to the Ministry of Economic Affairs, Agriculture and Innovation, as a result of a merger with the Ministry of Economic Affairs.

These changes do not have any impact on the functions of the National System.

14 Information on changes in national registry

14.1 Changes to national registry

Reporting Item	Submission
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	There is no change in name or contact information of the registry administrator designated by the Netherlands.
15/CMP.1 annex II.E paragraph 32.(b) Change of co-operation arrangement	There is no change in the co-operation arrangement.
15/CMP.1 annex II.E paragraph 32.(c) Change to database or the capacity of national registry	In 2011 two registry software version updates have been implemented, namely Greta version 5.2 on 9 March and version 5.3 on 23 August. Both upgrades included regular maintenance fixes, which contribute to the robustness and therefore capacity of the Registry. **Update from version 5.1 to version 5.2** This update included regular maintenance fixes, which contribute to the robustness and therefore capacity of the Registry. Additionally, this version added support for the improved transaction message flow which was added to the DES and implemented in ITL in October 2010. With this support the chance of (false) discrepant transactions occurring has been significantly reduced. **Update from version 5.2 to version 5.3** This update included regular maintenance fixes, which contribute to the robustness and therefore capacity of the Registry. Please consult the documents referred to in Annex A6.5 for the following: • Release notes version 5.1.26, 5.2.20, 5.1.21 • Release notes version 5.3.14, 5.3.16 These describe the details of the changes compared to Greta version 5.1.24 used in 2010 up to version 5.3.

Reporting Item	Submission
15/CMP.1 annex II.E paragraph 32.(d) Change of conformance to technical standards	As stated above, version 5.2 added support for the improved transaction message flow, which was added to the DES technical standard in 2010. The support was added in conformance with these updated technical standards. With this the registry remained conformant to the technical standards during the reporting period.
15/CMP.1 annex II.E paragraph 32.(e) Change of discrepancies procedures	As stated above, version 5.2 added support for the improved transaction message flow, which was implemented in the ITL in October 2010. As expected, this has resulted in significantly fewer discrepancies in 2011 compared to the previous year. Compared to 2010 the number of occurrences of 4003 result codes decreased 100% from 466 to 0 (zero) per 100,000 transactions. The occurrences of 4010 result codes decreased 100% from 709 to 0 (zero) per 100,000 transactions.
15/CMP.1 annex II.E paragraph 32.(f) Change of security	Improving security of the Registry remained a top priority in 2011. Both registry software version updates implemented in 2011 included changes to further improve the security of the Registry. **Update from version 5.1 to version 5.2** Several changes were made to further improve the security of the Registry. Due to the nature of the changes the details are not included here. Please refer to the Release Notes for further details. **Update from version 5.2 to version 5.3** Several changes were made to further improve the security of the Registry. Amongst other changes the concept of Trusted Accounts was introduced. With this it is ensured that transactions can only be performed with the approval of two separate persons with the proper authorisation (4-eyes principal). Accounts can be marked as Trusted, by which transfers to such accounts are given pre-approval. Additionally, as reported in the previous NIR, 2-factor authentication has been enabled for all users on 10 January 2011.
15/CMP.1 annex II.E paragraph 32.(g) Change of list of publicly available information	No change in publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry Internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change of data integrity measures	**Software improvements** Both registry software updates have implemented several maintenance fixes, which contribute to the data integrity of the Registry. In particular, some minor time logging errors have been corrected (e.g., SFW8479, SFW9259, SFW9281) and some minor user interface improvements (e.g., SFW8657) have been implemented. Please refer to the release notes for more details. **Disaster recovery test** Netherlands planned to test disaster recovery in December. Unfortunately, there were not enough resources available at the side of ITL to support Netherlands in performing this test. Therefore, the disaster recovery test will be planned to take place some time in 2012 when all the required resources are available.
15/CMP.1 annex II.E paragraph 32.(j) Change of test results	Please consult documents referred to in Annex A6.5 for the following: • Greta test plan and report for versions 5.2 & 5.3 • Certification email from Trasys on behalf of UNFCCC Secretariat and European Commission for versions 5.2 & 5.3 • Localisation test results for versions 5.2 & 5.3

15 Information on minimisation of adverse impacts in accordance with Article 3, paragraph 14

The Netherlands has reported information on minimisation of adverse impacts in its 5th National Communication, submitted to the UNFCCC in December 2009 and in the NIR 2010 and 2011.
Since the reported information in the NIR 2011, there have been limited changes in the activities on minimising adverse impacts. Policies are still in place and being executed. One of the changes is the improvements concerning the Green Climate Fund and New Market Mechanisms. These are seen as important steps to facilitate developing countries in climate adaptation and mitigation. Furthermore, there have been some developments in Carbon Capture and Storage, which are described in this chapter.

Green Climate Fund

By operationalising the Green Climate Fund, COP 17 in Durban has taken an important step towards an effective climate finance regime. In the Transitional Committee, The Netherlands has been actively involved in formulating a set of robust rules for the efficient and effective management and governance of the Fund and therefore, welcomes the consolidation of these rules in the Durban Agreements.

It is pleased that by effectuating the aforementioned rules, the important role of the private sector in realising the necessary investments has been formally acknowledged by COP17.

Furthermore, the newly established 'private sector facility' will facilitate public-private partnerships as part of the Fund, and for the sake of an effective disbursement, projects are only eligible to be financed by the Fund when a positive effect on tackling climate change can be clearly demonstrated.

It is important for the Netherlands that the Fund will be equipped with instruments to attract and generate as much private capital and investment as possible and make foreign direct investments in developing countries climate proof. In 2012 it will not be hesitant in addressing the importance of this issue in international fora.

The Netherlands is pleased that its website, www.faststartfinance.org, could be of value to the promotion of transparency on fast start finance. From this moment on, the UNFCCC will carry responsibility for safeguarding transparency with the launch of a module on the UNFCCC website. It is confident that with the recently established fast start finance module on the UNFCCC website, this transparency will be safeguarded.

Market Mechanisms

In the view of the Netherlands, COP17 in Durban has shown important progress on the future and the use of (flexible) market mechanisms. COP17 has 'defined a new market based mechanism operating under the guidance and authority of the COP' (note that in 1997 the word

‘define’ was also used to establish CDM under the Kyoto Protocol). In 2012 work will continue to develop the Modalities and Procedures for the use of this new market based mechanism, which in fact will allow different approaches, including sectoral ones, to accommodate the differing needs of countries. By this decision, a total fragmentation of the carbon market is minimised.
Another important outcome of COP17 is the decision to continue the Kyoto Protocol, which in practice implies CDM and JI can continue to operate beyond 2012. For CDM and JI, decisions were taken to further enhance their efficiency and the credibility.

Carbon Capture and Storage

Carbon Capture and Storage will reduce the emissions of CO_2 into the air, noting that using fossil fuels will still be inevitable in the coming decades.
The Netherlands is preparing two large-scale demonstration projects on CCS. The first project, the ROAD project, will capture CO_2 from a coal-fired power plant with storage in a depleted gas field under the North Sea close to the shore.
The second project, the Green Hydrogen Project, is a collaboration of industries from the Netherlands and Denmark planning to capture CO_2 from an industrial source, transport by ship and inject into an oil field under the North Sea for EOR and consequently storage.

16 Other information

No other information.

Acknowledgements

Many colleagues from a number of organisations (CBS, EC-LNV, LEI, Alterra, NL Agency, PBL, RIVM and TNO) have been involved in the annual update of the Netherlands Pollutant Release & Transfer Register (PRTR), also called the Emission Registration (ER) system, which contains emissions data on about
350 pollutants. The emission calculations, including those for greenhouse gas emissions, are performed by members of the ER 'Task Forces'. This is a major task, since the Netherlands' inventory contains many detailed emission sources.
Subsequently, the emissions and activity data of the Netherlands' inventory are converted into the IPCC source categories contained in the CRF files, which form a supplement to this report.
The description of the various sources, the analysis of trends and uncertainty estimates (see chapters 3 to 8) were made in co-operation with the following emission experts: Mr Guus van den Berghe (NL Agency) (waste), Mr Klaas van der Hoek and Mrs Isabel van den Wyngaert (land use), Mr Gerben Geilenkirchen (transport), Mr Romuald te Molder (key sources), Mr Jan Dirk te Biesebeek (solvent and product use), Mrs Rianne Dröge (energy), Mrs Johanna Montfoort (fugitive emissions), Mr Kees Peek (industrial processes, data control, chart production), Mr Kees Baas (CBS) (wastewater handling), Mr Jan Vonk (agriculture). In addition, Mr Bas Guis of CBS has provided pivotal information on CO_2 related to energy use. This group has also provided activity data and additional information for the CRF files in cases where these were not included in the data sheets submitted by the ER Task Forces. We are particularly grateful to Mrs Marian Abels, Mr Bert Leekstra, Mr Jack Pesik, Mr Bart Jansen and Mr Dirk Wever, for their contribution to data processing, chart production and quality control.
We greatly appreciate the contributions of each of these groups and individuals to this National Inventory Report and supplemental CRF files, as well as the external reviewers that provided comments on the draft report.

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Annexes

Annex 1
Key sources

A1.1 Introduction

As explained in the Good Practice Guidance (IPCC, 2001), a key source category is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions or both.

For the identification of key sources in the Netherlands inventory, we allocated the national emissions according to the Intergovernmental Panel on Climate Change (IPCC) potential key source list, as presented in Table 7.1 in chapter 7 of the Good Practice Guidance. As suggested in this table, the carbon dioxide (CO_2) emissions from stationary combustion (1A1, 1A2 and 1A4) are aggregated by fuel type. CO_2, methane (CH_4) and nitrous oxide (N_2O) emissions from 'Mobile combustion: road vehicles' (1A3) are assessed separately. The CH_4 and N_2O emissions from aircraft and ships are relatively small (about 1–2 Gg CO_2 equivalents). Other mobile sources are not assessed separately by gas. 'Fugitive emissions from oil and gas operations' (1B) is an important source of greenhouse gas emissions in the Netherlands. The most important gas/source combinations in this category are separately assessed. Emissions in other IPCC sectors are disaggregated, as suggested by the IPCC.

The IPCC Tier 1 method consists of ranking the list of source category/gas combinations according to their contribution to the national total annual emissions and to the national total trend. The areas at the top of the tables in this Annex are the largest sources, of which the total adds up to 95% of the national total (excluding LULUCF): 33 sources for annual level assessment (emissions in 2010) and 32 sources for the trend assessment out of a total of 72 sources. Both lists can be combined to obtain an overview of sources that meet any of these two criteria.

The IPCC Tier 2 method for identification of key sources requires the incorporation of the uncertainty in each of these sources before ordering the list of shares. This has been carried out using the uncertainty estimates presented in Annex 7 (for details on the Tier 1 uncertainty analysis see Olivier et al., 2009). Here, a total contribution of up to 90% to the overall uncertainty has been used to avoid the inclusion of too many small sources. The results of the Tier 1 and Tier 2 level and trend assessments are summarised in Table A1.1 and show a total of 42 key sources excluding LULUCF). As expected, the Tier 2 level and trend assessment increases the importance of very uncertain sources. It can be concluded that in using the results of a Tier 2 key source assessment,
three sources are added to the list of 42 Tier 1 level and trend key sources (excluding LULUCF):

- 1A3 Mobile combustion: road vehicles N_2O (Tier 2 level);
- 4B9 Emissions from manure management: poultry CH_4(Tier 2 trend);
- 6B Emissions from waste water handling N_2O (Tier2 level).

The share of these sources in the national annual total becomes more important when taking their uncertainty (50%–100%) into account (Table A1.4). We then include the most important Land Use, Land Use Change and Forestry (LULUCF) emission sinks and sources in the Tier 1 and Tier 2 key source calculations to identify the key sources in IPCC Sector 5. This results in 5 additional key sources, giving an overall total of 46 key sources (including LULUCF); see also Table A1.2. In this report, the key source assessment is based on emission figures from Common Reporting Format (CRF) 2012 version 1.2, submitted to the European Union (EU) in March 2012.

Please note that the key source analysis for the base year (1990 for the direct GHG and 1995 for the F gasses) is included in the CRF Reporter and not in this annex.

Table A1.1 Key source list identified by the Tier 1 level and trend assessments for 2010 emissions (excluding LULUCF sources).

IPCC	Source category	Gas	Key source?	Tier 1 level recent year without LULUCF	Tier 1 trend without LULUCF	Tier 2 level recent year without LULUCF	Tier 2 trend without LULUCF
	ENERGY SECTOR						
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	Key(L1,)	1	0	0	0
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	Key(L,T1)	1	1	1	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	Key(L,T)	1	1	1	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	Key(L,T)	1	1	1	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	Non key	0	0	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	Key(L,T)	1	1	1	1
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	Key(L,T1)	1	1	1	0
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	CO_2	Key(L,T1)	1	1	1	0
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	Key(L,T)	1	1	1	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	Key(L1,T)	1	1	0	1
1A3	Mobile combustion: water-borne navigation	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: aircraft	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (railways)	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	N_2O	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	N_2O	Key(L2,)	0	0	1	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	Non key	0	0	0	0
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	Key(L,T)	1	1	1	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	Key(L,T1)	1	1	1	0
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	Key(L,T)	1	1	1	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	Key(L,T)	1	1	1	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	Key(,T)	0	1	0	1
1A5	Military use of fuels (1A5 Other)	CO_2	Non key	0	0	0	0
1A	Emissions from stationary combustion: non-CO_2	CH_4	Key(L,T)	1	1	1	1

IPCC	Source category	Gas	Key source?	Tier 1 level recent year without LULUCF	Tier 1 trend without LULUCF	Tier 2 level recent year without LULUCF	Tier 2 trend without LULUCF
1A	Emissions from stationary combustion: non-CO_2	N_2O	Non key	0	0	0	0
1B1	Coal mining	CH_4					
1B1b	Coke production	CO_2	Key(L,T)	1	1	1	1
1B2	Fugitive emissions from venting/flaring: CO_2	CO_2	Key(,T)	0	1	0	1
1B2	Fugitive emissions venting/flaring	CH_4	Key(,T)	0	1	0	1
1B2	Fugitive emissions from oil and gas: gas distribution	CH_4	Non key	0	0	0	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	Non key	0	0	0	0
	INDUSTRIAL PROCESSES						
2A1	Cement production	CO_2	Non key	0	0	0	0
2A3	Limestone and dolomite use	CO_2	Non key	0	0	0	0
2A7	Other minerals	CO_2	Non key	0	0	0	0
2B1	Ammonia production	CO_2	Key(L1,)	1	0	0	0
2B2	Nitric acid production	N_2O	Key(,T)	0	1	0	1
2B5	Caprolactam production	N_2O	Key(L1,)	1	0	0	0
2B5	Other chemical product manufacture	CO_2	Key(L,)	1	0	1	0
2C1	Iron and steel production (carbon inputs)	CO_2	Key(L1,T1)	1	1	0	0
2C3	CO_2 from aluminium production	CO_2	Non key	0	0	0	0
2C3	PFC from aluminium production	PFC	Key(,T)	0	1	0	1
2F	SF_6 emissions from SF_6 use	SF_6	Non key	0	0	0	0
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	Key(L,T)	1	1	1	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	Key(,T)	0	1	0	1
2E	HFC by-product emissions from HFC manufacture	HFC	Non key	0	0	0	0
2F	PFC emissions from PFC use	PFC	Non key	0	0	0	0
2G	Other industrial: CO_2	CO_2	Non key	0	0	0	0
2G	Other industrial: CH_4	CH_4	Non key	0	0	0	0
2G	Other industrial: N_2O	N_2O	Non key	0	0	0	0
	SOLVENTS AND OTHER PRODUCT USE						
3	Indirect CO_2 from solvents/product use	CO_2	Non key	0	0	0	0
3	Solvents and other product use	CH_4					
	AGRICULTURAL SECTOR						
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	Key(L,)	1	0	1	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	Non key	0	0	0	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	Key(L,T1)	1	1	1	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	Non key	0	0	0	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	Non key	0	0	0	0
4B	Emissions from manure management	N_2O	Key(L,T2)	1	0	1	1
4B1	Emissions from manure management: cattle	CH_4	Key(L,T)	1	1	1	1
4B8	Emissions from manure management: swine	CH_4	Key(L,)	1	0	1	0
4B9	Emissions from manure management: poultry	CH_4	Key(,T2)	0	0	0	1

IPCC	Source category	Gas	Key source?	Tier 1 level recent year without LULUCF	Tier 1 trend without LULUCF	Tier 2 level recent year without LULUCF	Tier 2 trend without LULUCF
4B	Emissions from manure management: other	CH_4	Non key	0	0	0	0
4C	Rice cultivation	CH_4					
4D1	Direct N_2O emissions from agricultural soils	N_2O	Key(L,T)	1	1	1	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	Key(L,T)	1	1	1	1
4D2	Animal production on agricultural soils	N_2O	Key(L,T)	1	1	1	1
	WASTE SECTOR						
6A1	CH_4 emissions from solid waste disposal sites	CH_4	Key(L,T)	1	1	1	1
6B	Emissions from wastewater handling	CH_4	Non key	0	0	0	0
6B	Emissions from wastewater handling	N_2O	Key(L2,)	0	0	1	0
6C	Emissions from waste incineration	all					
	OTHER						
6D	OTHER CH_4	CH_4	Non key	0	0	0	0
3, 6D	OTHER N_2O	N_2O	Non key	0	0	0	0
	[1)] = 6D Other waste						
	[2)] = 4D animal production - waste dropped on soils + 3D Solvents		SUM	33	32	28	24

Table A1.2 Key source list identified by the Tier 1 level and trend assessments. Level assessment for 2010 emissions (including LULUCF sources)

IPCC	Source category	Gas	Key source?	Tier 1 level recent year with LULUCF	Tier 1 trend with LULUCF	Tier 2 level recent year with LULUCF	Tier 2 trend with LULUCF
	ENERGY SECTOR						
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	Key(L1,)	1	1	0	0
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	Key(L,T1)	1	1	1	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	Key(L,T)	1	1	1	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	Key(L,T)	1	1	1	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	Non key	0	0	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	Key(L,T)	1	1	1	1
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	Key(L,T1)	1	1	1	0
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	CO_2	Key(L,T1)	1	1	1	0
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	Key(L,T)	1	1	1	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	Key(L1,T)	1	1	0	1
1A3	Mobile combustion: water-borne navigation	CO_2	Key(L1)	1	0	0	0
1A3	Mobile combustion: aircraft	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (railways)	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	N2O	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	N2O	Key(L2,)	0	0	0	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	Non key	0	0	0	0
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	Key(L,T)	1	1	1	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	Key(L,T1)	1	1	1	0
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	Key(L,T)	1	1	1	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	Key(L,T)	1	1	1	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	Key(,T)	0	1	0	1
1A5	Military use of fuels (1A5 Other)	CO_2	Non key	0	0	0	0

IPCC	Source category	Gas	Key source?	Tier 1 level recent year with LULUCF	Tier 1 trend with LULUCF	Tier 2 level recent year with LULUCF	Tier 2 trend with LULUCF
1A	Emissions from stationary combustion: non-CO_2	CH_4	Key(L,T)	1	1	1	1
1A	Emissions from stationary combustion: non-CO_2	N_2O	Non key	0	0	0	0
1B1	Coal mining	CH_4					
1B1b	Coke production	CO_2	Key(L,T)	1	1	1	1
1B2	Fugitive emissions from venting/flaring: CO_2	CO_2	Key(,T)	0	1	0	1
1B2	Fugitive emissions venting/flaring	CH_4	Key(,T)	0	1	0	1
1B2	Fugitive emissions from oil and gas: gas distribution	CH_4	Non key	0	0	0	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	Non key	0	0	0	0
	INDUSTRIAL PROCESSES						
2A1	Cement production	CO_2	Non key	0	0	0	0
2A3	Limestone and dolomite use	CO_2	Non key	1	0	0	0
2A7	Other minerals	CO_2	Non key	0	0	0	0
2B1	Ammonia production	CO_2	Key(L1,)	1	0	0	0
2B2	Nitric acid production	N_2O	Key(,T)	0	1	0	1
2B5	Caprolactam production	N_2O	Key(L1,)	1	0	0	0
2B5	Other chemical product manufacture	CO_2	Key(L,)	1	0	1	0
2C1	Iron and steel production (carbon inputs)	CO_2	Key(L1,T1)	1	1	0	0
2C3	CO_2 from aluminium production	CO_2	Non key	0	0	0	0
2C3	PFC from aluminium production	PFC	Key(,T)	0	1	0	1
2F	SF_6 emissions from SF_6 use	SF_6	Non key	0	0	0	0
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	Key(L,T)	1	1	1	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	Key(,T)	0	1	0	1
2E	HFC by-product emissions from HFC manufacture	HFC	Non key	0	0	0	0
2F	PFC emissions from PFC use	PFC	Non key	0	0	0	0
2G	Other industrial: CO_2	CO_2	Non key	0	0	0	0
2G	Other industrial: CH_4	CH_4	Non key	0	0	0	0
2G	Other industrial: N_2O	N_2O	Non key	0	0	0	0
	SOLVENTS AND OTHER PRODUCT USE						
3	Indirect CO_2 from solvents/product use	CO_2	Non key	0	0	0	0
3	Solvents and other product use	CH_4					
	AGRICULTURAL SECTOR						
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	Key(L,)	1	0	1	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	Non key	0	0	0	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	Key(L,T1)	1	1	1	1
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	Non key	0	0	0	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	Non key	0	0	0	0
4B	Emissions from manure management	N_2O	Key(L,T2)	1	0	1	1
4B1	Emissions from manure management: cattle	CH_4	Key(L,T)	1	1	1	1
4B8	Emissions from manure management: swine	CH_4	Key(L,)	1	0	1	0

IPCC	Source category	Gas	Key source?	Tier 1 level recent year with LULUCF	Tier 1 trend with LULUCF	Tier 2 level recent year with LULUCF	Tier 2 trend with LULUCF
4B9	Emissions from manure management: poultry	CH_4	Key(,T2)	0	0	0	1
4B	Emissions from manure management: other	CH_4	Non key	0	0	0	0
4C	Rice cultivation	CH_4					
4D1	Direct N_2O emissions from agricultural soils	N_2O	Key(L,T)	1	1	1	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	Key(L,T)	1	1	1	1
4D2	Animal production on agricultural soils	N_2O	Key(L,T)	1	1	1	1
	LULUCF						
5A1	Forest Land remaining Forest Land	CO_2	Key(L,)	1	0	1	0
5A2	Land converted to Forest Land	CO_2	Key(L2,T)	0	1	1	1
5B2	Land converted to Cropland	CO_2	Non key	0	0	0	0
5C1	Grassland remaining Grassland	CO_2	Key(L,)	1	0	1	0
5C2	Land converted to Grassland	CO_2	Non key	0	0	0	0
5D2	Land converted to Wetlands	CO_2	Non key	0	0	0	0
5E2	Land converted to Settlements	CO_2	Key(L,T)	0	1	1	1
5F2	Land converted to Other Land	CO_2	Non key	0	0	0	0
5G	Other (liming of soils)	CO_2	Non key	0	0	0	0
	WASTE SECTOR						
6A1	CH_4 emissions from solid waste disposal sites	CH_4	Key(L,T)	1	1	1	1
6B	Emissions from wastewater handling	CH_4	Non key	0	0	0	0
6B	Emissions from wastewater handling	N_2O	Key(L2,)	0	0	1	0
6C	Emissions from waste incineration	all					
	OTHER						
6D	OTHER CH_4	CH_4	Non key	0	0	0	0
3, 6D	OTHER N_2O	N_2O	Non key	0	0	0	0
	[1] = 6D Other waste						
	[2] = 4D animal production - waste dropped on soils + 3D Solvents		SUM	37	35	32	27

A1.2 Changes in key sources compared to previous submission

Due to the use of emission data for 2010, the following changes have taken place compared to the previous NIR:

- 1A3 Mobile combustion water-borne navigation CO_2, now non–key (L1 key in NIR 2011);
- 1A5 Military use of fuels CO_2, now non-key (T1 key in NIR 2011);
- 2B5 Caprolactam production N_2O, now L1, L2 key (non-key in NIR 2011);
- 5E2 Land converted to settlements CO_2, now L2,T key (non-key in NIR 2011).

A1.3 Tier 1 key source and uncertainty assessment

In Tables A1.3 and A1.4, the source ranking is done according to the contribution to the 2010 annual emissions total and to the base year to 2010 trend, respectively. This resulted in 33 level key sources and 32 trend key sources (indicated in blue at the top, excluding LULUCF). Inclusion of LULUCF sources in the analysis adds 4 additional Tier 1 level and trend key sources (see Table A1.2).

Table A1.3a Source ranking using IPCC Tier 1 level assessment 2010, excluding LULUCF (amounts in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	27281	13%	13%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	24098	11%	24%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	20476	10%	34%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20001	10%	44%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	13821	7%	50%	1
1A4a	Stationary combustion: Other Sectors: Commercial/ Institutional, gases	CO_2	12932	6%	56%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12819	6%	62%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	9280	4%	67%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	8538	4%	71%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	7532	4%	75%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	4307	2%	77%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	4140	2%	79%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	2%	80%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3286	2%	82%	1
2B1	Ammonia production	CO_2	3156	2%	83%	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	3062	1%	85%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	2473	1%	86%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2435	1%	87%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1802	1%	88%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	1763	1%	89%	1
4B1	Emissions from manure management: cattle	CH_4	1715	1%	90%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1669	1%	91%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1652	1%	91%	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1491	1%	92%	1
4D2	Animal production on agricultural soils	N_2O	1307	1%	93%	1
4B8	Emissions from manure management: swine	CH_4	1063	1%	93%	1
4B	Emissions from manure management	N_2O	1004	0%	94%	1
1B1b	CO_2 from coke production	CO_2	972	0%	94%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	911	0%	95%	1
2B5	Other chemical product manufacture	CO_2	725	0%	95%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	705	0%	95%	1
2C1	Iron and steel production (carbon inputs)	CO_2	687	0%	96%	1
2B5	Caprolactam production	N_2O	681	0%	96%	1
1A3	Mobile combustion: water-borne navigation	CO_2	595	0%	96%	0
2A3	Limestone and dolomite use	CO_2	574	0%	96%	0

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	555	0%	97%	0
6B	Emissions from wastewater handling	N_2O	449	0%	97%	0
1A3	Mobile combustion: road vehicles	N_2O	435	0%	97%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	394	0%	97%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	391	0%	98%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	386	0%	98%	0
2A1	Cement production	CO_2	348	0%	98%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	343	0%	98%	0
2G	Other industrial: CO_2	CO_2	339	0%	98%	0
2A7	Other minerals	CO_2	331	0%	98%	0
1A5	Military use of fuels (1A5 Other)	CO_2	327	0%	99%	0
2C3	CO_2 from aluminium production	CO_2	311	0%	99%	0
1B2	Fugitive emissions venting/flaring	CH_4	304	0%	99%	0
2B2	Nitric acid production	N_2O	301	0%	99%	0
2G	Other industrial: CH_4	CH_4	291	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	269	0%	99%	0
6B	Emissions from wastewater handling	CH_4	198	0%	99%	0
2F	SF_6 emissions from SF_6 use	SF_6	184	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	175	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	171	0%	100%	0
2F	PFC emissions from PFC use	PFC	151	0%	100%	0
3	Indirect CO_2 from solvents/product use	CO_2	128	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	106	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	90	0%	100%	0
3, 6D	OTHER N_2O	N_2O	80	0%	100%	0
4B9	Emissions from manure management: poultry	CH_4	68	0%	100%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	66	0%	100%	0
2C3	PFC from aluminium production	PFC	58	0%	100%	0
1A3	Mobile combustion: road vehicles	CH_4	50	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	0%	100%	0
4B	Emissions from manure management: other	CH_4	33	0%	100%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	28	0%	100%	0
6D	OTHER CH_4	CH_4	20	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%	0
			210388			33

Table A1.3b Source ranking using IPCC Tier 1 level assessment 2010, including LULUCF (amounts in Gg CO_2 eq)

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	27281	12.5%	12%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	24098	11.0%	23%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	20476	9.4%	33%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20001	9.1%	42%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	13821	6.3%	48%	1
1A4a	Stationary combustion: Other Sectors: Commercial/ Institutional, gases	CO_2	12932	5.9%	54%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12819	5.9%	60%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	9280	4.2%	64%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	8538	3.9%	68%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	7532	3.4%	72%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	4307	2.0%	74%	1
5C1	Grassland remaining Grassland	CO_2	4246	1.9%	76%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	4140	1.9%	77%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	1.8%	79%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3286	1.5%	81%	1
2B1	Ammonia production	CO_2	3156	1.4%	82%	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	3062	1.4%	84%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	2473	1.1%	85%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2435	1.1%	86%	1
5A1	Forest Land remaining Forest Land	CO_2	2296	1.0%	87%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1802	0.8%	88%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	1763	0.8%	89%	1
4B1	Emissions from manure management: cattle	CH_4	1715	0.8%	89%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1669	0.8%	90%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1652	0.8%	91%	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1491	0.7%	92%	1
4D2	Animal production on agricultural soils	N_2O	1307	0.6%	92%	1
4B8	Emissions from manure management: swine	CH_4	1063	0.5%	93%	1
4B	Emissions from manure management	N_2O	1004	0.5%	93%	1
1B1b	CO_2 from coke production	CO_2	972	0.4%	94%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	911	0.4%	94%	1
2B5	Other chemical product manufacture	CO_2	725	0.3%	94%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	705	0.3%	95%	1
2C1	Iron and steel production (carbon inputs)	CO_2	687	0.3%	95%	1
2B5	Caprolactam production	N_2O	681	0.3%	95%	1
1A3	Mobile combustion: water-borne navigation	CO_2	595	0.3%	96%	1

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
2A3	Limestone and dolomite use	CO_2	574	0.3%	96%	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	555	0.3%	96%	0
5E2	Land converted to Settlements	CO_2	553	0.3%	96%	0
5A2	Land converted to Forest Land	CO_2	547	0.3%	97%	0
6B	Emissions from wastewater handling	N_2O	449	0.2%	97%	0
1A3	Mobile combustion: road vehicles	N_2O	435	0.2%	97%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	394	0.2%	97%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	391	0.2%	97%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	386	0.2%	98%	0
2A1	Cement production	CO_2	348	0.2%	98%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	343	0.2%	98%	0
2G	Other industrial: CO_2	CO_2	339	0.2%	98%	0
2A7	Other minerals	CO_2	331	0.2%	98%	0
1A5	Military use of fuels (1A5 Other)	CO_2	327	0.1%	98%	0
2C3	CO_2 from aluminium production	CO_2	311	0.1%	99%	0
1B2	Fugitive emissions venting/flaring	CH_4	304	0.1%	99%	0
2B2	Nitric acid production	N_2O	301	0.1%	99%	0
2G	Other industrial: CH_4	CH_4	291	0.1%	99%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	269	0.1%	99%	0
5C2	Land converted to Grassland	CO_2	259	0.1%	99%	0
6B	Emissions from wastewater handling	CH_4	198	0.1%	99%	0
2F	SF_6 emissions from SF6 use	SF_6	184	0.1%	99%	0
5B2	Land converted to Cropland	CO_2	181	0.1%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	175	0.1%	99%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	171	0.1%	100%	0
2F	PFC emissions from PFC use	PFC	151	0.1%	100%	0
3	Indirect CO_2 from solvents/product use	CO_2	128	0.1%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	106	0.0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	90	0.0%	100%	0
3, 6D	OTHER N_2O	N_2O	80	0.0%	100%	0
5D2	Land converted to Wetlands	CO_2	72	0.0%	100%	0
4B9	Emissions from manure management: poultry	CH_4	68	0.0%	100%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	66	0.0%	100%	0
5G	Other (liming of soils)	CO_2	60	0.0%	100%	0
2C3	PFC from aluminium production	PFC	58	0.0%	100%	0
1A3	Mobile combustion: road vehicles	CH_4	50	0.0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	0.0%	100%	0
4B	Emissions from manure management: other	CH_4	33	0.0%	100%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	28	0.0%	100%	0
5F2	Land converted to Other Land	CO_2	21	0.0%	100%	0
6D	OTHER CH_4	CH_4	20	0.0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0.0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0.0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0.0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0.0%	100%	0
			218756	100.0%		37

Table A1.4a Source ranking using IPCC Tier 1 trend assessment 2010, excluding LULUCF (amounts in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	13348	27281	13%	7%	16%	16%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	20001	10%	4%	10%	26%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	4307	2%	4%	8%	34%	1
2B2	Nitric acid production	N_2O	6330	301	0%	3%	7%	41%	1
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	7632	12932	6%	3%	6%	47%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	391	0%	3%	6%	53%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	19020	13821	7%	2%	5%	58%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	9999	7532	4%	1%	3%	61%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	18696	20476	10%	1%	2%	64%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12819	6%	1%	2%	66%	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	1042	3062	1%	1%	2%	68%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	601	2473	1%	1%	2%	70%	1
2C3	PFC from aluminium production	PFC	1901	58	0%	1%	2%	72%	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1491	1%	1%	2%	74%	1
4D2	Animal production on agricultural soils	N_2O	3150	1307	1%	1%	2%	77%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	911	0%	1%	2%	79%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1802	1%	1%	2%	80%	1
2C1	Iron and steel production (carbon inputs)	CO_2	2267	687	0%	1%	2%	82%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7330	8538	4%	1%	2%	84%	1
4B1	Emissions from manure management: cattle	CH_4	3034	1715	1%	1%	1%	85%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	25776	24098	11%	1%	1%	86%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1652	1%	1%	1%	88%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2435	1%	0%	1%	89%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	304	0%	0%	1%	90%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	5033	4140	2%	0%	1%	91%	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	1356	555	0%	0%	1%	91%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2587	1763	1%	0%	1%	92%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3286	2%	0%	1%	93%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	66	0%	0%	1%	94%	1
1B1b	CO_2 from coke production	CO_2	403	972	0%	0%	1%	95%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1669	1%	0%	1%	95%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	8956	9280	4%	0%	1%	96%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	705	0%	0%	1%	96%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4356	3996	2%	0%	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	566	327	0%	0%	0%	97%	0
4B9	Emissions from manure management: poultry	CH_4	289	68	0%	0%	0%	97%	0
1A3	Mobile combustion: water-borne navigation	CO_2	405	595	0%	0%	0%	97%	0
3	Indirect CO_2 from solvents/product use	CO_2	316	128	0%	0%	0%	98%	0
3, 6D	OTHER N_2O	N_2O	250	80	0%	0%	0%	98%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	189	28	0%	0%	0%	98%	0
1A3	Mobile combustion: road vehicles	N_2O	286	435	0%	0%	0%	98%	0
4B	Emissions from manure management	N_2O	1173	1004	0%	0%	0%	98%	0
2B1	Ammonia production	CO_2	3096	3156	2%	0%	0%	98%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	343	0%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	37	151	0%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	158	50	0%	0%	0%	99%	0
2A3	Limestone and dolomite use	CO_2	481	574	0%	0%	0%	99%	0
2F	SF_6 emissions from SF_6 use	SF_6	287	184	0%	0%	0%	99%	0
2B5	Other chemical product manufacture	CO_2	649	725	0%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	198	0%	0%	0%	99%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	90	0%	0%	0%	99%	0
2C3	CO_2 from aluminium production	CO_2	395	311	0%	0%	0%	99%	0
2B5	Caprolactam production	N_2O	766	681	0%	0%	0%	100%	0
2A7	Other minerals	CO_2	275	331	0%	0%	0%	100%	0
2A1	Cement production	CO_2	416	348	0%	0%	0%	100%	0
4B8	Emissions from manure management: swine	CH_4	1140	1063	1%	0%	0%	100%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	386	0%	0%	0%	100%	0
2G	Other industrial: CO_2	CO_2	304	339	0%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	394	0%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	449	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	269	0%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
6D	OTHER CH_4	CH_4	1	20	0%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	106	0%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	175	0%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	171	0%	0%	0%	100%	0
4B	Emissions from manure management: other	CH_4	29	33	0%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	41	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	0%	100%	0
2G	Other industrial: CH_4	CH_4	297	291	0%	0%	0%	100%	0
			214806	210388		43%			32

Table A1.4b Source ranking using IPCC Tier 1 trend assessment 2010, including LULUCF (amounts in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	13348	27281	12%	7%	16%	16%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	20001	9%	4%	9%	25%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	4307	2%	3%	8%	34%	1
2B2	Nitric acid production	N_2O	6330	301	0%	3%	7%	40%	1
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	7632	12932	6%	3%	6%	46%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	391	0%	2%	6%	52%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	19020	13821	6%	2%	5%	58%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	9999	7532	3%	1%	3%	60%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12819	6%	1%	2%	62%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	18696	20476	9%	1%	2%	65%	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	1042	3062	1%	1%	2%	67%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	601	2473	1%	1%	2%	69%	1
2C3	PFC from aluminium production	PFC	1901	58	0%	1%	2%	71%	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1491	1%	1%	2%	73%	1
4D2	Animal production on agricultural soils	N_2O	3150	1307	1%	1%	2%	75%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	911	0%	1%	2%	77%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1802	1%	1%	2%	79%	1
2C1	Iron and steel production (carbon inputs)	CO_2	2267	687	0%	1%	2%	81%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7330	8538	4%	1%	1%	82%	1
4B1	Emissions from manure management: cattle	CH_4	3034	1715	1%	1%	1%	84%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	25776	24098	11%	1%	1%	85%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1652	1%	1%	1%	86%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2435	1%	0%	1%	87%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	304	0%	0%	1%	88%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	5033	4140	2%	0%	1%	89%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3286	2%	0%	1%	90%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2587	1763	1%	0%	1%	91%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	1356	555	0%	0%	1%	93%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	66	0%	0%	1%	93%	1
1B1b	CO_2 from coke production	CO_2	403	972	0%	0%	1%	94%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1669	1%	0%	1%	94%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	705	0%	0%	1%	95%	1
5A2	Land converted to Forest Land	CO_2	56	547	0%	0%	1%	95%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	8956	9280	4%	0%	1%	96%	1
5E2	Land converted to Settlements	CO_2	203	553	0%	0%	0%	96%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4356	3996	2%	0%	0%	96%	0
1A5	Military use of fuels (1A5 Other)	CO_2	566	327	0%	0%	0%	97%	0
4B9	Emissions from manure management: poultry	CH_4	289	68	0%	0%	0%	97%	0
1A3	Mobile combustion: water-borne navigation	CO_2	405	595	0%	0%	0%	97%	0
3	Indirect CO_2 from solvents/product use	CO_2	316	128	0%	0%	0%	97%	0
3, 6D	OTHER N_2O	N_2O	250	80	0%	0%	0%	97%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	189	28	0%	0%	0%	98%	0
1A3	Mobile combustion: road vehicles	N_2O	286	435	0%	0%	0%	98%	0
4B	Emissions from manure management	N_2O	1173	1004	0%	0%	0%	98%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	343	0%	0%	0%	98%	0
5G	Other (liming of soils)	CO_2	183	60	0%	0%	0%	98%	0
5C2	Land converted to Grassland	CO_2	245	259	0%	0%	0%	98%	0
2F	PFC emissions from PFC use	PFC	37	151	0%	0%	0%	98%	0
2B1	Ammonia production	CO_2	3096	3156	1%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	158	50	0%	0%	0%	99%	0
2A3	Limestone and dolomite use	CO_2	481	574	0%	0%	0%	99%	0
5A1	Forest Land remaining Forest Land	CO_2	2434	2296	1%	0%	0%	99%	0
2F	SF_6 emissions from SF_6 use	SF_6	287	184	0%	0%	0%	99%	0
2B5	Other chemical product manufacture	CO_2	649	725	0%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	198	0%	0%	0%	99%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	90	0%	0%	0%	99%	0
2C3	CO_2 from aluminium production	CO_2	395	311	0%	0%	0%	99%	0
2B5	Caprolactam production	N_2O	766	681	0%	0%	0%	99%	0
5C1	Grassland remaining Grassland	CO_2	4246	4246	2%	0%	0%	100%	0
2A7	Other minerals	CO_2	275	331	0%	0%	0%	100%	0
2A1	Cement production	CO_2	416	348	0%	0%	0%	100%	0
4B8	Emissions from manure management: swine	CH_4	1140	1063	0%	0%	0%	100%	0
5B2	Land converted to Cropland	CO_2	125	181	0%	0%	0%	100%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	386	0%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
2G	Other industrial: CO_2	CO_2	304	339	0%	0%	0%	100%	0
5D2	Land converted to Wetlands	CO_2	38	72	0%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	394	0%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	449	0%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	1	20	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	269	0%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	106	0%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	175	0%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	171	0%	0%	0%	100%	0
4B	Emissions from manure management: other	CH_4	29	33	0%	0%	0%	100%	0
5F2	Land converted to Other Land	CO_2	17	21	0%	0%	0%	100%	0
2G	Other industrial: CH_4	CH_4	297	291	0%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	41	0%	0%	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	0%	100%	0
			222389	218756		42%			35

A1.4 Tier 2 key source assessment

Using the uncertainty estimate for each key source as a weighting factor (see Annex 7), the key source assessment was performed again. This is called the Tier 2 key source assessment. The results of this assessment are presented in Tables A1.5 and A1.6 for the contribution to the 2010 annual emissions total and to the trend respectively. Comparison with the Tier 1 assessment presented in Tables A1.3 and A1.4 show less level and trend key sources (28 and 24 respectively instead of 33 and 32). Inclusion of LULUCF sources in the analysis adds four additional Tier 2 level and trend key sources (see Table A1.2).

Table A1.5a Source ranking using IPCC Tier 2 level assessment 2010, excluding LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1491	1%	206%	1%	11%	11%	1
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	12932	6%	20%	1%	9%	20%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3286	2%	61%	1%	7%	27%	1
4B1	Emissions from manure management: cattle	CH_4	1715	1%	100%	1%	6%	33%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	4307	2%	34%	1%	5%	38%	1
4D2	Animal production on agricultural soils	N_2O	1307	1%	100%	1%	5%	42%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20001	10%	5%	1%	4%	46%	1
4B8	Emissions from manure management: swine	CH_4	1063	1%	100%	1%	4%	50%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	7532	4%	14%	1%	4%	54%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	20476	10%	5%	0%	4%	57%	1
4B	Emissions from manure management	N_2O	1004	0%	100%	0%	4%	61%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1802	1%	51%	0%	3%	64%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	8538	4%	10%	0%	3%	67%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1652	1%	50%	0%	3%	70%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	24098	11%	3%	0%	3%	72%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	2%	16%	0%	2%	75%	1
2B5	Other chemical product manufacture	CO_2	725	0%	71%	0%	2%	76%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2435	1%	21%	0%	2%	78%	1
1B1b	CO_2 from coke production	CO_2	972	0%	50%	0%	2%	80%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	9280	4%	5%	0%	2%	82%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	4140	2%	10%	0%	1%	83%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12819	6%	3%	0%	1%	84%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	1763	1%	20%	0%	1%	86%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1669	1%	21%	0%	1%	87%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	13821	7%	2%	0%	1%	88%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	2473	1%	11%	0%	1%	89%	1

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
6B	Emissions from wastewater handling	N_2O	449	0%	54%	0%	1%	90%	1
1A3	Mobile combustion: road vehicles	N_2O	435	0%	50%	0%	1%	90%	1
2B5	Caprolactam production	N_2O	681	0%	30%	0%	1%	91%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	386	0%	50%	0%	1%	92%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	343	0%	50%	0%	1%	92%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	27281	13%	1%	0%	1%	93%	0
2G	Other industrial: CH_4	CH_4	291	0%	51%	0%	1%	93%	0
2A3	Limestone and dolomite use	CO_2	574	0%	25%	0%	1%	94%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	394	0%	30%	0%	0%	94%	0
1A3	Mobile combustion: water-borne navigation	CO_2	595	0%	20%	0%	0%	95%	0
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	555	0%	20%	0%	0%	95%	0
1A3b	Mobile combustion: road vehicles: LPG	CO_2	911	0%	10%	0%	0%	95%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	171	0%	54%	0%	0%	96%	0
2A7	Other minerals	CO_2	331	0%	25%	0%	0%	96%	0
1B2	Fugitive emissions venting/flaring	CH_4	304	0%	25%	0%	0%	96%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	705	0%	10%	0%	0%	97%	0
2B1	Ammonia production	CO_2	3156	2%	2%	0%	0%	97%	0
2G	Other industrial: CO_2	CO2	339	0%	21%	0%	0%	97%	0
4B9	Emissions from manure management: poultry	CH_4	68	0%	100%	0%	0%	97%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	269	0%	25%	0%	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	327	0%	20%	0%	0%	98%	0
6B	Emissions from wastewater handling	CH_4	198	0%	32%	0%	0%	98%	0
2F	SF_6 emissions from SF_6 use	SF_6	184	0%	34%	0%	0%	98%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	391	0%	14%	0%	0%	98%	0
3, 6D	OTHER N_2O	N_2O	80	0%	54%	0%	0%	99%	0
2C1	Iron and steel production (carbon inputs)	CO_2	687	0%	6%	0%	0%	99%	0
2A1	Cement production	CO_2	348	0%	11%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	151	0%	25%	0%	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	175	0%	21%	0%	0%	99%	0
3	Indirect CO_2 from solvents/product use	CO_2	128	0%	27%	0%	0%	99%	0
4B	Emissions from manure management: other	CH_4	33	0%	100%	0%	0%	99%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	66	0%	50%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	50	0%	50%	0%	0%	99%	0
2B2	Nitric acid production	N_2O	301	0%	8%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	0%	50%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
2E	HFC by-product emissions from HFC manufacture	HFC	90	0%	22%	0%	0%	100%	0
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	3062	1%	1%	0%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	311	0%	5%	0%	0%	100%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	28	0%	50%	0%	0%	100%	0
2C3	PFC from aluminium production	PFC	58	0%	20%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	71%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	20	0%	32%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	106	0%	5%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	112%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	112%	0%	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0%	0%	100%	0
			210388			14%			28

Table A1.5b Source ranking using IPCC Tier 2 level assessment 2010, including LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1491	1%	206%	1%	11%	11%	1
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	12932	6%	20%	1%	9%	20%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3286	2%	61%	1%	7%	27%	1
4B1	Emissions from manure management: cattle	CH_4	1715	1%	100%	1%	6%	33%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	4307	2%	34%	1%	5%	38%	1
4D2	Animal production on agricultural soils	N_2O	1307	1%	100%	1%	5%	42%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20001	10%	5%	1%	4%	46%	1
4B8	Emissions from manure management: swine	CH_4	1063	1%	100%	1%	4%	50%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	7532	4%	14%	1%	4%	54%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	20476	10%	5%	0%	4%	57%	1
4B	Emissions from manure management	N_2O	1004	0%	100%	0%	4%	61%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1802	1%	51%	0%	3%	64%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	8538	4%	10%	0%	3%	67%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1652	1%	50%	0%	3%	70%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	24098	11%	3%	0%	3%	72%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	2%	16%	0%	2%	75%	1
2B5	Other chemical product manufacture	CO_2	725	0%	71%	0%	2%	76%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2435	1%	21%	0%	2%	78%	1
1B1b	CO_2 from coke production	CO_2	972	0%	50%	0%	2%	80%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	9280	4%	5%	0%	2%	82%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	4140	2%	10%	0%	1%	83%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12819	6%	3%	0%	1%	84%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	1763	1%	20%	0%	1%	86%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1669	1%	21%	0%	1%	87%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	13821	7%	2%	0%	1%	88%	1

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	2473	1%	11%	0%	1%	89%	1
6B	Emissions from wastewater handling	N_2O	449	0%	54%	0.11%	1%	90%	1
5C2	Land converted to Grassland	CO_2	259	0%	56%	0.10%	1%	91%	0
1A3	Mobile combustion: road vehicles	N_2O	435	0%	50%	0.10%	1%	91%	0
2B5	Caprolactam production	N_2O	681	0%	30%	0.09%	1%	92%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	386	0%	50%	0.09%	1%	92%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	343	0%	50%	0.08%	1%	93%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	27281	12%	1%	0.07%	0%	93%	0
2G	Other industrial: CH_4	CH_4	291	0%	51%	0.07%	0%	94%	0
2A3	Limestone and dolomite use	CO_2	574	0%	25%	0.07%	0%	94%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	394	0%	30%	0.05%	0%	95%	0
1A3	Mobile combustion: water-borne navigation	CO_2	595	0%	20%	0.05%	0%	95%	0
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	555	0%	20%	0.05%	0%	95%	0
5B2	Land converted to Cropland	CO_2	181	0%	56%	0.05%	0%	96%	0
1A3b	Mobile combustion: road vehicles: LPG	CO_2	911	0%	10%	0.04%	0%	96%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	171	0%	54%	0.04%	0%	96%	0
2A7	Other minerals	CO_2	331	0%	25%	0.04%	0%	96%	0
1B2	Fugitive emissions venting/flaring	CH_4	304	0%	25%	0.03%	0%	97%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	705	0%	10%	0.03%	0%	97%	0
2B1	Ammonia production	CO_2	3156	1%	2%	0.03%	0%	97%	0
2G	Other industrial: CO_2	CO_2	339	0%	21%	0.03%	0%	97%	0
4B9	Emissions from manure management: poultry	CH_4	68	0%	100%	0.03%	0%	97%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	269	0%	25%	0.03%	0%	98%	0
1A5	Military use of fuels (1A5 Other)	CO_2	327	0%	20%	0.03%	0%	98%	0
6B	Emissions from wastewater handling	CH_4	198	0%	32%	0.03%	0%	98%	0
2F	SF_6 emissions from SF_6 use	SF_6	184	0%	34%	0.03%	0%	98%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	391	0%	14%	0.03%	0%	98%	0
3, 6D	OTHER N_2O	N_2O	80	0%	54%	0.02%	0%	99%	0
5D2	Land converted to Wetlands	CO_2	72	0%	56%	0.02%	0%	99%	0
2C1	Iron and steel production (carbon inputs)	CO_2	687	0%	6%	0.02%	0%	99%	0
2A1	Cement production	CO_2	348	0%	11%	0.02%	0%	99%	0
2F	PFC emissions from PFC use	PFC	151	0%	25%	0.02%	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	175	0%	21%	0.02%	0%	99%	0
3	Indirect CO_2 from solvents/product use	CO_2	128	0%	27%	0.02%	0%	99%	0

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4B	Emissions from manure management: other	CH_4	33	0%	100%	0.02%	0%	99%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	66	0%	50%	0.02%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	50	0%	50%	0.01%	0%	99%	0
2B2	Nitric acid production	N_2O	301	0%	8%	0.01%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	0%	50%	0.01%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	90	0%	22%	0.01%	0%	100%	0
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	3062	1%	1%	0.01%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	311	0%	5%	0.01%	0%	100%	0
5G	Other (liming of soils)	CO_2	60	0%	25%	0.01%	0%	100%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	28	0%	50%	0.01%	0%	100%	0
2C3	PFC from aluminium production	PFC	58	0%	20%	0.01%	0%	100%	0
5F2	Land converted to Other Land	CO_2	21	0%	56%	0.01%	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	71%	0.00%	0%	100%	0
6D	OTHER CH_4	CH_4	20	0%	32%	0.00%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	106	0%	5%	0.00%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	112%	0.00%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	112%	0.00%	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0.00%	0%	100%	0
			218756			15.35%			32

With respect to Tier 2 level key sources, and perhaps surprisingly, the energy industries, with the highest share (30%) in the national total are not number one when uncertainty estimates are included. As Table A1.5 shows, two large but quite uncertain N_2O sources are now in the top five list of level key sources:

- indirect N_2O emissions from nitrogen used in agriculture;
- direct N_2O emissions from agricultural soils.

The uncertainty in these emissions is estimated at 50% to 200%, with indirect N_2O emissions having an uncertainty factor of two; one or two orders of magnitude higher than the 4% uncertainty estimated for CO_2 from the energy industries.

Table A1.6a Source ranking using IPCC Tier 2 trend assessment, excluding LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1491	1%	1%	206%	2%	20%	20%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	4307	2%	4%	34%	1%	14%	34%	1
4D2	Animal production on agricultural soils	N_2O	3150	1307	1%	1%	100%	1%	10%	43%	1
4B1	Emissions from manure management: cattle	CH_4	3034	1715	1%	1%	100%	1%	7%	50%	1
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	7632	12932	6%	3%	20%	1%	6%	56%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1802	1%	1%	51%	0%	4%	60%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	391	0%	3%	14%	0%	4%	65%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1652	1%	1%	50%	0%	3%	67%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3286	2%	0%	61%	0%	3%	70%	1
2B2	Nitric acid production	N_2O	6330	301	0%	3%	8%	0%	3%	73%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	20001	10%	4%	5%	0%	2%	75%	1
2C3	PFC from aluminium production	PFC	1901	58	0%	1%	20%	0%	2%	77%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	66	0%	0%	50%	0%	2%	79%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	9999	7532	4%	1%	14%	0%	2%	81%	1
1B1b	CO_2 from coke production	CO_2	403	972	0%	0%	50%	0%	2%	82%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	304	0%	0%	25%	0%	1%	83%	1
4B9	Emissions from manure management: poultry	CH_4	289	68	0%	0%	100%	0%	1%	85%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	601	2473	1%	1%	11%	0%	1%	86%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2435	1%	0%	21%	0%	1%	87%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	911	0%	1%	10%	0%	1%	88%	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	1356	555	0%	0%	20%	0%	1%	89%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2587	1763	1%	0%	20%	0%	1%	89%	1
4B	Emissions from manure management	N_2O	1173	1004	0%	0%	100%	0%	1%	90%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7330	8538	4%	1%	10%	0%	1%	91%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1669	1%	0%	21%	0%	1%	92%	0
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	18696	20476	10%	1%	5%	0%	1%	92%	0
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	19020	13821	7%	2%	2%	0%	1%	93%	0
2C1	Iron and steel production (carbon inputs)	CO_2	2267	687	0%	1%	6%	0%	0%	93%	0
3, 6D	OTHER N_2O	N_2O	250	80	0%	0%	54%	0%	0%	94%	0
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	5033	4140	2%	0%	10%	0%	0%	94%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	13348	27281	13%	7%	1%	0%	0%	94%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	189	28	0%	0%	50%	0%	0%	95%	0
1A3	Mobile combustion: road vehicles	N_2O	286	435	0%	0%	50%	0%	0%	95%	0
2B5	Other chemical product manufacture	CO_2	649	725	0%	0%	71%	0%	0%	96%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	343	0%	0%	50%	0%	0%	96%	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12819	6%	1%	3%	0%	0%	96%	0
4B8	Emissions from manure management: swine	CH_4	1140	1063	1%	0%	100%	0%	0%	97%	0
1A3	Mobile combustion: road vehicles	CH_4	158	50	0%	0%	50%	0%	0%	97%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	705	0%	0%	10%	0%	0%	97%	0
3	Indirect CO_2 from solvents/ product use	CO_2	316	128	0%	0%	27%	0%	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	566	327	0%	0%	20%	0%	0%	98%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4356	3996	2%	0%	16%	0%	0%	98%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A3	Mobile combustion: water-borne navigation	CO_2	405	595	0%	0%	20%	0%	0%	98%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	25776	24098	11%	1%	3%	0%	0%	98%	0
2F	SF_6 emissions from SF_6 use	SF_6	287	184	0%	0%	34%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	37	151	0%	0%	25%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	198	0%	0%	32%	0%	0%	99%	0
2A3	Limestone and dolomite use	CO_2	481	574	0%	0%	25%	0%	0%	99%	0
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	8956	9280	4%	0%	5%	0%	0%	99%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	386	0%	0%	50%	0%	0%	99%	0
2B5	Caprolactam production	N_2O	766	681	0%	0%	30%	0%	0%	99%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	90	0%	0%	22%	0%	0%	99%	0
2A7	Other minerals	CO_2	275	331	0%	0%	25%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	449	0%	0%	54%	0%	0%	100%	0
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	1042	3062	1%	1%	1%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	394	0%	0%	30%	0%	0%	100%	0
2G	Other industrial: CO_2	CO_2	304	339	0%	0%	21%	0%	0%	100%	0
2A1	Cement production	CO_2	416	348	0%	0%	11%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	1	20	0%	0%	32%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	71%	0%	0%	100%	0
4B	Emissions from manure management: other	CH_4	29	33	0%	0%	100%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	269	0%	0%	25%	0%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	395	311	0%	0%	5%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	175	0%	0%	21%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	171	0%	0%	54%	0%	0%	100%	0
2B1	Ammonia production	CO_2	3096	3156	2%	0%	2%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	106	0%	0%	5%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	112%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A3	Mobile combustion: aircraft	CO_2	41	41	0%	0%	50%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	112%	0%	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	20%	0%	0%	100%	0
2G	Other industrial: CH_4	CH_4	297	291	0%	0%	51%	0%	0%	100%	0
			214806	210388				9%			24

Table A1.6b Source ranking using IPCC Tier 2 trend assessment, including LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1491	1%	1%	206%	2%	19%	19%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	4307	2%	3%	34%	1%	13%	32%	1
4D2	Animal production on agricultural soils	N_2O	3150	1307	1%	1%	100%	1%	9%	42%	1
4B1	Emissions from manure management: cattle	CH_4	3034	1715	1%	1%	100%	1%	7%	48%	1
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	7632	12932	6%	3%	20%	1%	6%	54%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1802	1%	1%	51%	0%	4%	58%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	391	0%	2%	14%	0%	4%	62%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1652	1%	1%	50%	0%	3%	65%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3286	2%	0%	61%	0%	2%	67%	1
2B2	Nitric acid production	N_2O	6330	301	0%	3%	8%	0%	2%	70%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	20001	9%	4%	5%	0%	2%	72%	1
2C3	PFC from aluminium production	PFC	1901	58	0%	1%	20%	0%	2%	74%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	66	0%	0%	50%	0%	2%	76%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	9999	7532	3%	1%	14%	0%	2%	77%	1
5A2	Land converted to Forest Land	CO_2	56	547	0%	0%	63%	0%	2%	79%	1
1B1b	CO_2 from coke production	CO_2	403	972	0%	0%	50%	0%	1%	80%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	304	0%	0%	25%	0%	1%	82%	1
4B9	Emissions from manure management: poultry	CH_4	289	68	0%	0%	100%	0%	1%	83%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	601	2473	1%	1%	11%	0%	1%	84%	1
5E2	Land converted to Settlements	CO_2	203	553	0%	0%	56%	0%	1%	85%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2435	1%	0%	21%	0%	1%	86%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	911	0%	1%	10%	0%	1%	87%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2587	1763	1%	0%	20%	0%	1%	88%	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	1356	555	0%	0%	20%	0%	1%	88%	1
4B	Emissions from manure management	N_2O	1173	1004	0%	0%	100%	0%	1%	89%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7330	8538	4%	1%	10%	0%	1%	90%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1669	1%	0%	21%	0%	1%	91%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	18696	20476	9%	1%	5%	0%	1%	91%	0
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	19020	13821	6%	2%	2%	0%	1%	92%	0
2C1	Iron and steel production (carbon inputs)	CO_2	2267	687	0%	1%	6%	0%	0%	92%	0
3, 6D	OTHER N_2O	N_2O	250	80	0%	0%	54%	0%	0%	93%	0
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	5033	4140	2%	0%	10%	0%	0%	93%	0
1A4	Stationary combustion: Other Sectors, solids	CO_2	189	28	0%	0%	50%	0%	0%	93%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	13348	27281	12%	7%	1%	0%	0%	94%	0
1A3	Mobile combustion: road vehicles	N_2O	286	435	0%	0%	50%	0%	0%	94%	0
5C2	Land converted to Grassland	CO_2	245	259	0%	0%	56%	0%	0%	95%	0
5A1	Forest Land remaining Forest Land	CO_2	2434	2296	1%	0%	67%	0%	0%	95%	0
2B5	Other chemical product manufacture	CO_2	649	725	0%	0%	71%	0%	0%	95%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	343	0%	0%	50%	0%	0%	96%	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12819	6%	1%	3%	0%	0%	96%	0
4B8	Emissions from manure management: swine	CH_4	1140	1063	0%	0%	100%	0%	0%	96%	0
1A3	Mobile combustion: road vehicles	CH_4	158	50	0%	0%	50%	0%	0%	96%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	705	0%	0%	10%	0%	0%	97%	0
3	Indirect CO_2 from solvents/ product use	CO_2	316	128	0%	0%	27%	0%	0%	97%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A5	Military use of fuels (1A5 Other)	CO_2	566	327	0%	0%	20%	0%	0%	97%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4356	3996	2%	0%	16%	0%	0%	97%	0
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	25776	24098	11%	1%	3%	0%	0%	98%	0
1A3	Mobile combustion: water-borne navigation	CO_2	405	595	0%	0%	20%	0%	0%	98%	0
5C1	Grassland remaining Grassland	CO_2	4246	4246	2%	0%	56%	0%	0%	98%	0
2F	SF_6 emissions from SF_6 use	SF_6	287	184	0%	0%	34%	0%	0%	98%	0
5B2	Land converted to Cropland	CO_2	125	181	0%	0%	56%	0%	0%	98%	0
5G	Other (liming of soils)	CO_2	183	60	0%	0%	25%	0%	0%	98%	0
2F	PFC emissions from PFC use	PFC	37	151	0%	0%	25%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	198	0%	0%	32%	0%	0%	99%	0
2A3	Limestone and dolomite use	CO_2	481	574	0%	0%	25%	0%	0%	99%	0
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	8956	9280	4%	0%	5%	0%	0%	99%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	386	0%	0%	50%	0%	0%	99%	0
2B5	Caprolactam production	N_2O	766	681	0%	0%	30%	0%	0%	99%	0
5D2	Land converted to Wetlands	CO_2	38	72	0%	0%	56%	0%	0%	99%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	90	0%	0%	22%	0%	0%	99%	0
2A7	Other minerals	CO_2	275	331	0%	0%	25%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	449	0%	0%	54%	0%	0%	100%	0
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	1042	3062	1%	1%	1%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	394	0%	0%	30%	0%	0%	100%	0
2G	Other industrial: CO_2	CO_2	304	339	0%	0%	21%	0%	0%	100%	0
2A1	Cement production	CO_2	416	348	0%	0%	11%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	1	20	0%	0%	32%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	71%	0%	0%	100%	0
4B	Emissions from manure management: other	CH_4	29	33	0%	0%	100%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	269	0%	0%	25%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
2C3	CO_2 from aluminium production	CO_2	395	311	0%	0%	5%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	175	0%	0%	21%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	171	0%	0%	54%	0%	0%	100%	0
2B1	Ammonia production	CO_2	3096	3156	1%	0%	2%	0%	0%	100%	0
5F2	Land converted to Other Land	CO_2	17	21	0%	0%	56%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	106	0%	0%	5%	0%	0%	100%	0
2G	Other industrial: CH_4	CH_4	297	291	0%	0%	51%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	112%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	112%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	41	41	0%	0%	50%	0%	0%	100%	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	20%	0%	0%	100%	0
			222389	218756		42%		9%			27

Annex 2
Detailed discussions of methodology and data for estimating CO_2 emissions from fossil fuel combustion

The Netherlands list of fuels and standard CO_2 emission factors was originally approved in 2004 by the Steering Committee Emission Registration, and is revised following decisions on the CO_2 emission factor for natural gas by this Steering Group in its meetings of 25 April 2006 and 21 April 2009.
On 21 April 2009, Steering Committee Emission Registration delegated the authority to decide on revisions of the list to the Working Group Emission Monitoring (WEM). On 19 January 2012 the present document (version January 2012; Vreuls and Zijlema, 2012) was approved by the WEM.
For a description of the methodology and activity data used for the calculation of CO_2 emissions from fossil fuel combustion we refer to the monitoring protocols (see Annex 6, protocol 12-002 for stationary sources and protocols 12-004 to 12-011 for mobile sources).

A2.1 Introduction

For national monitoring of greenhouse gas emissions under the framework of the UN Climate Change Convention (UNFCCC) and monitoring at corporate level for the European CO_2 emissions trade, international agreements state that each country must draw up a national list of defined fuels and standard CO_2 emission factors. This is based on the IPCC list (with default CO_2 emission factors), but should include national values that reflect the specific national situation. This list will also be used by the Netherlands in the e-MJV (electronic annual environmental report), because these are used for the national monitoring.
The Netherlands list of energy carriers and standard CO_2 emission factors (further referred to as 'the Netherlands list') is now available in the form of:

- a table containing the names (in Dutch and English) of the energy carrier and the accompanying standard energy content and CO_2 emissions factor;
- a fact sheet per energy carrier, substantiating the values given, presenting similar names and possible specifications and providing an overview of the codes that organisations use for the individual energy carriers.

This Annex is for people using the Netherlands list. It contains the starting points for this list and indicates how it should be used for various objectives, for example, national monitoring of greenhouse gas emissions, the European CO_2 emissions trade and the e-MJV. It also includes background information. The list, plus this document and the background documents for substantiating the specific Netherlands values can be found on the website: www.nlagency.nl/nie/.
Based on new scientific knowledge in 2006 the CO_2 emission factor for natural gas has been changed for the period 1990-2006. From 2007 onwards, the CO_2 emission factor for natural gas has been assessed annually. In this document, the CO_2 emission factor for natural gas for 2010 has been determined.

A2.2 Starting points for the Netherlands list

The following starting points were used to draw up the Netherlands list:

1. The list contains all the fuels, as included in the IPCC guidelines (Revised 1996 Intergovernmental Panel on Climate Change (IPCC) for national greenhouse gas inventories, further known as the '1996 IPCC guidelines'), Table 1-1 (in chapter 1 of the Reference Manual, Volume 3 of the 1996 IPCC guidelines) and the differentiation thereof in the Workbook Table 1.2 (Module 1 of the Workbook, Volume 2 of the 1996 IPCC guidelines). The 1996 IPCC Guidelines are applicable to the national monitoring of greenhouse gas emissions under the UNFCCC framework.
2. The list contains all fuels, as included in European Commission (EC) Directive 2004/156/EG on reporting CO_2 emissions trading ('... defining guidelines for monitoring and reporting greenhouse gas emissions...'), Appendix 1, chapter 8.
3. The definition of fuels is based on the definition used by the CBS (Statistics Netherlands) when collating energy statistics. As a result of the 1996 IPCC guidelines and the EC Directive 2004/156/EG mentioned in 1 and 2 above, the CO_2 emission factors are accurate to one digit after the decimal point.
4. The list assumes the standard CO_2 emission factors as used in the 1996 IPCC guidelines and the EC Directive 2004/156/EG but, where the Netherlands' situation deviates from this norm, specific standard values for the Netherlands are used, which are documented and substantiated.

A2.3 The Netherlands list

A study was carried out in 2002 with respect to specific Netherlands CO_2 emission factors (TNO, 2002). This study showed that, for a limited number of Dutch fuels, their situations deviated such that national values needed to be determined. For a number of fuels, the previously defined national values (Emission Registration, 2002) could be updated but for others new values were required.
A specific Netherlands standard CO_2 emissions factor has been determined for the following fuels, which does not

appear in the 1996 IPCC Guidelines or in the EC Directive 2007/589/EG, but has been added as specification for one of the following fuels in:

1. petrol/gasoline
2. gas and diesel oil
3. LPG
4. coke coals (coke ovens and blast furnaces)
5. other bituminous coal
6. coke ovens/gas cokes
7. coke oven gas
8. blast furnace gas
9. oxygen furnace gas
10. phosphorus furnace gas
11. natural gas.

For industrial gases, chemical waste gas is also differentiated from refinery gas. For the IPCC main group 'other fuels', only non-biogenic waste is differentiated.

Coking Coal

For coking coal the standard CO_2 emissions factor is also a weighted average, for example of coke coals used in coke ovens and in blast furnaces.

Natural gas

In 2006, a study was commissioned to research methods to determine the CO_2 emission factor for natural gas (TNO, 2006). This resulted in an advice to use a a country specific factor for natural gas from the year 1990 onwards (SenterNovem, 2006). In its meeting of 25 April 2006, the Steering Committee Emission Registration agreed with this advice and approved an update of the National list for the period 1990-2006.

From 2007 onwards, the CO_2 emission factor for natural gas has been assessed annually. In the meeting of the Steering Committee Emission Registration of 21 April 2009, the procedure was approved for the annual update of the emission factor of natural gas. In this document (version January 2012) the emission factor of natural gas for 2011 was determined according to this procedure.

Waste

From 2009 onwards, on the Netherlands list the fuel Waste (non-biogenic) is replaced by the fuel Waste. This fuel concerns all waste that is incinerated in the Netherlands, both residential waste and other waste. In addition, from 2009 onwards the heating value and the emission factor will be determined annually on the Netherlands list. These values are not used as input for the calculation of greenhouse gas emissions under the framework of the UN Climate Change Convention (UNFCCC), but are the result of these calculations (see Renewable Energy Monitoring Protocol, NL Agency, 2010). In the e-MJV these values can be used by companies that incinerate waste.
In this document (version January 2012) the heating value and the emission factor of Waste are determined for 2010. The incinerated waste is a mixture of biogenic and non-biogenic waste. Therefore, the percentage of biogenic is given for both the heating value and the emission factor.

Biomass

The list also includes biomass as a fuel, with accompanying specific Netherlands CO_2 emission factors. Biomass emissions are reported separately in the national monitoring of greenhouse gas emissions under the UNFCCC framework (as a memo element) and are not included in the national emissions figures. For the European CO_2 emissions trading, the emissions are not included because an emissions factor of zero is used for biomass.
The CO_2 emissions factor for wood is used for solid biomass and that of palm oil is used for liquid biomass[1].
A weighted average of three specified biogases is used as the standard factor for gaseous biomass:

1. sewage treatment facility (WWTP) biogas
2. landfill gas
3. industrial organic waste gas.

Heating values

The heating values are the same as those used by the CBS for observed fuels in its surveys for collating energy statistics.

A2.4 Fact sheets

A fact sheet (consisting of at least two sections) has been drawn up for each fuel:

1) General information
   a. Name of the fuel, in Dutch and English
   b. Other names used (Dutch and English)
   c. Description
   d. Codes (in Dutch) used to specify the fuel
   e. Unit
2) Specific values and substantiation
   a. Heating value
   b. Carbon content
   c. CO_2 emissions factor
   d. Density (if relevant), converting from weight to volume or converting from gases to m3 standard natural gas equivalents
   e. Substantiating the choices, plus accurate referral to references and/or specific text sections within the reference
   f. Year and/or period for which the specific values apply.

[1] The heating value and the emission factor of liquid biomass are not used in the calculations of the national transport emissions for biofuels. For an explanation, see Klein, 2011 (Table 1.31)

If a standard Dutch value for a fuel exists, this has been added to the fact sheet (as a third section containing the same information as that described under 1) and 2) above).

A2.5 Using the Netherlands list in national monitoring, European CO_2 emissions trade and in the e-MJV National monitoring

National monitoring

The 1996 IPCC Guidelines are among those valid for national monitoring under the UNFCCC framework, which is reported annually in the NIR (National Inventory Report). This includes the default CO_2 emission factors shown in Table 1-1 (chapter 1 of the Reference Manual, volume 3 of the 1996 IPCC Guidelines) and Table 1-2 (Module 1 of the Workbook, volume 2 of the 1996 IPCC Guidelines). With respect to the specification at national level: '…default assumptions and data should be used only when national assumptions and data are not available.' (Overview of the Reporting Instructions, volume 1 of the 1996 IPCC Guidelines) and '…because fuel qualities and emission factors may differ markedly between countries, sometimes by as much as 10% for nominally similar fuels, national inventories should be prepared using local emission factors and energy data where possible.' (Chapter 1, section 1.1 of the Reference Manual, volume 3 of the 1996 IPCC Guidelines).

With respect to documentation: 'When countries use local values for the carbon emission factors they should note the differences from the default values and provide documentation supporting the values used in the national inventory calculations' (chapter 1, section 1.4.1.1 of the Reference Manual, volume 3 of the 1996 IPCC Guidelines). Exactly when and how the Netherlands list should be used in the national monitoring process is further described in the 1996 IPCC Guidelines. The Netherlands list is included in the country's national report to the UNFCCC on greenhouse gas emissions.

Monitoring European CO_2 emissions trade

The EC Directive 2007/589/EG covers monitoring under the framework of the European CO_2 emissions trade. This Directive serves as a starting point for the Netherlands monitoring system for trading in emission allowances. With respect to the CO_2 emission factors and the calculations of CO_2 emissions at level 2a, the Directive states: 'The operator should use the relevant fuel caloric values that apply in that Member State, for example, as indicated in the relevant Member State's latest national inventory, which has been submitted to the secretariat of the UNFCCC (EC Directive 2007/589/EC, Appendix II, section 2.1.1.1).

With respect to the reports, this states that: 'Fuels and the resulting emissions must be reported in accordance with the IPCC format for fuels (…) this is based on the definitions set out by the IEA (International Energy Agency). If the Member State (relevant to the operator) has already published a list of fuel categories, including definitions and emission factors, which is consistent with the latest national inventory such as submitted to the UNFCCC secretariat, these categories and the accompanying emission factors should be used, if these have been approved within the framework of the relevant monitoring methodology.' (EC Directive 2007/589/EG, Appendix I, section 5). When and how the Netherlands list should be used in the monitoring process under the framework of the EU CO_2 emissions trading is further explained in EC Directive 2007/589/EG and the Netherlands system for monitoring the trade in emission allowances.

e-MJV

Within the UNFCCC framework, the national monitoring of greenhouse gases is partly based on the information provided in the MJVs (annual environmental reports). Information on CO_2 emissions trading is (also) reported in the MJV, which is why the Netherlands list is also used in the e-MJV. Since the monitoring of the energy covenant known as MJA (long-term energy agreement) can be carried out via the e-MJV, the Netherlands list is also used to compile these reports. Exactly how the Netherlands list should be used in the e-MJV is further described in the e-MJV itself.

Use of the Netherlands list by other stakeholders in the Netherlands

The Netherlands list can also be used for other purposes (e.g., monitoring energy covenants, predicting future CO_2 emissions). Selections can be taken from the list, depending on the application. This usage is not defined in the legislation but offers the advantage of harmonising national monitoring under the UNFCCC framework. Whenever CO_2 emissions are defined for the Government, the Netherlands list will be used wherever possible.

A2.6 Defining and maintaining the Netherlands list

The Ministry of Infrastructure and the Environment initiated the compilation of the Netherlands list, as it is responsible for the national monitoring of greenhouse gas emissions under the UNFCCC framework. This list has been prepared in consultation with those national institutes involved in national monitoring activities, such as PBL, CBS and NL Agency and other relevant organisations, such as the e-MJV, CO_2 emissions trade and ECN. The Steering Committee Emission Registration (the collaborative agencies implementing the national monitoring) compiled the list during its meeting in October 2004.

The list will be maintained within the National System, the

Table A2.1 Netherlands fuels and standard CO_2 emission factors, version January 2012.

Main group (Dutch language)	Main group (English) IPCC (supplemented)	Unit	Heating value (MJ/unit)	CO_2 EF (kg/GJ)
	A. Liquid Fossil, Primary Fuels			
Ruwe aardolie	Crude oil	kg	42.7	73.3
Orimulsion	Orimulsion	kg	27.5	80.7
Aardgascondensaat	Natural Gas Liquids	kg	44.0	63.1
	Liquid Fossil, Secondary Fuels/Products			
Motorbenzine	Petrol/gasoline	kg	44.0	72.0
Kerosine luchtvaart	Jet Kerosene	kg	43.5	71.5
Petroleum	Other Kerosene	kg	43.1	71.9
Leisteenolie	Shale oil	kg	36.0	73.3
Gas-/dieselolie	Gas/Diesel oil	kg	42.7	74.3
Zware stookolie	Residual Fuel oil	kg	41.0	77.4
LPG	LPG	kg	45.2	66.7
Ethaan	Ethane	kg	45.2	61.6
Nafta's	Naphtha	kg	44.0	73.3
Bitumen	Bitumen	kg	41.9	80.7
Smeeroliën	Lubricants	kg	41.4	73.3
Petroleumcokes	Petroleum Coke	kg	35.2	100.8
Raffinaderij grondstoffen	Refinery Feedstocks	kg	44.8	73.3
Raffinaderijgas	Refinery Gas	kg	45.2	66.7
Chemisch restgas	Chemical Waste Gas	kg	45.2	66.7
Overige oliën	Other Oil	kg	40.2	73.3
	B. Solid Fossil, Primary Fuels			
Antraciet	Anthracite	kg	26.6	98.3
Cokeskolen	Coking Coal	kg	28.7	94.0
Cokeskolen (cokeovens)	Coking Coal (used in coke oven)	kg	28.7	95.4
Cokeskolen (basismetaal)	Coking Coal (used in blast furnaces)	kg	28.7	89.8
Overige bitumineuze steenkool	Other Bituminous Coal	kg	24.5	94.7
Sub-bitumineuze kool	Sub-bituminous Coal	kg	20.7	96.1
Bruinkool	Lignite	kg	20.0	101.2
Bitumineuze Leisteen	Oil Shale	kg	9.4	106.7
Turf	Peat	kg	10.8	106.0
	Solid Fossil, Secondary Fuels			
Steenkool- en bruinkoolbriketten	BKB & Patent Fuel	kg	23.5	94.6
Cokesoven/gascokes	Coke Oven/Gas Coke	kg	28.5	111.9
Cokesovengas	Coke Oven gas	MJ	1.0	41.2
Hoogovengas	Blast Furnace Gas	MJ	1.0	247.4
Oxystaalovengas	Oxy Gas	MJ	1.0	191.9
Fosforovengas	Phosphor Gas	Nm^3	11.6	149.5
	C. Gaseous Fossil Fuels			
Aardgas	Natural Gas (dry)	Nm^3	31.65	56.5 [1)]
Koolmonoxide	Carbon Monoxide	Nm^3	12.6	155.2
Methaan	Methane	Nm^3	35.9	54.9
Waterstof	Hydrogen	Nm^3	10.8	0.0
	Biomass [2)]			
Biomassa vast	Solid Biomass	kg	15.1	109.6
Biomassa vloeibaar	Liquid Biomass	kg	39.4	71.2
Biomassa gasvormig	Gas Biomass	Nm^3	21.8	90.8
RWZI biogas	Wastewater biogas	Nm^3	23.3	84.2
Stortgas	Landfill gas	Nm^3	19.5	100.7
Industrieel fermentatiegas	Industrial organic waste gas	Nm^3	23.3	84.2
	D. Other fuels			
Afval [3)]	Waste	kg	9.9	106.1

[1)] The emission factor for natural gas in this table (56.5 kg CO_2/GJ) is applicable for the calculation of the emissions in the emission year 2011 (Zijlema, 2011).
The emission factor for natural gas was 56.6 kg CO_2/GJ in the emission years 2009 (Zijlema, 2010a) and 2010 (Zijlema, 2010b).
The emission factor for natural gas was 56.7 kg CO_2/GJ in the emission years 2007 (Zijlema, 2008) and 2008 (Zijlema, 2009).
For the period 1990–2006 the emission factor for natural gas was 56.8 kg CO_2/GJ (TNO, 2006).
[2)] Biomass: the value of the CO_2 emission factor is shown as a memo item in reports for the climate change convention; the value is zero for emissions trading and for the Kyoto Protocol.
[3)] The values are applicable for the emission year 2010. The percentage of biogenic in the heating value is 53%. The percentage of biogenic in the emission factor is 63%. In the emission year 2009 the heating value was 10.0 MJ/kg (51% biogenic) and the emission factor was 105.7 kg/GJ (62% biogenic). In the emission year 2008 the heating value was 10.3 MJ/kg (49% biogenic) and the emission factor was 97.5 kg/GJ (63% biogenic).

organisational structure that co-ordinates national greenhouse gas monitoring under the UNFCCC framework. The Netherlands list, this document and the background documents are all publicly accessible from the Dutch website (www.agentschapnl.nl/nie or the English version, www.nlagency.nl/nie). As part of the quality monitoring system for national monitoring of greenhouse gases, this list will be evaluated every three years.
This document was updated in November 2005 with some editorial changes. This document and the Netherlands list were updated in 2006 based on research for methods to determine the CO_2 emission factor for natural gas in the Netherlands for the period 1990-2006.
From 2007 onwards, the CO_2 emission factor for natural gas has been assessed annually, based on measurement by Gasunie and Zebragas. On 21 April 2009, this procedure was approved by the Steering Committee Emission Registration.
On 21 April 2009, Steering Committee Emission Registration delegated the authority to decide on revisions of the list to the Working Group Emission Monitoring (WEM). On 19 January 2012 the present document (version January 2012) was approved by the WEM. In this document, the CO_2 emission factor for natural gas for the emission year 2011 has been determined. Besides, for the fuel Waste the heating value and emission factor for the emission year 2010 were determined, including the percentage of biogenic in both parameters.

A2.7 Application of the Netherlands standard and source-specific CO_2 emission factors in the national emission inventory

For the most common fuels (natural gas, coal, coal products, diesel and petrol), country-specific standard CO_2 emission factors are used; otherwise default IPCC emission factors are used (see Table A2.1). However, for some of the derived fuels the chemical composition and thus the CO_2 emission factor is highly variable between source categories and over time.
Thus, for blast furnace gas and oxygen furnace gas, refinery gas, chemical waste gas (liquids and solids treated separately) and solid waste (the biogenic and fossil carbon part treated separately), mostly source-specific (or plant-specific) emission factors have been used, that may also change over time. In addition, for raw natural gas combustion by the oil and gas production industry, a source-specific (or company-specific) CO_2 emission factor is used. This refers to the 'own use' of unprocessed natural gas used by the gas and oil production industry, of which the composition may differ significantly from that of treated standard natural gas supplied to end-users. These emission factors are based on data submitted by industries in their Annual Environmental Reports (MJVs). These fuels are used in the subcategories 'Public electricity and heat production' (1A1a), 'Refineries' (1A1b) and 'Other energy industries' included in 1A1c.
Fossil-based CO_2 emissions from waste incineration are calculated from the total amount of waste that is incinerated, split into six waste types per waste stream, each with a specific carbon content and fraction of fossil carbon in total carbon (see section 8.4.2 for more details).
More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see Annex 6).

Annex 3
Other detailed methodological descriptions for individual source or sink categories

A detailed description of methodologies per source/sink category can be found in protocols on the website www.nlagency.nl/nie, including country-specific emission factors. Annex 6 provides an overview of the available monitoring protocols at this site.

Annex 4
CO_2 Reference Approach and comparison with Sectoral Approach

A4.1 Comparison of CO_2 emissions

The IPCC Reference Approach (RA) for CO_2 from energy use uses apparent consumption data per fuel type to estimate CO_2 emissions from fossil fuel use. This has been used as a means of verifying the sectoral total CO_2 emissions from fuel combustion (IPCC, 2001). For the Reference Approach, energy statistics (production, imports, export, stock changes) were provided by Statistics Netherlands (CBS); national default, partly country-specific, CO_2 emission factors (see Annex 2.1, Table A2.1) and constant carbon storage fractions based on the average of annual carbon storage fractions calculated per fossil fuel type for 1995-2002 from reported CO_2 emissions in the sectoral approach. Also, bunker fuels were corrected for the modification made to include fisheries, internal navigation, military aviation and shipping in domestic consumption instead of included in the bunker total in the original national energy statistics .

Table A4.1 presents the results of the Reference Approach calculation for 1990-2010 compared with the official national total emissions reported as fuel combustion (source category 1A). The annual difference calculated from the direct comparison varies between 2 to 4%.

The Reference Approach (RA) and National Approach (NA) data show an 11% RA vs. 8% NA increase in emissions from liquid fuels (1990-2010) and a 27% RA vs. 29% NA increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period by 12% in the RA vs. a decrease of 9% in the NA. The emissions from others (fossil carbon in waste) from 0.6 Tg in 1990 to 2.5 Tg CO_2 in 2010. However, these numbers cannot be compared well since the RA includes sources not included in the NA and *vice versa*.

A4.2 Causes of differences between the two approaches

There are three main reasons for differences in the two approaches (see Table A4.2):

1. The fossil-fuel related emissions reported as process emissions (sector 2) and fugitive emissions (Sector 1B), which are not included in the Sectoral Approach total of Sector 1A. The most significant are gas used as feedstock in ammonia production (2B1) and losses from coke/coal inputs in blast furnaces (2C1).
2. In addition, the country-specific carbon storage factors used in the Reference Approach are multi-annual averages, so the RA calculation for a specific year will deviate somewhat from the factors that could be calculated from the specific mix of feedstock/non-energy uses of different fuels.
3. The use of plant-specific emission factors in the NA vs. national defaults in the RA.

Correction of inherent differences
The correction terms for the RA/NA total are for the Netherlands selected CRF Sector 2 components listed in Table A4.2 and selected fugitive CO_2 emissions included in CRF Sector 1B.

If the NA is corrected by including selected Sector 1B and Sector 2 emissions that should be added to the 1A total before the comparison is made (see Table A4.2), then a much smaller difference remains between the approaches. The remaining differences are generally below ±2%. Remaining differences must be due to the use of one multi-annual average carbon storage factor per fuel type for all years (see section A4.3) and plant-specific emission factors in some cases, as discussed in section A4.4 (for more details, see Annex 2).

A4.3 Other country-specific data used in the Reference Approach

Apart from different storage fractions of non-energy use of fuels as presented in Table A4.5, other country-specific information used in the RA is found in:

Carbon contents (CO_2 emission factors) used
For the fuels used in the Reference Approach, the factors used are listed in Table A.2.1. These are the national defaults. For 'other bituminous coal' and 'BKB & Patent fuel' the values are used of bituminous coal and coal bitumen respectively;.

Fuel consumption in international marine and aviation bunkers
Some changes are made annually in the national energy statistics of total apparent consumption, mainly for diesel, jet kerosene and residual fuel oil, due to the reallocation for the emissions inventory of part of the bunker fuels to domestic consumption (e.g., fisheries and inland navigation). This explains the difference between the original bunker statistics in the national energy statistics (and as reported to international agencies such as the IEA) and the bunker fuel data used in the Reference Approach calculation.

A4.4 Feedstock component in the CO_2 Reference Approach

Feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for CO_2 from fossil fuel use. The fraction of carbon not oxidised during the use of these fuels during product manufacture or other uses is subtracted from total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidised have been calculated as three average values, one for gas, liquid and solid fossil fuels:

- 77.7±2% for liquid fuels
- 55.5±13% for solid fuels
- 38.8±4% for natural gas.

These were calculated from all processes for which emissions are calculated in the NA, either by assuming a fraction oxidised, for example ammonia, or by accounting for by-product gases (excluding emissions from blast furnaces and coke ovens). (In Table A.4.4 of the NIR 2005, the calculation of annual oxidation fractions for 1995-2002 are presented and the average values derived from them.) It shows indeed that the factors show significant interannual variation, in particular for solid fuels.

The use of one average oxidation factor per fuel type for all years, whereas in the derivation of the annual oxidation figures differences up to a few per cent can be observed, are one reason for differences between the RA and the corrected NA.

In the Netherlands, about 10 to 25% of all carbon in the apparent consumption of fossil fuels is stored in manufactured products.

Table A4.1 Comparison of CO_2 emissions: Reference Approach (RA)1) versus National Approach (NA) (in Tg).

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Reference Approach									
Liquid fuels	49.7	51.4	53.8	55.2	54.6	58.2	55.9	53.1	54.9
Solid fuels	34.0	34.7	30.5	32.2	30.2	33.2	31.4	29.4	29.9
Gaseous fuels	71.9	79.9	81.0	81.8	79.6	77.1	80.6	81.3	91.1
Others[1)]	0.6	0.8	1.6	2.1	2.1	2.2	2.2	2.5	2.5
Total RA	**156.2**	**166.9**	**166.9**	**171.3**	**166.6**	**170.7**	**170.2**	**166.3**	**178.3**
National Approach									
Liquid fuels	49.7	52.4	54.6	56.3	56.0	56.1	56.1	53.0	53.7
Solid fuels	31.0	32.4	28.8	30.2	28.7	30.7	30.1	27.6	28.3
Gaseous fuels	68.6	76.0	76.7	78.5	77.0	74.5	78.4	78.9	88.6
Others [1)]	0.6	0.8	1.6	2.1	2.1	2.2	2.2	2.5	2.5
Total NA	**149.9**	**161.6**	**161.7**	**167.1**	**163.8**	**163.6**	**166.9**	**162.0**	**173.0**
Difference (%)									
Liquid fuels	0.0%	-1.9%	-1.5%	-2.0%	-2.5%	3.6%	-0.3%	0.2%	2.3%
Solid fuels	9.8%	7.2%	6.1%	6.6%	5.3%	8.2%	4.2%	6.6%	5.6%
Gaseous fuels	4.8%	5.2%	5.5%	4.2%	3.4%	3.4%	2.8%	3.0%	2.8%
Others	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	**4.2%**	**3.2%**	**3.2%**	**2.5%**	**1.7%**	**4.3%**	**2.0%**	**2.7%**	**3.1%**

1) The CO_2 from incineration of waste that contains fossil carbon (reported under 1A1a) is now included in the Reference Approach.

Table A4.2 Corrections of Reference Approach and National Approach for a proper comparison (in Tg).

RA, NA, correction term	1990	1995	2000	2005	2008	2009	2010
Difference RA-NA	6.4	5.2	5.2	4.2	3.3	4.3	5.3
National Approach:	149.9	161.6	161.7	167.1	166.9	162.0	173.0
CO_2 fossil in Sector 1B:							
1B1b Solid Fuel Transf.	0.4	0.5	0.4	0.6	0.7	0.5	1.0
1B2c Flaring	0.4	0.3	0.2	0.1	0.0	0.0	0.1
1B2a iv. Oil refining	0.0	0.0	0.0	0.9	0.8	1.0	1.0
CO_2 fossil in Sector 2:	6.0	5.8	5.1	4.7	4.2	4.2	4.4
A Mineral Products							
Soda Ash Production	0.1	0.3	0.1	0.1	0.1	0.0	0.0
B Chemical industry							
1 Ammonia production	3.1	3.6	3.6	3.1	2.9	2.9	3.2
5 Other, excl. act. carbon	0.4	0.2	0.2	0.4	0.4	0.3	0.4
C Metal industry							
1 Inputs in blast furnace	2.2	1.5	1.0	0.9	0.7	0.8	0.7
D Other Production							
2 Food and Drink	0.1	0.0	0.0	0.0	0.0	0.0	0.0
G Other (please specify)							
Other economic sectors *	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Not in NA-1A:	6.9	6.6	5.7	5.4	5.0	4.8	5.5
NA+1B+Ind. Proc.	156.7	168.2	167.4	172.5	171.8	166.8	178.5
New difference (abs)	0.5	1.4	0.5	1.2	1.7	0.5	0.1
New difference (%)	0.3%	0.8%	0.3%	0.7%	1.0%	0.3%	0.1%

* Comprises lubricants and waxes.

Annex 5
Assessment of completeness and (potential) sources and sinks

The Netherlands emissions inventory focuses on completeness and improving accuracy in the most relevant sources. This means that for all 'NE' sources, it is investigated what information is available and whether it could be assumed that a source is really (very) small/ negligible. For those sources that were not small, during the improvement programme, methods for estimating the emissions were developed. As a result of this process, it was decided to keep only very few sources as 'NE', since data for estimating emissions are not available and the source is very small. Of course, on a regular basis it is being checked/re-assessed whether there are developments in NE sources that indicate any (major) increase in emissions or new data sources for estimating emissions.

Following the 2011 review, one NE source has been reviewed for the potential magnitude and then an estimate was made and included in the inventory. As a result, Charcoal production (1B2) and Charcoal use (1A4) are no longer included in this Annex. The Netherlands greenhouse gas emission inventory includes all sources identified by the Revised IPCC Guidelines (IPCC, 1996) – with the exception of the following (very) minor sources:

- CO_2 from asphalt roofing (2A5) and CO_2 from road paving (2A6), both due to missing activity data; information on the use of bitumen is only available for two groups: the chemical industry and all others. There is no information on the amount of asphalt roofing production and also no information on road paving with asphalt. The statistical information on sales (value) of asphalt roofing and asphalt for road paving was finalised by 2002.
  Based on this information it was assumed that emissions related to these two categories are very low/ undetectable and that the effort in generating activity data would, therefore, not be cost effective. So not only the missing activity data but also the very limited amount of emissions was the rationale of the decision to not estimate these emissions. As a follow up on the 2008 review, information has been collected from the branch organisation for roofing, indicating that the number of producers of asphalt roofing declined from about fifteen in 1990 to less than five in 2008 and that the import of asphalt roofing increased. Also, information has been researched on asphalt production (for road paving), as reported in the progress of the voluntary agreements for energy efficiency. A first estimate indicates that the CO_2 emissions could be around 0.5 kton.
- CH_4 from Enteric fermentation poultry (4A9), due to missing emission factors; for this source category no IPCC default emission factor is available.
- N_2O from Industrial wastewater (6B1), due to negligible amounts. As presented in the NIR 2008, page 194, the annual source for activity data are yearly questionnaires which cover all urban WWTPs and all anaerobic industrial WWTPs. From this anaerobic pre-treatment, there is no N_2O emission.

In 2000, the Netherlands investigated not previously estimated sources for non-CO_2 emissions. One of these sources was waste water handling (DHV, 2000). As a result of this study, emissions were estimated (Oonk, 2004) and the methods are presented in the protocols CH_4, N_2O from wastewater treatment (6B). We are not able to estimate N_2O emissions from aerobic industrial WWTPs, as there is no information available on these installations. In the priority setting for allocation of budgets for improvements in emission estimates, we did consider this as a source for which it could not be argued that a new data collection process or new statistics was a priority. Arguments for this decision include:

- The majority of the small and medium enterprises are linked to the municipal wastewater treatment plants (for which we made emission estimates) and do not have their own wastewater treatment;
- The anaerobic pre-treatment reduces the N load to the aerobic final treatment;
- Aerobic (post) treatment is done for several of the industrial companies in the municipal WWTPs;
- The composition of the industrial wastewater is mainly process water and although we have no specific information on the N-content of the influent, it is assumed that it is low N content.
- In addition, there are indications that the number of industrial wastewater treatment plants will reduce in the near future and this will also further minimise the minor effect of not estimating this source.
- Part of CH_4 from industrial waste water (6B1b Sludge), due to negligible amounts. For industrial waste water treatment the situation is as follows:
  - The major part of Dutch industry emits in the sewer system, which is connected to municipal waste water treatment. These emissions are included in the category: Domestic and commercial waste water.
  - In case of anaerobic waste water treatment, the emissions from sludge handling are included in the emissions from industrial anaerobic waste water handling.

– Among the aerobic waste water handling systems used in Industry, there are only two plants operating a separate anaerobic sludge digester and CH_4 emissions from these two plants are not estimated. Within other industrial WWTP, the sludge undergoes simultaneous stabilisation in the aerobic waste water reactors. The industrial sludge produced is therefore already very stable in terms of digestible matter. CH_4 emissions therefore are considered to be very low and do not justify setting up a yearly monitoring and estimation method.

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

Annex 6
Additional information to be considered as part of the NIR submission

The following information should be considered as part of this NIR submission:

A6.1 List of protocols

Table A6.1 Methodological description (monitoring protocols 2012, from 15 April 2012 available at the website).

Protocol	IPCC code	Description	Gases
H12-001	All	Reference approach	CO_2
H12-002	1A1 1A2 1A4	Stationary combustion (fossil) *	CO_2 N_2O CH_4
H12-003	1A1b 1B1b 1B2aiv 2A4i 2B1 2B4i 2B5i 2B5vii 2B5viii 2C1vi 2D2 2Giv	Process emissions (fossil)	CO_2 N_2O CH_4
H12-004	1A2f 1A4c	Mobile equipment	CO_2 N_2O CH_4
H12-005	1A3a	Inland aviation	CO_2 N_2O CH_4
H12-006	1A3b	Road transport	CO_2
H12-007	1A3b	Road transport	N_2O CH_4
H12-008	1A3c	Rail transport	CO_2 N_2O CH_4
H12-009	1A3d	Inland navigation	CO_2 N_2O CH_4
H12-010	1A4c	Fisheries	CO_2 N_2O CH_4
H12-011	1A5	Defence	CO_2 N_2O CH_4
H12-012	1B2	Oil & gas production	CO_2 CH_4
H12-013	1B2	Oil & gas distribution/transport	CO_2 CH_4
H12-014	2A1 2A2 2A3 2A4ii 2A7i 2B5ix 2C1i 2C1vii 2C3 2Gi 2Gii 2Giii 2Gv 3A 3B 3C 3D	Process emissions (non-fossil)	CO_2 N_2O CH_4
H12-015	2B2	Nitric acid	N_2O
H12-016	2B5	Caprolactam	N_2O
H12-017	2C3	Aluminium production	PFC
H12-018	2E1	HCFC-22 production	HFC
H12-019	2E3	HFC by product emissions	HFC
H12-020	2F1	Stationary refrigeration	HFC
H12-021	2F1	Mobile refrigeration	HFC
H12-022	2F2, 2F4	Hard foams, Aerosols	HFC
H12-024	2F8	Soundproof windows, Electron microscopes	SF_6
H12-025	2F8	Semi-conductors	SF_6 PFC
H12-026	2F8	Electrical equipment	SF_6
H12-027	4A	Enteric fermentation,	CH_4
H12-028	4B	Manure management	N_2O
H12-029	4B	Manure management	CH_4
H12-030	4D	Agricultural soils, indirect	N_2O
H12-031	4D	Agricultural soils, direct	N_2O
H12-032	5A	Forest	CO_2
H12-033	5D-5G	Soil	CO_2
H12-034	6A1	Waste disposal	CH_4
H12-035	6B	Waste water treatment	CH_4 N_2O
H12-036	6D	Large-scale composting	CH_4 N_2O
H12-037	Memo item	International bunker emissions	CO_2 N_2O CH_4
H12-038	1A, (CO_2 memo item)	Biomass	CO_2 CH_4 N_2O
H12-039	5(KP-I KP-II)	KP LULUCF	CO_2 CH_4 N_2O

A6.2 Documentation of uncertainties used in IPCC Tier 1 uncertainty assessments and Tier 2 key source identification

- Olivier, J.G.J., L.J. Brandes, R.A.B. te Molder, 2009: Estimate of annual and trend uncertainty for Dutch sources of greenhouse gas emissions using the IPCC Tier 1 approach. PBL Report 500080013, PBL, Bilthoven.
- Olsthoorn, X. and A. Pielaat, 2003: Tier-2 uncertainty analysis of the Dutch greenhouse gas emissions 1999. Institute for Environmental Studies (IVM), Free University, Amsterdam. IVM Report no. R03-06.
- Ramírez-Ramírez, A., C. de Keizer and J.P. van der Sluijs, 2006: Monte Carlo Analysis of Uncertainties in the Netherlands Greenhouse Gas Emission Inventory for 1990–2004, report NWS-E-2006-58, Department of Science, Technology and Society, Copernicus Institute for Sustainable Development and Innovation, Utrecht University, Utrecht, the Netherlands.

A6.3 Background documents and uncertainty discussion papers

- Van Amstel, A.R., J.G.J. Olivier and P.G. Ruyssenaars (eds.), 2000a: Monitoring of Greenhouse Gases in the Netherlands: Uncertainty and Priorities for Improvement. Proceedings of a National Workshop held in Bilthoven, the Netherlands, 1 September 1999. WIMEK report/RIVM report no. 773201 003. Bilthoven, May 2000.
- Kuikman, P.J., J.J.H van den Akker and F. de Vries, 2005: Lachgasemissie uit organische landbouwbodems. Alterra, Wageningen. Alterra rapport 1035-II.
- Hoek, K. W. van der and M. W. van Schijndel, 2006: Methane and nitrous oxide emissions from animal manure management, including an overview of emissions 1990-2003. Background document for the Dutch National Inventory Report. RIVM report 680.125.002, Bilthoven.
- Hoek, K.W. van der, M.W. van Schijndel, P.J. Kuikman, 2007. Direct and indirect nitrous oxide emissions from agricultural soils, 1990 - 2003. Background document on the calculation method for the Dutch National Inventory Report. RIVM Report No. 68012.003/2007 MNP Report No. 500080003/2007 Bilthoven, the Netherlands.
- Nabuurs, G.J., I.J. van den Wyngaert, W.D. Daamen, A.T.F. Helmink, W de Groot, W.C. Knol, H. Kramer, P Kuikman, 2005: National System of Greenhouse Gas Reporting for Forest and Nature Areas under UNFCCC in the Netherlands - version 1.0 for 1990–2002. Alterra, Wageningen. Alterra rapport 1035-I.
- Van den Wyngaert, I.J.J., Kramer, H., Kuikman, P.,
- Nabuurs, G.J. (2009) Greenhouse gas reporting of the LULUCF sector, revisions and updates related to the Dutch NIR 2009. Alterra report1035.7, Alterra, Wageningen.

A6.4 Documentation of Quality Assurance and Quality Control for national greenhouse gas inventory compilation and reporting

- DHV, 2002: Quality Assurance and Quality Control for the Dutch National Inventory Report; report on phase 1, January 2002, report no. ML-BB-20010367. DHV, Amersfoort.
- RIVM, 2011. Werkplan EmissieRegistratie ronde 2011 – 2012. RIVM, Bilthoven, 2011.
- NL Agency, The Netherlands National System: QA/QC programme 2011/2012 Version 7.0

A6.5 Documentation of Changes to the National Registry

- Release Notes, Greta Emissions Trading Registry Version 5.1.26 Date: 28th March 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Release Notes, Greta Emissions Trading Registry Version 5.2 Date: 25th February 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Release Notes, Greta Emissions Trading Registry Version 5.2.21, Date: 14th March 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Release Notes, Greta Emissions Trading Registry Version 5.3, Date: 17th June 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Release Notes, Greta Emissions Trading Registry Version 5.3.16, Date: 12th September 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Test report, Greta Registry Release V5.2, Version 1.0, Date of creation: 21 March 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Greta Regression Testing Results, Greta Registry Release V5.2, Date of creation: 21 March 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Localisation Regression Test Results, Greta Registry Release V5.2, Nederlandse Emissieautoriteit, Prinses Beatrixlaan 2, 2595 AL Den Haag
- Test report, Greta Registry Release V5.3, QME201 Version 1.1, Date of creation: 9 January 2011, SFW Limited, Southern House Station Approach Woking Surrey GU22 7UY
- Localisation Functional Test Results, Greta Registry Release V5.3, Nederlandse Emissieautoriteit, Prinses Beatrixlaan 2, 2595 AL Den Haag
- Localisation Functional Test Summary, Greta Registry Release V5.3, Nederlandse Emissieautoriteit, Prinses Beatrixlaan 2, 2595 AL Den Haag
- Certification for NL's testing performed on version 5.2 in the Registry Test Environment, E-mail from Application manager for the CITL, 7th March 2011

- Certification for NL's testing performed on version 5.3 in the Registry Test Environment, E-mail from Application manager for the CITL, 11th August 2011

A6.6 Registry Information

Report R1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	626814684	2602173	NO	15103900	NO	NO
Entity holding accounts	115303838	1168575	NO	5730632	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	500	NO	NO	1020	NO	NO
Retirement account	287982275	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	1030101297	3770748	NO	20835552	NO	NO

Table 2 (a). Annual internal transactions

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Article 6 issuance and conversion												
Party-verified projects		NO					NO		NO			
Independently verifed projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							3479	NO	NO	60154	NO	NO
Sub-total		NO	NO				3479	NO	NO	60154	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	84411123	NO	NO	NO	NO	NO

Party	Netherlands
Submission year	2012
Reported year	2011
Commitment period	1

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
CDM	NO	NO	NO	22031313	NO	NO	NO	NO	NO	NO	NO	NO
AT	675000	1290	NO	NO	NO	NO	570000	NO	NO	351147	NO	NO
BE	31559136	173651	NO	100329	NO	NO	41328215	85934	NO	2643948	NO	NO
BG	1665575	820397	NO	NO	NO	NO	618059	10740	NO	6408	NO	NO
CZ	358370	281491	NO	NO	NO	NO	319900	NO	NO	381088	NO	NO
DK	300200	NO	NO	NO	NO	NO	130000	NO	NO	277789	NO	NO
EE	48653	56848	NO	NO	NO	NO	2650	NO	NO	NO	NO	NO
FI	25000	NO	NO	NO	NO	NO	NO	24450	NO	107000	NO	NO
FR	40358842	26546	NO	5484237	NO	NO	11421219	28651	NO	3590349	NO	NO
DE	25531922	157245	NO	5729069	NO	NO	24134402	2758286	NO	12153241	NO	NO
GR	127880	NO	NO	15000	NO	NO	244305	NO	NO	72828	NO	NO
HU	33355	255780	NO	NO	NO	NO	660270	230	NO	97363	NO	NO
IE	17525	NO	NO	NO	NO	NO	15000	2957	NO	1171898	NO	NO
IT	5508020	NO	NO	538643	NO	NO	2198865	657528	NO	2774847	NO	NO
JP	NO	NO	NO	966641	NO	NO	NO	NO	NO	2046517	NO	NO
LV	7200	626	NO	NO	NO	NO	NO	3140	NO	NO	NO	NO
LT	1243083	NO	NO	NO	NO	NO	NO	66321	NO	86700	NO	NO
LU	12548	17264	NO	NO	NO	NO	NO	15694	NO	173094	NO	NO
NZ	NO	529991	NO	235000	NO	NO	NO	NO	NO	110000	NO	NO
NO	204544	NO	NO	309094	NO	NO	261309	NO	NO	72249	NO	NO
PL	1334940	50000	NO	4000	NO	NO	14600090	650000	NO	395964	NO	NO
PT	258470	NO	NO	NO	NO	NO	718616	314988	NO	1201795	NO	NO
RO	2331199	668016	NO	7000	NO	NO	NO	NO	NO	40000	NO	NO
SK	3747684	NO	NO	NO	NO	NO	667350	NO	NO	535009	NO	NO
SI	413217	21000	NO	26500	NO	NO	35154	34000	NO	21090	NO	NO
ES	1500976	NO	NO	1026792	NO	NO	5676751	800000	NO	985719	NO	NO
SE	1622	NO	NO	2417560	NO	NO	5100	18798	NO	869541	NO	NO
CH	53588	4460894	NO	10224373	NO	NO	NO	241632	NO	4463357	NO	NO
UA	31732	3336742	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
GB	52838359	4564436	NO	36952712	NO	NO	39193629	6567423	NO	30666057	NO	NO
Sub-total	170188640	15422217	NO	86068263	NO	NO	142800884	12280772	NO	65294998	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	170188640	15422217	NO	86068263	NO	NO	142804363	12280772	NO	65355152	NO	NO

Party	Netherlands
Submission year	2012
Reported year	2011
Commitment period	1

Table 3. Expiry, cancellation and replacement

	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
Transaction or event type	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Party	Netherlands
Submission year	2012
Reported year	2011
Commitment period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	533219656	4866337	NO	23172040	NO	NO
Entity holding accounts	151872020	2045856	NO	18375603	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	3979	NO	NO	61174	NO	NO
Retirement account	372393398	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	1057489053	6912193	NO	41608817	NO	NO

Party	Netherlands
Submission year	2012
Reported year	2011
Commitment period	1

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Issuance pursuant to Article 3.7 and 3.8	1001262141											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Sub-total	1001262141	NO		NO			NO	NO	NO	NO		
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	87571284	NO	NO	39222701	NO	NO	83469551	NO	NO	22711813	NO	NO
Year 2 (2009)	209068825	1400858	NO	73230286	NO	NO	202657603	363650	NO	72500058	NO	NO
Year 3 (2010)	170114509	7224084	NO	53694569	NO	NO	151788808	4490544	NO	50101153	NO	NO
Year 4 (2011)	170188640	15422217	NO	86068263	NO	NO	142804363	12280772	NO	65355152	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	636943258	24047159	NO	252215819	NO	NO	580720325	17134966	NO	210668176	NO	NO
Total	1638205399	24047159	NO	252215819	NO	NO	580720325	17134966	NO	210668176	NO	NO

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 (c). Summary information on retirement

Year	Retirement				
	Unit type				
	AAUs	ERUs	RMUs	CERs	tCERs
Year 1 (2008)	NO	NO	NO	NO	NO
Year 2 (2009)	83512630	NO	NO	NO	NO
Year 3 (2010)	204469645	NO	NO	NO	NO
Year 4 (2011)	84411123	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO
Total	372393398	NO	NO	NO	NO

Party	Netherlands
Submission year	2012
Reported year	2011
Commitment period	1

Table 6 (a). Memo item: Corrective transactions relating to additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 (b). Memo item: Corrective transactions relating to replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 (c). Memo item: Corrective transactions relating to retirement

	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Annex 7
Tables 6.1 and 6.2 of the IPCC Good Practice Guidance

As described in section 1.7, a Tier 1 uncertainty assessment was made to estimate the uncertainty in total national greenhouse gas emissions and in their trend. Tier 1 here means that non-Gaussian uncertainty distributions and correlations between sources have been neglected. The uncertainty estimates for activity data and emission factors as listed in Table A7.2 were also used for a Tier 1 trend uncertainty assessment, as shown in Table A7.1. Uncertainties for the activity data and emission factors are derived from a mixture of empirical data and expert judgment and presented here as half the 95% confidence interval. The reason for halving the 95% confidence interval is that the value then corresponds to the familiar plus or minus value when uncertainties are loosely quoted as 'plus or minus x%'.
We note that a Tier 2 uncertainty assessment and a comparison with a Tier 1 uncertainty estimate based on similar data showed that in the Dutch circumstances the errors made in the simplified Tier 1 approach for estimating uncertainties are quite small (Olsthoorn and Pielaat, 2003; and Ramírez-Ramírez et al., 2006). This conclusion holds for both annual uncertainties and the trend uncertainty (see section 1.7 for more details).

Details on this calculation can be found in Table A7.2 and in Olivier et al. (2009). It should be stressed that most uncertainty estimates are ultimately based on collective expert judgment and are therefore also rather uncertain (usually of the order of 50%). However, the reason to make these estimates is to identify the relatively most important uncertain sources. For this purpose, a reasonable order-of-magnitude estimate of the uncertainty in activity data and in emission factors is usually sufficient: uncertainty estimates are a means to identify and prioritise inventory improvement activities, rather than an objective in themselves.

This result may be interpreted in two ways: part of the uncertainty is due to inherent lack of knowledge on the sources that cannot be improved. Another part, however, can be attributed to elements of the inventory of which the uncertainty could be reduced in the course of time.. The latter may be a result of either dedicated research initiated by the Inventory Agency or by other researchers. When this type of uncertainty is in sources that are expected to be relevant for emission reduction policies, the effectiveness of the policy package could be in jeopardy if the unreduced emissions turn out to be much less than originally estimated.

The results of this uncertainty assessment for the list of potential key sources can also be used to refine the Tier 1 key source assessment discussed above.

Table A7.1 Uncertainty estimates for Tier 1 trend.

Year	Uncertainty in emission level	Uncertainty in emission trend
CO_2	± 2%	± 3%-points of 14% increase
CH_4	± 16%	± 8%-points of 38% decrease
N_2O	± 43%	± 8%-points of 53% decrease
F-gases	± 35%	± 11%-points of 68% decrease

Table A7.2 Tier 1 level and trend uncertainty assessment 1990–2009 (for F-gases with base year 1995) with the categories of the IPCC potential key source list (without adjustment for correlation sources).

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last ye	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	705	1%	10%	10%	0,0%	0,2%	0%	0,0%	0,0%	0,0%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25.776	24.098	1%	3%	3%	0,4%	-0,5%	11%	0,0%	0,2%	0,2%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	27281	1%	0%	1%	0,1%	6,5%	13%	0,0%	0,1%	0,1%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2473	10%	5%	11%	0,1%	0,9%	1%	0,0%	0,2%	0,2%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9.999	7.532	10%	10%	14%	0,5%	-1,0%	3%	-0,1%	0,5%	0,5%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1.042	3.062	1%	0%	1%	0,0%	0,9%	1%	0,0%	0,0%	0,0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	20%	2%	20%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1.526	2.435	20%	5%	21%	0,2%	0,4%	1%	0,0%	0,3%	0,3%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8.956	9.280	1%	5%	5%	0,2%	0,2%	4%	0,0%	0,1%	0,1%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5.033	4.140	2%	10%	10%	0,2%	-0,4%	2%	0,0%	0,1%	0,1%
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19.020	13.821	2%	0%	2%	0,1%	-2,2%	6%	0,0%	0,2%	0,2%
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	28	50%	5%	50%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7.632	12.932	20%	0%	20%	1,2%	2,5%	6%	0,0%	1,7%	1,7%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18.696	20.476	5%	0%	5%	0,5%	1,0%	9%	0,0%	0,7%	0,7%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7.330	8.538	10%	0%	10%	0,4%	0,6%	4%	0,0%	0,6%	0,6%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2.587	1.763	20%	2%	20%	0,2%	-0,4%	1%	0,0%	0,2%	0,2%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1.356	555	20%	2%	20%	0,1%	-0,4%	0%	0,0%	0,1%	0,1%
1A5	Military use of fuels (1A5 Other)	CO_2	566	327	20%	2%	20%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1.652	3%	50%	50%	0,4%	0,5%	1%	0,3%	0,0%	0,3%
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	343	3%	50%	50%	0,1%	0,1%	0%	0,0%	0,0%	0,0%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10.908	12.819	2%	2%	3%	0,2%	1,0%	6%	0,0%	0,2%	0,2%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11.821	20.001	5%	2%	5%	0,5%	3,9%	9%	0,1%	0,7%	0,7%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2.740	911	10%	2%	10%	0,0%	-0,8%	0%	0,0%	0,1%	0,1%
1A3	Mobile combustion: water-borne navigation	CO_2	405	595	20%	0%	20%	0,1%	0,1%	0%	0,0%	0,1%	0,1%
1A3	Mobile combustion: aircraft	CO_2	41	41	50%	1%	50%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: other (railways)	CO_2	91	106	5%	0%	5%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: other (non-road)	CH_4	1	1	50%	100%	112%	0,0%	0,0%	0%	0,0%	0,0%	0,0%

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last ye	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1A3	Mobile combustion: other (non-road)	N_2O	1	2	50%	100%	112%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: road vehicles	CH_4	158	50	3%	50%	50%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: road vehicles	N_2O	286	435	5%	50%	50%	0,1%	0,1%	0%	0,0%	0,0%	0,0%
1B2	Fugitive emissions venting/flaring	CH_4	1.252	304	2%	25%	25%	0,0%	-0,4%	0%	-0,1%	0,0%	0,1%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	269	2%	25%	25%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	171	20%	50%	54%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
1B1b	CO_2 from coke production	CO_2	403	972	50%	2%	50%	0,2%	0,3%	0%	0,0%	0,3%	0,3%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	66	50%	2%	50%	0,0%	-0,3%	0%	0,0%	0,0%	0,0%
2A1	Cement production	CO_2	416	348	5%	10%	11%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2A3	Limestone and dolomite use	CO_2	481	574	25%	5%	25%	0,1%	0,0%	0%	0,0%	0,1%	0,1%
2A7	Other minerals	CO_2	275	331	25%	5%	25%	0,0%	0,0%	0%	0,0%	0,1%	0,1%
2B1	Ammonia production	CO_2	3.096	3.156	2%	1%	2%	0,0%	0,1%	1%	0,0%	0,0%	0,0%
2B2	Nitric acid production	N_2O	6.330	301	5%	6%	8%	0,0%	-2,7%	0%	-0,2%	0,0%	0,2%
2B5	Caprolactam production	N_2O	766	681	20%	23%	30%	0,1%	0,0%	0%	0,0%	0,1%	0,1%
2B5	Other chemical product manufacture	CO_2	649	725	50%	50%	71%	0,2%	0,0%	0%	0,0%	0,2%	0,2%
2C1	Iron and steel production (carbon inputs)	CO_2	2.267	687	3%	5%	6%	0,0%	-0,7%	0%	0,0%	0,0%	0,0%
2C3	CO_2 from aluminium production	CO_2	395	311	2%	5%	5%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2C3	PFC from aluminium production	PFC	1.901	58	2%	20%	20%	0,0%	-0,8%	0%	-0,2%	0,0%	0,2%
2F	SF_6 emissions from SF_6 use	SF_6	287	184	30%	15%	34%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1.802	10%	50%	51%	0,4%	0,7%	1%	0,4%	0,1%	0,4%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5.759	391	10%	10%	14%	0,0%	-2,4%	0%	-0,2%	0,0%	0,2%
2E	HFC by-product emissions from HFC manufacture	HFC	12	90	10%	20%	22%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2F	PFC emissions from PFC use	PFC	37	151	5%	25%	25%	0,0%	0,1%	0%	0,0%	0,0%	0,0%
2G	Other industrial: CO_2	CO_2	304	339	5%	20%	21%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
2G	Other industrial: CH_4	CH_4	297	291	10%	50%	51%	0,1%	0,0%	0%	0,0%	0,0%	0,0%
2G	Other industrial: N_2O	N_2O	3	11	50%	50%	71%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
3	Indirect CO_2 from solvents/product use	CO_2	316	128	25%	10%	27%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4.356	3.996	5%	15%	16%	0,3%	-0,1%	2%	0,0%	0,1%	0,1%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	175	5%	20%	21%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2.264	1.669	5%	20%	21%	0,2%	-0,3%	1%	-0,1%	0,1%	0,1%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	386	5%	50%	50%	0,1%	0,0%	0%	0,0%	0,0%	0,0%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	394	5%	30%	30%	0,1%	0,0%	0%	0,0%	0,0%	0,0%
4B	Emissions from manure management	N_2O	1.173	1.004	10%	100%	100%	0,5%	-0,1%	0%	-0,1%	0,1%	0,1%
4B1	Emissions from manure management : cattle	CH_4	3.034	1.715	10%	100%	100%	0,8%	-0,6%	1%	-0,6%	0,1%	0,6%
4B8	Emissions from manure management : swine	CH_4	1.140	1.063	10%	100%	100%	0,5%	0,0%	0%	0,0%	0,1%	0,1%

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last ye	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
4B9	Emissions from manure management : poultry	CH_4	289	68	10%	100%	100%	0,0%	-0,1%	0%	-0,1%	0,0%	0,1%
4B	Emissions from manure management : other	CH_4	29	33	10%	100%	100%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4.137	3.286	10%	60%	61%	0,9%	-0,4%	2%	-0,2%	0,2%	0,3%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3.358	1.491	50%	200%	206%	1,4%	-0,8%	1%	-1,7%	0,5%	1,7%
4D2	Animal production on agricultural soils	N_2O	3.150	1.307	10%	100%	100%	0,6%	-0,8%	1%	-0,8%	0,1%	0,8%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12.011	4.307	30%	15%	34%	0,7%	-3,4%	2%	-0,5%	0,8%	1,0%
6B	Emissions from wastewater handling	CH_4	290	198	20%	25%	32%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
6B	Emissions from wastewater handling	N_2O	482	449	20%	50%	54%	0,1%	0,0%	0%	0,0%	0,1%	0,1%
6D	OTHER CH_4	CH_4	1	20	20%	25%	32%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
3, 6D	OTHER N_2O	N_2O	250	80	20%	50%	54%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
5A1	5A1. Forest Land remaining Forest Land	CO_2	-2.434	-2.296	25%	62%	67%	-0,7%	0,0%	-1%	0,0%	-0,4%	0,4%
5A2	5A2. Land converted to Forest Land	CO_2	56	-547	25%	58%	63%	-0,2%	-0,3%	0%	-0,2%	-0,1%	0,2%
5B2	5B2. Land converted to Cropland	CO_2	125	181	25%	50%	56%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
5C1	5C1. Grassland remaining Grassland	CO_2	4.246	4.246	25%	50%	56%	1,1%	0,0%	2%	0,0%	0,7%	0,7%
5C2	5C2. Land converted to Grassland	CO_2	279	394	25%	50%	56%	0,1%	0,1%	0%	0,0%	0,1%	0,1%
5D2	5D2. Land converted to Wetlands	CO_2	38	72	25%	50%	56%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
5E2	5E2. Land converted to Settlements	CO_2	203	553	25%	50%	56%	0,1%	0,2%	0%	0,1%	0,1%	0,1%
5F2	5F2. Land converted to Other Land	CO_2	17	21	25%	50%	56%	0,0%	0,0%	0%	0,0%	0,0%	0,0%
5G	5G. Other (liming of soils)	CO_2	183	60	25%	1%	25%	0,0%	-0,1%	0%	0,0%	0,0%	0,0%
	TOTAL	GHG	217520	213070				3%					3,3%
Procental change in emission from bases year to latest reported year						-2%							

Table A7.3 Emissions (Gg) and uncertainty estimates for the subcategories of Sector 5 LULUCF, as used in the Tier 1 uncertainty analysis.

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq latest year	AD unc	EF unc	Uncertainty estimate
5A1	5A1. Forest Land remaining Forest Land	CO_2	-2,412	-2,146	25,0%	61,8%	67%
5A2	5A2. Land converted to Forest Land	CO_2	56	-547	25,0%	57,9%	63%
5B2	5B2. Land converted to Cropland	CO_2	122	164	25,0%	50,0%	56%
5C1	5C1. Grassland remaining Grassland	CO_2	4,246	4,246	25,0%	50,0%	56%
5C2	5C2. Land converted to Grassland	CO_2	245	259	25,0%	50,0%	56%
5D2	5D2. Land converted to Wetlands	CO_2	80	131	25,0%	50,0%	56%
5E2	5E2. Land converted to Settlements	CO_2	459	808	25,0%	50,0%	56%
5F2	5F2. Land converted to Other Land	CO_2	20	27	25,0%	50,0%	56%
5G	5G. Other (liming of soils)	CO_2	183	60	25,0%	1,0%	25%

Annex 8
Emission Factors and Activity Data Agriculture

For years in between see Van der Maas et al. 2009.

Table A8.1 Animal numbers.

	1990	1995	2000	2005	2008	2009	2010
Cattle for breeding							
Female young stock under 1 yr	752,658	696,063	562,563	499,937	532,259	577,084	545,419
Male young stock under 1 yr	53,229	44,163	37,440	33,778	33,545	32,976	28,856
Female young stock, 1-2 yrs	734,078	682,888	594,100	515,972	509,763	527,537	563,966
Male young stock, 1-2 yrs	34,635	33,118	26,328	18,149	14,939	14,244	13,808
Female young stock, 2 yrs and over	145,648	124,970	104,633	74,180	79,489	85,381	86,913
Cows in milk and in calf	1,877,684	1,707,875	1,504,097	1,433,202	1,466,134	1,489,071	1,478,635
Bulls for service 2 yrs and over	8,762	8,674	10,410	12,391	7,718	8,119	7,756
Cattle for fattening							
Meat calves, for rosé veal production	28,876	85,803	145,828	204,227	272,117	269,306	293,901
Meat calves, for white veal production	572,709	583,516	636,907	624,513	626,596	624,942	633,798
Female young stock < 1 yr	53,021	57,218	41,300	43,313	42,657	41,113	39,231
Male young stock (incl. young bullocks) < 1 yr	255,375	188,193	83,447	66,655	53,875	52,764	48,790
Female young stock, 1-2 yrs	56,934	66,653	44,807	43,452	44,005	45,130	43,080
Male young stock (incl. young bullocks), 1-2 yrs	178,257	169,546	88,669	52,788	52,029	48,183	46,391
Female young stock, 2 yrs and over	42,555	48,365	16,917	15,260	18,755	19,935	19,848
Male young stock (incl. young bullocks) ≥ 2 yrs	12,073	10,969	9,397	9,346	9,334	8,512	9,463
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	119,529	146,181	163,397	151,641	126,980	123,302	115,339
Pigs							
Piglets	5,190,749	5,596,117	5,102,434	4,562,991	4,965,922	5,068,497	5,123,807
Fattening pigs	7,025,102	7,123,923	6,504,540	5,504,295	5,838,974	5,872,351	5,904,172
Gilts not yet in pig	385,502	357,520	339,570	274,085	231,500	249,118	232,261
Sows	1,272,215	1,287,224	1,129,174	946,466	977,983	985,244	983,552
Young boars	13,893	11,382	6,917	6,486	4,335	3,550	3,946
Boars for service	27,587	21,297	35,182	17,235	7,753	7,693	7,234
Poultry							
Broilers	41,172,110	43,827,286	50,936,625	44,496,116	44,357,773	43,285,129	44,747,893
Broilers parents under 18 weeks	2,882,250	3,065,170	3,644,120	2,191,650	2,386,073	2,645,986	2,895,975
Broilers parents 18 weeks and over	4,389,830	4,506,840	5,397,520	3,596,700	4,862,707	4,287,967	4,447,519
Laying hens < 18 weeks, liq. manure	7,339,708	4,889,555	2,865,850	1,035,581	586,885	578,681	663,430
Laying hens < 18 weeks, solid manure	3,781,062	4,000,545	8,597,550	9,751,719	10,920,673	10.768,005	12,345,009
Laying hens ≥ 18 weeks, liq. manure	19,919,466	12,294,122	7,166,060	2,292,654	806,067	847,049	253,035
Laying hens ≥ 18 weeks, solid manure	13,279,644	16,977,598	25,406,940	29,549,756	32,780,059	34,446,667	35,894,850
Ducks for slaughter	1,085,510	868,965	958,466	1,030,867	1,063,799	1,156,699	1,086,990
Turkeys for slaughter	1,003,350	1,175,527	1,543,830	1,245,420	1,044,315	1,059,693	1,036,277
Turkeys parents under 7 months	28,550	13,930					
Turkeys parents 7 months and over	20,460	17,290					
Rabbits (mother animals)	105,246	64,234	52,252	48,034	41,410	40,760	38,512
Minks (mother animals)	543,969	456,104	584,806	691,862	848,664	869,941	962,409
Foxes (mother animals)	10,029	7,102	3,816	5,240			
Other grazing animals							
Sheep (ewes)	789,691	770,730	681,441	648,235	583,408	538,279	558,184
Sheep , other	912,715	903,445	626,116	714,288	629,548	578,330	571,316
Goats (mothers)	37,472	43,231	98,077	172,159	207,882	231,090	221,977
Goats, other	23,313	32,832	80,825	120,073	146,996	143,094	130,851
Horses	369,592	400,004	418,244	433,321	444,078	444,924	441,481

Table A8.2 Gross energy intake (MJ/head/day) for cattle.

	1990	1995	2000	2005	2008	2009	2010
Cattle for breeding							
Female young stock under 1 yr	73.6	75.6	75.0	75.8	75.5	74.4	74.0
Male young stock under 1 yr	86.1	86.7	85.1	89.1	89.8	85.5	85.2
Female young stock, 1-2 yrs	139.5	142.5	139.5	144.6	147.1	146.0	144.9
Male young stock, 1-2 yrs	151.1	162.2	155.9	154.1	154.7	152.3	151.0
Female young stock, 2 yrs and over	139.4	142.5	139.5	144.6	147.1	146.0	144.9
Cows in milk and in calf	279.6	292.1	306.8	321.2	332.1	329.9	333.2
Bulls for service 2 yrs and over	151.1	162.2	155.9	154.1	154.7	152.3	151.0
Cattle for fattening							
Meat calves, for rosé veal production	77.9	77.9	95.5	82.8	82.8	82.8	77.1
Meat calves, for white veal production	30.9	32.7	35.6	34.8	37.2	37.2	41.9
Female young stock < 1 yr	73.6	75.5	74.9	75.8	75.3	74.1	73.8
Male young stock (incl. young bullocks) < 1 yr	82.3	87.6	88.8	86.7	86.2	85.6	84.7
Female young stock, 1-2 yrs	139.5	142.4	139.3	144.4	147.0	146.0	144.9
Male young stock (incl. young bullocks), 1-2 yrs	167.3	164.1	154.1	157.5	156.7	155.8	154.7
Female young stock, 2 yrs and over	139.5	142.5	139.4	144.5	147.1	146.0	144.9
Male young stock (incl. young bullocks) ≥ 2 yrs	167.3	164.1	154.1	157.5	156.7	155.8	154.7
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	165.0	167.1	169.1	180.0	184.9	183.7	183.2

Table A8.3 Emission factors enteric fermentation for cattle (kg/animals/year).

	1990	1995	2000	2005	2008	2009	2010
Cattle for breeding							
Female young stock under 1 yr	29.0	29.8	29.5	29.8	29.7	29.3	29.1
Male young stock under 1 yr	33.9	34.1	33.5	35.0	35.3	33.7	33.5
Female young stock, 1-2 yrs	54.9	56.1	54.9	56.9	57.9	57.4	57.0
Male young stock, 1-2 yrs	59.5	63.8	61.3	60.7	60.9	59.9	59.4
Female young stock, 2 yrs and over	54.9	56.1	54.9	56.9	57.9	57.5	57.0
Cows in milk and in calf	110.5	115.8	120.0	126.3	128.3	127.0	128.7
Bulls for service 2 yrs and over	59.5	63.8	61.3	60.7	60.9	59.9	59.4
Cattle for fattening							
Meat calves, for rosé veal production	30.6	30.6	37.6	32.6	32.6	32.6	41.3
Meat calves, for white veal production	8.1	8.6	9.3	9.1	9.8	9.8	3.7
Female young stock < 1 yr	29.0	29.7	29.5	29.8	29.6	29.2	29.0
Male young stock (incl. young bullocks) < 1 yr	32.4	34.5	34.9	34.1	33.9	33.7	33.3
Female young stock, 1-2 yrs	54.9	56.0	54.8	56.8	57.9	57.4	57.0
Male young stock (incl. young bullocks), 1-2 yrs	65.8	64.6	60.7	62.0	61.7	61.3	60.9
Female young stock, 2 yrs and over	54.9	56.1	54.9	56.9	57.9	57.4	57.0
Male young stock (incl. young bullocks) ≥ 2 yrs	65.8	64.6	60.7	62.0	61.7	61.3	60.9
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	64.9	65.8	66.6	70.8	72.8	72.3	72.1

Table A8.4 Volatile Solids (= Organic Matter) per 1000 kg manure.

		1990	1995	2000	2005	2008	2009	2010
Cattle for breeding								
Female young stock under 1 yr	liquid manure	60	66	64	64	64	64	64
Male young stock under 1 yr	liquid manure	60	66	64	64	64	64	64
Female young stock, 1-2 yrs	liquid manure	60	66	64	64	64	64	64
Male young stock, 1-2 yrs	liquid manure	60	66	64	64	64	64	64
Female young stock, 2 yrs and over	liquid manure	60	66	64	64	64	64	64
Cows in milk and in calf	liquid manure	60	66	64	64	64	64	64
Bulls for service 2 yrs and over	liquid manure	60	66	64	64	64	64	64
Cattle for fattening								
Meat calves, for rosé veal production	liquid manure	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Meat calves, for white veal production	liquid manure	15	15	15	15	15	15	15
Female young stock < 1 yr	liquid manure	60	66	64	64	64	64	64
Male young stock (incl. young bullocks) < 1 yr	liquid manure	60	66	64	64	64	64	64
Female young stock, 1-2 yrs	liquid manure	60	66	64	64	64	64	64
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	60	66	64	64	64	64	64
Female young stock, 2 yrs and over	liquid manure	60	66	64	64	64	64	64
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	60	66	64	64	64	64	64
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	140	153	150	150	150	150	150
Cattle for breeding								
Female young stock under 1 yr	Pasture	60	66	64	64	64	64	64
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	60	66	64	64	64	64	64
Male young stock, 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	60	66	64	64	64	64	64
Cows in milk and in calf	Pasture	60	66	64	64	64	64	64
Bulls for service 2 yrs and over								
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	60	66	64	64	64	64	64
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	60	66	64	64	64	64	64
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	60	66	64	64	64	64	64
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	60	66	64	64	64	64	64
Pigs								
Piglets								
Fattening pigs	liquid manure	50	60	60	60	60	60	60
Gilts not yet in pig	liquid manure	35	35	35	35	35	35	35
Sows	liquid manure	35	35	35	35	35	35	35
Young boars 1	liquid manure	35	35	35	35	35	35	35
Boars for service	liquid manure	35	35	35	35	35	35	35
Poultry								
Broilers	solid manure	508	508	508	508	508	508	508
Broilers parents under 18 weeks	solid manure	423	423	423	423	423	423	423
Broilers parents 18 weeks and over	solid manure	423	423	423	423	423	423	423
Laying hens < 18 weeks, liq. manure	liquid manure	90	93	93	93	93	93	93

		1990	1995	2000	2005	2008	2009	2010
Laying hens < 18 weeks, solid manure	solid manure	350	350	350	350	350	350	350
Laying hens ≥ 18 weeks, liq. manure	liquid manure	90	93	93	93	93	93	93
Laying hens ≥ 18 weeks, solid manure	solid manure	350	350	350	350	350	350	350
Ducks for slaughter	solid manure	209	209	209	209	209	209	209
Turkeys for slaughter	solid manure	464	464	464	464	464	464	464
Turkeys parents under 7 months	solid manure	464	464	464	464	464	464	464
Turkeys parents 7 months and over	solid manure	464	464	464	464	464	464	464
Rabbits (mother animals)	solid manure	367	367	367	367	367	367	367
Minks (mother animals)	solid manure	185	185	185	185	185	185	185
Foxes (mother animals)	solid manure	185	185	185	185	185	185	185
Ruminants, not cattle								
Sheep (ewes)	solid manure	205	205	205	205	205	205	205
Goats (mothers)	solid manure	182	182	182	182	182	182	182
Horses	solid manure	250	250	250	250	250	250	250
Ponies	solid manure	250	250	250	250	250	250	250
Ruminants, not cattle								
Sheep (ewes)	Pasture	60	66	64	64	64	64	64
Goats (mothers)								
Horses	Pasture	60	66	64	64	64	64	64
Ponies	Pasture	60	66	64	64	64	64	64

Table A8.5 Methane conversion factor for pigs and poultry.

		1990	1995	2000	2005	2008	2009	2010
Pigs								
Piglets								
Fattening pigs	liquid manure	0.34	0.36	0.39	0.39	0.39	0.39	0.39
Gilts not yet in pig	liquid manure	0.34	0.36	0.39	0.39	0.39	0.39	0.39
Sows	liquid manure	0.34	0.36	0.39	0.39	0.39	0.39	0.39
Young boars	liquid manure	0.34	0.36	0.39	0.39	0.39	0.39	0.39
Boars for service	liquid manure	0.34	0.36	0.39	0.39	0.39	0.39	0.39
Poultry								
Broilers	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Broilers parents under 18 weeks	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Broilers parents 18 weeks and over	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Laying hens < 18 weeks, liq. manure	liquid manure	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Laying hens < 18 weeks, solid manure	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Laying hens ≥ 18 weeks, solid manure	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Ducks for slaughter	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkeys for slaughter	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkeys parents under 7 months	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkeys parents 7 months and over	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Rabbits (mother animals)	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Minks (mother animals)	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Foxes (mother animals)	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Table A8.6 Methane conversion factor for cattle and ruminants and ultimate CH4 production (B0 in m³ CH_4/kg VS).

		MCF	B0
Cattle for breeding			
Female young stock under 1 yr	liquid manure	0.17	0.25
Male young stock under 1 yr	liquid manure	0.17	0.25
Female young stock, 1-2 yrs	liquid manure	0.17	0.25
Male young stock, 1-2 yrs	liquid manure	0.17	0.25
Female young stock, 2 yrs and over	liquid manure	0.17	0.25
Cows in milk and in calf	liquid manure	0.17	0.25
Bulls for service 2 yrs and over	liquid manure	0.17	0.25
Cattle for fattening	liquid manure		
Meat calves, for rosé veal production	liquid manure	0.14	0.25
Meat calves, for white veal production	liquid manure	0.14	0.25
Female young stock < 1 yr	liquid manure	0.17	0.25
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.17	0.25
Female young stock, 1-2 yrs	liquid manure	0.17	0.25
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	0.17	0.25
Female young stock, 2 yrs and over	liquid manure	0.17	0.25
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.17	0.25
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	0.015	0.25
Cattle for breeding			
Female young stock under 1 yr	Pasture	0.01	0.25
Male young stock under 1 yr			
Female young stock, 1-2 yrs	Pasture	0.01	0.25
Male young stock, 1-2 yrs			
Female young stock, 2 yrs and over	Pasture	0.01	0.25
Cows in milk and in calf	Pasture	0.01	0.25
Bulls for service 2 yrs and over			
Cattle for fattening			
Meat calves, for rosé veal production			
Meat calves, for white veal production			
Female young stock < 1 yr	Pasture	0.01	0.25
Male young stock (incl. young bullocks) < 1 yr			
Female young stock, 1-2 yrs	Pasture	0.01	0.25
Male young stock (incl. young bullocks), 1-2 yrs			
Female young stock, 2 yrs and over	Pasture	0.01	0.25
Male young stock (incl. young bullocks) ≥ 2 yrs			
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	0.01	0.25
Pigs			
Piglets			
Fattening pigs	liquid manure		0.34
Gilts not yet in pig	liquid manure		0.34
Sows	liquid manure		0.34
Young boars	liquid manure		0.34
Boars for service	liquid manure		0.34
Poultry			
Broilers	solid manure		0.34
Broilers parents under 18 weeks	solid manure		0.34
Broilers parents 18 weeks and over	solid manure		0.34
Laying hens < 18 weeks, liq. manure	liquid manure		0.34
Laying hens < 18 weeks, solid manure	solid manure		0.34
Laying hens ≥ 18 weeks, liq. manure	liquid manure		0.34

		MCF	B0
Laying hens ≥ 18 weeks, solid manure	solid manure		0.34
Ducks for slaughter	solid manure		0.34
Turkeys for slaughter	solid manure		0.34
Turkeys parents under 7 months	solid manure		0.34
Turkeys parents 7 months and over	solid manure		0.34
Rabbits (mother animals)	solid manure		0.34
Minks (mother animals)	solid manure		0.34
Foxes (mother animals)	solid manure		0.34
Ruminants, not cattle			
Sheep (ewes)	solid manure	0.015	0.25
Goats (mothers)	solid manure	0.015	0.25
Horses	solid manure	0.015	0.25
Ponies	solid manure	0.015	0.25
Ruminants, not cattle			
Sheep (ewes)	pasture	0.01	0.25
Goats (mothers)			
Horses	pasture	0.01	0.25
Ponies	pasture	0.01	0.25

Table A8.7 Emission factors for methane from manure (CH_4/kg manure/year).

		1990	1995	2000	2005	2008	2009	2010
Cattle for breeding								
Female young stock under 1 yr	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock under 1 yr	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 1-2 yrs	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock, 1-2 yrs	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 2 yrs and over	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Cows in milk and in calf	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Bulls for service 2 yrs and over	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Cattle for fattening								
Meat calves, for rosé veal production	liquid manure	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052
Meat calves, for white veal production	liquid manure	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035
Female young stock < 1 yr	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 1-2 yrs	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Female young stock, 2 yrs and over	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.00169	0.00186	0.00180	0.00180	0.00180	0.00180	0.00180
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	0.00035	0.00038	0.00037	0.00037	0.00037	0.00037	0.00037
Cattle for breeding								
Female young stock under 1 yr	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock, 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Cows in milk and in calf	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Bulls for service 2 yrs and over								

		1990	1995	2000	2005	2008	2009	2010
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Pigs								
Piglets								
Fattening pigs	liquid manure	0.00383	0.00486	0.00527	0.00527	0.00527	0.00527	0.00527
Gilts not yet in pig	liquid manure	0.00268	0.00284	0.00307	0.00307	0.00307	0.00307	0.00307
Sows	liquid manure	0.00268	0.00284	0.00307	0.00307	0.00307	0.00307	0.00307
Young boars	liquid manure	0.00268	0.00284	0.00307	0.00307	0.00307	0.00307	0.00307
Boars for service	liquid manure	0.00268	0.00284	0.00307	0.00307	0.00307	0.00307	0.00307
Poultry								
Broilers	solid manure	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172	0.00172
Broilers parents under 18 weeks	solid manure	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143
Broilers parents 18 weeks and over	solid manure	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143	0.00143
Laying hens < 18 weeks, liq. manure	liquid manure	0.00790	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816
Laying hens < 18 weeks, solid manure	solid manure	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.00790	0.00816	0.00816	0.00816	0.00816	0.00816	0.00816
Laying hens ≥ 18 weeks, solid manure	solid manure	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118	0.00118
Ducks for slaughter	solid manure	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071
Turkeys for slaughter	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Turkeys parents under 7 months	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Turkeys parents 7 months and over	solid manure	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157	0.00157
Rabbits (mother animals)	solid manure	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124	0.00124
Minks (mother animals)	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Foxes (mother animals)	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ruminants, not cattle								
Sheep (ewes)	solid manure	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051	0.00051
Goats (mothers)	solid manure	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Horses	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ponies	solid manure	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062	0.00062
Ruminants, not cattle								
Sheep (ewes)	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Goats (mothers)								
Horses	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Ponies	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011

Table A8.8 Manure production (kg/animal/year).

		1990	1995	2000	2005	2008	2009	2010
Cattle for breeding								
Female young stock under 1 yr	liquid manure	3,500	3,500	3,500	3,500	4,000	4,000	4,000
Male young stock under 1 yr	liquid manure	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Female young stock, 1-2 yrs	liquid manure	6,000	6,000	6,000	6,000	6,500	8,000	8,000
Male young stock, 1-2 yrs	liquid manure	11,500	11,500	11,500	11,500	11,500	12,000	12,000
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	6,500	8,000	8,000
Cows in milk and in calf	liquid manure	16,000	16,000	18,000	20,500	20,500	23,000	23,500
Bulls for service 2 yrs and over	liquid manure	11,500	11,500	11,500	11,500	11,500	12,000	12,000
Cattle for fattening								
Meat calves, for rosé veal production	liquid manure	5,000	5,000	5,000	5,000	4,300	4,500	4,500
Meat calves, for white veal production	liquid manure	3,500	3,500	3,500	3,000	3,000	2,800	2,800
Female young stock < 1 yr	liquid manure	3,500	3,500	3,500	3,500	4,000	4,000	4,000
Male young stock (incl. young bullocks) < 1 yr	liquid manure	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Female young stock, 1-2 yrs	liquid manure	6,000	6,000	6,000	6,000	6,500	8,000	8,000
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	6,500	8,000	8,000
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Cattle for breeding								
Female young stock under 1 yr	Pasture	1,500	1,500	1,500	1,500	1,000	1,000	1,000
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	5,500	5,500	5,500	5,500	5,000	4,000	4,000
Male young stock, 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	5,500	5,500	5,500	5,500	5,000	4,000	4,000
Cows in milk and in calf	Pasture	7,000	7,000	7,000	5,500	5,500	3,000	2,500
Bulls for service 2 yrs and over								
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	1,500	1,500	1,500	1,500	1,000	1,000	1,000
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	5,500	5,500	5,500	5,500	5,000	4,000	4,000
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	5,500	5,500	5,500	5,500	5,000	4,000	4,000
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Pigs								
Piglets								
Fattening pigs	liquid manure	1,300	1,250	1,200	1,200	1,200	1,200	1,100
Gilts not yet in pig	liquid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Sows	liquid manure	5,200	5,200	5,100	5,100	5,100	5,100	5,100
Young boars	liquid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Boars for service	liquid manure	3,200	3,200	3,200	3,200	3,200	3,200	3,200
Poultry								
Broilers	solid manure	10	11	11	10.9	10.9	10.9	10.9
Broilers parents under 18 weeks	solid manure	15.4	13.4	13.4	8.2	8.2	8.2	8.2
Broilers parents 18 weeks and over	solid manure	25.3	23.0	23.0	20.6	20.6	20.6	20.6
Laying hens < 18 weeks, liq. manure	liquid manure	25.4	25.4	25.4	22.5	22.5	22.5	22.5

Laying hens < 18 weeks, solid manure	solid manure	10.0	10.0	9.0	7.6	7.6	7.6	7.6
		1990	1995	2000	2005	2008	2009	2010
Laying hens ≥ 18 weeks, liq. manure	liquid manure	63.5	63.5	63.5	53.4	53.4	53.4	53.4
Laying hens ≥ 18 weeks, solid manure	solid manure	22.5	23.5	24.0	18.9	18.9	18.9	18.9
Ducks for slaughter	solid manure	86.3	70.0	70.0	70.0	70.0	70.0	70.0
Turkeys for slaughter	solid manure	37.9	45.0	45.0	45.0	45.0	45.0	45.0
Turkeys parents under 7 months	solid manure	49.4	49.4					
Turkeys parents 7 months and over	solid manure	78.6	78.6					
Rabbits (mother animals)	solid manure	377	377	377	377	377	377	377
Minks (mother animals)	solid manure	104	104	104	104	104	104	155
Foxes (mother animals)	solid manure	272	272	272	272			
Ruminants, not cattle								
Sheep (ewes)	solid manure	325	325	325	325	325	140	140
Goats (mothers)	solid manure	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Horses	solid manure	5,200	5,200	5,200	5,200	5,200	5,200	5,200
Ponies	solid manure	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Ruminants, not cattle								
Sheep (ewes)	Pasture	2,000	2,000	2,000	2,000	2,000	2,400	2,400
Goats (mothers)								
Horses	Pasture	3,300	3,300	3,300	3,300	3,300	3,300	3,300
Ponies	Pasture	2,100	2,100	2,100	2,100	2,100	2,100	2,100

Table A8.9 N excretion (kg/animal/year).

		1990	1995	2000	2005	2008	2009	2010
Cattle for breeding								
Female young stock under 1 yr	liquid manure	26.5	29.8	29.0	23.0	29.2	28.8	28.6
Male young stock under 1 yr	liquid manure	39.6	40.8	37.0	37.0	35.9	33.2	33.2
Female young stock, 1-2 yrs	liquid manure	43.1	48.4	46.4	42.7	45.8	45.0	44.4
Male young stock, 1-2 yrs	liquid manure	90.6	101.9	96.8	88.5	86.0	84.4	83.4
Female young stock, 2 yrs and over	liquid manure	43.0	48.4	46.3	42.7	45.8	45.0	44.5
Cows in milk and in calf	liquid manure	95.9	104.0	97.2	103.2	103.2	104.2	107.9
Bulls for service 2 yrs and over	liquid manure	90.6	101.9	96.8	88.5	87.4	89.6	86.0
Cattle for fattening								
Meat calves, for rosé veal production	liquid manure	28.9	28.9	34.1	27.2	27.4	28.0	28.2
Meat calves, for white veal production	liquid manure	10.6	11.6	11.9	10.6	10.7	10.6	12.4
Female young stock < 1 yr	liquid manure	26.2	29.4	28.6	22.8	28.8	28.4	28.2
Male young stock (incl. young bullocks) < 1 yr	liquid manure	28.9	29.5	26.6	27.0	26.0	26.9	26.8
Female young stock, 1-2 yrs	liquid manure	43.0	48.2	46.0	42.4	45.0	44.1	43.6
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	72.6	64.7	56.1	56.8	53.8	54.9	53.8
Female young stock, 2 yrs and over	liquid manure	43.1	48.4	46.1	42.5	44.9	44.1	43.6
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	72.6	64.7	56.1	56.8	53.8	54.9	53.8
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	42.3	48.0	42.4	39.1	38.7	37.9	37.6
Cattle for breeding								
Female young stock under 1 yr	Pasture	15.3	14.4	13.0	17.0	7.5	7.1	7.4
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	51.2	47.5	42.9	33.1	29.0	28.2	28.8
Male young stock, 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	51.2	47.5	42.9	33.1	29.0	28.2	28.7
Cows in milk and in calf	Pasture	52.6	52.5	39.3	30.8	31.3	22.8	22.3
Bulls for service 2 yrs and over								

		1990	1995	2000	2005	2008	2009	2010
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	15.2	14.3	12.8	16.9	7.4	7.0	7.2
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	51.2	47.5	42.9	33.1	29.4	28.6	29.2
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	51.2	47.5	42.9	33.1	29.4	28.6	29.2
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	68.4	63.1	52.7	45.8	46.2	44.9	45.7
Pigs								
Piglets								
Fattening pigs	liquid manure	14.3	14.5	12.3	12.3	12.9	12.7	12.2
Gilts not yet in pig	liquid manure	14.0	14.4	14.2	14.3	13.5	13.6	15.4
Sows	liquid manure	33.8	31.4	30.9	30.7	30.8	30.3	30.2
Young boars	liquid manure	14.0	14.4	14.2	14.3	13.5	13.6	15.4
Boars for service	liquid manure	25.0	24.6	22.9	23.7	23.5	23.2	23.3
Poultry								
Broilers	solid manure	0.61	0.63	0.51	0.55	0.53	0.54	0.50
Broilers parents under 18 weeks	solid manure	0.52	0.45	0.37	0.32	0.33	0.34	0.35
Broilers parents 18 weeks and over	solid manure	1.33	1.29	1.13	1.10	1.12	1.14	1.11
Laying hens < 18 weeks, liq. manure	liquid manure	0.38	0.36	0.31	0.32	0.34	0.33	0.34
Laying hens < 18 weeks, solid manure	solid manure	0.38	0.36	0.31	0.32	0.34	0.33	0.34
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.75	0.81	0.67	0.71	0.75	0.77	0.80
Laying hens ≥ 18 weeks, solid manure	solid manure	0.75	0.81	0.67	0.71	0.75	0.77	0.80
Ducks for slaughter	solid manure	1.12	1.09	0.99	0.89	0.76	0.78	0.79
Turkeys for slaughter	solid manure	1.98	1.97	1.85	1.81	1.71	1.98	1.91
Turkeys parents under 7 months	solid manure	2.38	2.78					
Turkeys parents 7 months and over	solid manure	3.17	3.04					
Rabbits (mother animals)	solid manure	8.7	8.1	7.6	8.2	7.9	7.7	7.7
Minks (mother animals)	solid manure	4.08	4.08	3.5	2.7	2.4	1.9	2.2
Foxes (mother animals)	solid manure	13.9	13.9	8.3	6.9			
Ruminants, not cattle								
Sheep (ewes)	solid manure	3.9	4.0	3.9	2.6	2.5	1.4	1.3
Goats (mothers)	solid manure	19.9	21.5	19.4	17.7	16.0	16.1	17.5
Horses	solid manure	33.3	33.3	33.3	33.3	30.3	30.3	30.3
Ponies	solid manure	14.4	14.4	14.4	14.4	13.2	13.2	13.2
Ruminants, not cattle								
Sheep (ewes)	Pasture	21.1	20.3	19.5	12.2	11.9	12.5	12.8
Goats (mothers)								
Horses	Pasture	30.2	30.2	30.2	30.2	28.2	28.2	28.2
Ponies	Pasture	19.9	19.9	19.9	19.9	18.9	18.9	18.9

Table A8.10 Fraction liquid manure.

	1990	1995	2000	2005	2008	2009	2010
Cattle for breeding							
Female young stock under 1 yr	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Male young stock under 1 yr	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Female young stock, 1-2 yrs	0.85	0.88	0.91	0.94	0.95	0.95	0.95
Male young stock, 1-2 yrs	0.85	0.88	0.91	0.94	0.95	0.95	0.95
Female young stock, 2 yrs and over	0.85	0.88	0.91	0.94	0.95	0.95	0.95
Cows in milk and in calf, winter	0.89	0.92	0.96	0.97	0.98	0.98	0.98
Cows in milk and in calf, summer	0.98	0.99	0.99	1.00	1.00	1.00	1.00
Bulls for service 2 yrs and over	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Cattle for fattening							
Meat calves, for rosé veal production	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Meat calves, for white veal production	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female young stock < 1 yr	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Male young stock (incl. young bullocks) < 1 yr	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Female young stock, 1-2 yrs	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Male young stock (incl. young bullocks), 1-2 yrs	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Female young stock, 2 yrs and over	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Male young stock (incl. young bullocks) ≥ 2 yrs	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Pigs							
Piglets							
Fattening pigs	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Gilts not yet in pig	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sows	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Young boars	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Boars for service	1.00	1.00	1.00	1.00	0.81	0.81	0.81
Poultry							
Broilers	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broilers parents under 18 weeks	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broilers parents 18 weeks and over	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laying hens < 18 weeks	0.66	0.55	0.25	0.10	0.05	0.05	0.05
Laying hens ≥ 18 weeks	0.60	0.42	0.22	0.07	0.02	0.02	0.01
Ducks for slaughter	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turkeys for slaughter	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turkeys parents under 7 months	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turkeys parents 7 months and over	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rabbits (mother animals)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minks (mother animals)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Foxes (mother animals)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ruminants, not cattle							
Sheep (ewes)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goats (mothers)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horses	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ponies	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A8.11 Crop Area (*100 m²).

	1990	1995	2000	2005	2008	2009	2010
Winter wheat	13,510,369	12,559,909	12,050,981	11,603,963	14,061,700	12,889,423	13,499,853
Spring wheat	549,904	981,302	1,617,586	2,067,009	1,589,326	2,208,756	1,902,381
Winter barley	994,082	309,977	363,547	296,950	466,894	487,279	471,135
Spring barley	3,044,693	3,248,038	4,353,676	4,761,972	4,556,486	3,959,131	2,872,749
Rye	860,386	817,514	596,058	253,457	211,740	231,967	234,285
Oats	340,128	291,431	240,390	169,744	149,107	158,456	169,248
Triticale		257,947	664,635	408,259	319,918	273,462	267,869
Dried and green peas	1,090,832	69,149	75,204	192,508	39,448	52,106	49,319
Peas (green to harvest)	766,724	713,143	586,657	509,139	596,872	485,535	343,390
Marrowfats	79,350	36,732	38,849	39,585	52,318	69,187	45,673
Kidney beans	373,005	222,094	112,590	109,903	91,081	138,311	200,645
Broad and field beans	316,912	53,220	67,916	44,111	31,435	28,563	34,647
Grass seed	2,631,440	2,189,274	2,196,001	2,763,858	1,566,102	1,772,897	1,268,029
Rape seed	841,501	149,268	85,416	209,640	246,658	266,705	262,764
Caraway seed	34,158	121,059	13,806	9,034	3,646	9,341	11,087
Pop seed	26,356	141,119	58,806	28,286	84,182	67,873	70,837
Flax seed	553,468	440,738	437,930	473,339	261,793	216.061	189,613
Seed potatoes on sand or peat	548,553	536,058	709,599	352,313	322,942	341,500	336,534
Seed potatoes on clay	3,010,113	3,243,815	3,470,553	3,573,898	3,330,423	3,472,669	3,517,178
Potatoes on sand or peat	1,602,484	1,845,122	2,563,153	1,926,935	1,903,856	2,109,757	2,200,423
Potatoes on clay	6,086,924	6,170,599	6,180,900	4,656,037	5,026,336	4,942,270	5,103,070
Industrial potatoes	6,283,773	6,134,453	5,095,818	5,069,191	4,603,383	4,656,973	4,669,789
Sugar beets	12,499,462	11,608,057	11,099,810	9,131,265	7,223,132	7,270,147	7,058,416
Fodder beets	302,286	157,602	89,094	53,195	35,320	32,887	34,255
Lucerne	596,017	583,627	661,606	587,842	491,808	571,237	642,243
Green maize	20,181,089	21,921,725	20,532,074	23,508,819	24,344,498	24,197,217	23,076,537
Green manure	728,159	1,224,765	261,452	3,101,990	501,069	367,930	359,431
Grain maize		900,542	2,029,838	2,074,849	2,213,225	1,890,381	1,709,129
Corn cob mix		500,473	721,918	667,841	759,763	764,480	726,487
Chicory			475,596	433,848	340,924	441,616	468,640
Hemp			79,197	10,043	27,832	89,199	114,217
Onions	1,282,770	1,608,194	1,997,942	2,252,034	2,614,035	2,602,629	2,886,590
Other horticultural crops	808,437	598,220	1,088,320	1,186,888	929,158	870,402	1,063,448
Strawberry	186,688	176,313	174,568	230,089	292,561	305,475	311,100
Endive	23,392	27,629	25,198	27,971	28,795	21,044	21,136
Asparagus	266,313	232,356	208,408	233,366	247,717	261,998	269,453
Gherkin	25,738				41,912	48,593	49,189
Cabbage for preservation	157,620	178,353	152,753	139,794			
Cauliflower	236,792	242,970	216,038	239,408	253,917	240,026	236,926
Broccoli		53,379	84,602	131,115	173,165	197,874	196,558
Cabbage (spring and autumn)	100,151	113,850	101,629	107,505	306,418	278,903	275,274
Celeriac	136,263	141,421	128,519	112,772	132,991	122,325	131,064
Beetroot		35,349	29,015	27,619	40,473	41,527	40,509
Lettuce	95,475	104,217	108,978	130,353	207,633	195,592	191,408
Leeks	287,307	385,356	318,448	272,537	301,226	292,615	284,260
Scorzonera	139,536	148,006	113,796	86,697	95,895	111,817	85,167
Spinach	115,291	96,500	120,827	91,431	117,525	138,357	136,307
Brussels sprouts	480,319	438,811	483,409	309,508	324,297	299,714	294,997
Industrial French beans	369,501	467,764	362,736	425,410	342,903	291,995	275,278
Runner beans	22,493				7,090	5,935	4,440
Broad beans green	117,770	87,716	69,416	78,984	183,795	159,738	114,368
Carrot	302,983	327,442	298,512	255,140	265,776	268,781	240,223
Winter carrot (Danvers)	295,050	467,490	472,875	470,043	528,567	574,224	556,760
Chicory	591,896	388,881	419,858	342,321	316,209	301,247	301,631
Other outside horticultural crops	277,358	286,665	317,125	431,248	362,021	315,016	300,675

Table A8.12 N content per crop, crop residue and N fixation for crops.

	N content kg N/ha	Crop residue Frac	N fixation kg N/ha
Winter wheat	28	0.1	
Spring wheat	28	0.1	
Winter barley	19	0.1	
Spring barley	19	0.1	
Rye	16	0.1	
Oats	19	0.1	
Triticale	24	0.1	
Dried and green peas	74	1.0	164
Peas (green to harvest)	194	1.0	164
Marrowfats	74	1.0	164
Kidney beans	74	1.0	164
Broad and field beans	16	1.0	325
Grass seed	28	1.0	
Rape seed	42	1.0	
Caraway seed	37	1.0	
Pop seed	20	1.0	
Flax seed	23	1.0	
Seed potatoes on sand or peat	26	1.0	
Seed potatoes on clay	26	1.0	
Potatoes on sand or peat	26	1.0	
Potatoes on clay	26	1.0	
Industrial potatoes	26	1.0	
Sugar beets	174	1.0	
Fodder beets	92	1.0	
Lucerne	23	1.0	422
Green maize	22	0.1	
Green manure	80	1.0	
Grain maize	70	1.0	
Corn cob mix	70	1.0	
Chicory	40	1.0	
Hemp	40	1.0	
Onions	4	1.0	
Other horticultural crops	40	1.0	
Strawberry	23	1.0	
Endive	78	1.0	
Asparagus	24	1.0	
Gherkin	78	1.0	
Cabbage for preservation	206	1.0	
Cauliflower	89	1.0	
Broccoli	89	1.0	
Cabbage (spring and autumn)	206	1.0	
Celeriac	78	1.0	
Beetroot	78	1.0	
Lettuce	25	1.0	
Leeks	62	1.0	
Scorzonera	78	1.0	
Spinach	62	1.0	
Brussels sprouts	206	1.0	
Industrial French beans	61	1.0	75
Runner beans	61	1.0	75
Broad beans green	13	1.0	185
Carrot	99	1.0	
Winter carrot (Danvers)	99	1.0	
Chicory	78	1.0	
Other outside horticultural crops	78	1.0	

Annex 9
Chemical compounds, global warming potentials, units and conversion factors

A9.1 Chemical compounds

CF_4	Perfluoromethane (tetrafluoromethane)
C_2F_6	Perfluoroethane (hexafluoroethane)
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HNO_3	Nitric Acid
NH_3	Ammonia
NO_x	Nitrogen oxide (NO and NO_2), expressed as NO_2
N_2O	Nitrous oxide
NMVOC	Non-Methane Volatile Organic Compounds
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride
SO_2	Sulphur dioxide
VOC	Volatile Organic Compounds (may include or exclude methane)

A9.2 Global Warming Potentials for selected greenhouse gases

Gas	Atmospheric lifetime	20-year GWP	100-year GWP[1)]	500-year GWP
CO_2	Variable (50-200)	1	1	1
CH_4 [2)]	12±3	56	21	6.5
N_2O	120	280	310	170
HFCs [3)]:				
HFC-23	264	9,100	11,700	9,800
HFC-32	5.6	2,100	650	200
HFC-125	32.6	4,600	2,800	920
HFC-134a	10.6	3,400	1,300	420
HFC-143a	48.3	5,000	3,800	1,400
HFC-152a	1.5	460	140	42
HFC-227ea	36.5	4,300	2,900	950
HFC-236fa	209	5,100	6,300	4,700
HFC-245ca	6.6	1,800	560	170
PFCs [3)]:				
CF_4	50,000	4,400	6,500	10,000
C_2F_6	10,000	6,200	9,200	14,000
C_3F_8	2,600	4,800	7,000	10,100
C_4F_{10}	2,600	4,800	7,000	10,100
C_6F_{14}	3,200	5,000	7,400	10,700
SF_6	3,200	16,300	23,900	34,900

Source: IPCC (1996)

[1)] GWPs calculated with a 100-year time horizon (indicated in the shaded column) and from the SAR are used in this report (thus not of the Third Assessment Report), in compliance with the UNFCCC Guidelines for reporting (UNFCCC, 1999). Gases indicated in italics are not emitted in the Netherlands.

[2)] The GWP of methane includes the direct effects and the indirect effects due to the production of tropospheric ozone and stratospheric water vapour; the indirect effect due to the production of CO_2 is not included.

[3)] The GWP-100 of emissions reported as 'HFC-unspecified' and 'PFC-unspecified' differ per reported year. They are in the order of magnitude of 3000 and 8400, respectively.

A9.3 Units

MJ	Mega Joule (10^6 Joule)
GJ	Giga Joule (10^9 Joule)
TJ	Tera Joule (10^{12} Joule)
PJ	Peta Joule (10^{15} Joule)
Mg	Mega gramme (10^6 gramme)
Gg	Giga gramme (10^9 gramme)
Tg	Tera gramme (10^{12} gramme)
Pg	Peta gramme (10^{15} gramme)
ton	metric ton (= 1 000 kilogramme = 1 Mg)
kton	kiloton (= 1 000 metric ton = 1 Gg)
Mton	Megaton (= 1 000 000 metric ton = 1 Tg)
ha	hectare (= 10^4 m^2)
kha	kilo hectare (= 1 000 hectare = 10^7 m^2 = 10 km^2)
mln	million (= 10^6)
mld	milliard (= 10^9)

A9.4 Other conversion factors for emissions

From element basis to full molecular mass		From full molecular mass to element basis	
$C \rightarrow CO_2$:	x 44/12 = 3.67	$CO_2 \rightarrow C$:	x 12/44 = 0.27
$C \rightarrow CH_4$:	x 16/12 = 1.33	$CH_4 \rightarrow C$:	x 12/16 = 0.75
$C \rightarrow CO$:	x 28/12 = 2.33	$CO \rightarrow C$:	x 12/28 = 0.43
$N \rightarrow N_2O$:	x 44/28 = 1.57	$N_2O \rightarrow N$:	x 28/44 = 0.64
$N \rightarrow NO$:	x 30/14 = 2.14	$NO \rightarrow N$:	x 14/30 = 0.47
$N \rightarrow NO_2$:	x 46/14 = 3.29	$NO_2 \rightarrow N$:	x 14/46 = 0.30
$N \rightarrow NH_3$:	x 17/14 = 1.21	$NH_3 \rightarrow N$:	x 14/17 = 0.82
$N \rightarrow HNO_3$:	x 63/14 = 4.50	$HNO_3 \rightarrow N$:	x 14/63 = 0.22
$S \rightarrow SO_2$:	x 64/32 = 2.00	$SO_2 \rightarrow S$:	x 32/64 = 0.50

Annex 10
List of abbreviations

AD	Activity Data
AE	Anode Effect
ARD	Afforestation, Reforestation and Deforestation
AWMS	Animal Waste Management Systems
BAK	Monitoring report of gas consumption of small users
BEES	Order governing combustion plant emissions requirements (1992) (in Dutch: 'Besluit Emissie-Eisen Stookinstallaties')
BEK	Monitoring report of electricity consumption of small users
BF	Blast Furnace (gas)
BOD	Biological Oxygen Demand
C	Confidential (notation key in CRF)
CO	Coke Oven (gas)
CS	Country-Specific (notation key in CRF)
Cap	capita (person)
CBS	Statistics Netherlands
CDM	Clean Development Mechanism (one of three mechanisms of the Kyoto Protocol)
CHP	Combined Heat and Power
CLRTAP	Convention on Long-Range Transboundary Air Pollution (UN-ECE)
CORINAIR	CORe INventory AIR emissions
CRF	Common Reporting Format (of emission data files, annexed to a NIR)
CRT	Continuous Regeneration Trap
DM	Dry Matter
DOC	Degradable Organic Carbon
DOCF	Degradable Organic Carbon Fraction
EC-LNV	National Reference Centre for Agriculture
ECE	Economic Commission for Europe (UN)
ECN	Energy Research Centre of the Netherlands
EEA	European Environment Agency
EF	Emission Factor
EGR	Exhaust Gas Recirculation
EIT	Economies-In-Transition (countries from the former SU and Eastern Europe)
EL&I	Ministry of Economic Affairs, Agriculture and Innovation (formerly EZ and LNV)
EMEP	European programme for Monitoring and Evaluation of long-range transmission of air Pollutants
EMS	Emission Monitor Shipping
EMSG	Emissions Registration Steering Group
ENINA	Task Group Energy, Industry and Waste Handling
EPA	US Environmental Protection Agency
ER-I	Emission Registration-Individual firms
ERT	Expert Review Team
ET	Emissions Trading
ETC/ACC	European Topic Centre on Air and Climate Change
ETS	Emission Trading System
EU	European Union
FAD	Forest According to Definition
FAO	Food and Agricultural Organisation (UN)
F-gases	Group of fluorinated compounds comprising HFCs, PFCs and SF6
FGD	Flue Gas Desulphurisation
FO-I	Dutch Facilitating Organisation for Industry
GE	Gross Energy
GHG	Greenhouse Gas

GPG	Good Practice Guidance
GIS	Gas Insulated Switchgear
GWP	Global Warming Potential
HBO	Heating Oil
HDD	Heating-Degree Day
HFO	Heavy Fuel Oil
HOSP	Timber Production Statistics and Forecast (in Dutch: 'Hout Oogst Statistiek en Prognose oogstbaar hout')
IE	Included Elsewhere (notation key in CRF)
IEA	International Energy Agency
IEF	Implied Emission Factor
IenM	Ministry of Infrastructure and Environment (formerly VROM)
INK	Dutch Institute for Quality Management
IPCC	Intergovernmental Panel on Climate Change
KNMI	Royal Netherlands Meteorological Institute
LEI	Agricultural Economics Institute
LHV	Lower Heating Value
LPG	Liquefied Petroleum Gas
LTO	Landing and Take-Off
LULUCF	Land Use, Land Use Change and Forestry
MCF	Methane Conversion Factor
MEP	TNO Environment, Energy and Process Innovation
MFV	Measuring Network Functions (in Dutch: 'Meetnet Functievervulling')
MJV	Annual Environmental Report
MR	Methane Recovery
MSW	Municipal Solid Waste
MW	Mega Watt
NA	Not Available; Not Applicable (notation key in CRF); also: National Approach
NACE	Statistical Classification of Economic Activities from the European Union: Nomenclature générale des Activités économiques dans les Communautés Européennes.
NAM	Nederlandse Aardolie Maatschappij
NAV	Dutch Association of Aerosol Producers
ND	No Data
NDF	Neutral Detergent Fibre
NE	Not Estimated (notation key in CRF)
NEAT	Non-Energy CO_2 emissions Accounting Tables (model of NEU-CO_2 Group)
NEC	National Emission Ceilings
NGL	Natural Gas Liquids
NIE	National Inventory Entity
NIR	National Inventory Report (annual greenhouse gas inventory report to UNFCCC)
NLR	National Aerospace Laboratory
NOGEPA	Netherlands Oil and Gas Exploration and Production Association
NOP-MLK	National Research Programme on Global Air Pollution and Climate Change
NS	Dutch Railways
ODS	Ozone Depleting Substances
ODU	Oxidised During Use (of direct non-energy use of fuels or of petrochemical products)
OECD	Organisation for Economic Co-operation and Development
OM	Organic Matter
OX	Oxygen Furnace (gas)
PBL	Netherlands Environmental Assessment Agency (formerly MNP)
PRTR	Pollutant Release and Transfer Register
QA	Quality Assurance
QC	Quality Control
RA	Reference Approach (vs. Sectoral or National Approach)

RIVM	National Institute for Public Health and the Environment
RIZA	National Institute of Water Management and Waste Treatment
ROB	Reduction Programme on Other Greenhouse Gases
SA	Sectoral Approach; also: National Approach (vs. Reference Approach)
SBI	Standaard bedrijven indeling (NACE)
SCR	Selective Catalytic Reduction
SBSTA	Subsidiary Body for Scientific and Technological Advice (of Parties to the UNFCCC)
SGHP	Shell Gasification and Hydrogen Production
SNCR	Selective Non-Catalytic Reduction
SW	Streefwaarde (Dutch for 'target value')
SWDS	Solid Waste Disposal Site
TNO	Netherlands Organisation for Applied Scientific Research
TBFRA	Temperate and Boreal Forest Resources Assessment (ECE-FAO)
TOF	Trees outside Forests
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nation's Framework Convention on Climate Change
VOC	Volatile Organic Compound
VS	Volatile Solids
WBCSD	World Business Council for Sustainable Development
WEB	Working Group Emission Monitoring of Greenhouse Gases
WEM	Working Group Emission Monitoring
WIP	Waste Incineration Plant
WUR	Wageningen University and Research Centre (or: Wageningen UR)
WWTP	Wastewater Treatment Plant

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The total greenhouse gas emissions from the Netherlands in 2010 increased by approximately 6% compared to the emissions in 2009. This increase is mainly the result of increased fuel combustion in the energy sector and space heating.

In 2010, total direct greenhouse gas emissions (excluding emissions from LULUCF – land use, land use change and forestry) in the Netherlands amount to 210.1 Tg CO_2 eq. This is approximately 1.5% below the emissions in the base year (213.3 Tg CO2 eq).

This report documents the 2012 Netherlands' annual submission of its greenhouse gas emission inventory in accordance with the guidelines provided by the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the European Union's Greenhouse Gas Monitoring Mechanism.

The report comprises explanations of observed trends in emissions; a description of an assessment of key sources and their uncertainty; documentation of methods, data sources and emission factors applied; and a description of the quality assurance system and the verification activities performed on the data.

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