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

Greenhouse gas emission in The Netherlands 1990-2011

Greenhouse Gas Emissions in the Netherlands 1990-2011

National Inventory Report 2013

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RIVM Report 680355013/2013

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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 2011].

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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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.
The emissions and activity data of The Netherlands' inventory have been converted into the IPCC[1] source categories contained in the Common Reporting Format (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: Eric Arets (KP), Guus van den Berghe (Rijkswaterstaat, Waste), Klaas van der Hoek, Jan-Peter Lesschen and Peter Kuikman (Alterra, Land Use), Gerben Geilenkirchen (Transport), Romuald te Molder (Key Sources), Jan Dirk te Biesebeek (Solvent and Product Use), Rianne Dröge (Energy), Johanna Montfoort (Fugitive Emissions), Kees Peek (Industrial Processes, Data Control, Chart Production), Kees Baas (CBS, Wastewater Handling) and Jan Vonk (Agriculture). In addition, 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 Bert Leekstra, Jack Pesik and Dirk Wever for their contributions 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 those of the external reviewers who provided comments on the draft report.

[1] Intergovernmental Panel on Climate Change

Abstract

Total greenhouse gas emissions from The Netherlands in 2011 decreased by approximately 7 per cent compared with 2010 emissions. This decrease is mainly the result of decreased fuel combustion in the Energy sector (less electricity production) and in the petrochemical industry. Fuel use for space heating decreased due to the mild winter compared with the very cold 2010 winter.
In 2011, total direct greenhouse gas emissions (excluding emissions from LULUCF – land use, land use change and forestry) in The Netherlands amounted to 194.4 Tg CO_2 eq. This is approximately 9 per cent below the emissions in the base year [2] (213.2 Tg CO_2 eq).

This report documents the Netherlands' 2012 annual submission of its greenhouse gas emissions 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

Rapport in het kort

In 2011 is de totale emissie in Nederland van broeikasgassen, zoals CO_2, methaan en lachgas, met ongeveer 7 procent gedaald ten opzichte van 2010. De daling komt vooral door een lager brandstofgebruik in de energiesector en de petrochemische industrie. Dit lijkt een gevolg van de economische recessie en van een geringere elektriciteitsproductie in Nederland. Daarnaast is in 2011 ten opzichte van 2010 minder energie verbruikt om huizen en kantoren te verwarmen. Dat kwam vooral doordat in 2010 zowel de eerste als de laatste maanden relatief koud waren.

Totale uitstoot 9 procent lager dan basisjaar Kyoto
De totale uitstoot van broeikasgassen wordt uitgedrukt in CO_2-equivalenten en bedroeg in 2011 voor Nederland 194,4 miljard kilogram (megaton of teragram). Ten opzichte van de uitstoot in het Kyoto-basisjaar (213,2 miljard kilogram CO_2-equivalenten) is dit een afname van ongeveer 9 procent. Het basisjaar, dat afhankelijk van het broeikasgas 1990 of 1995 is, dient voor het Kyoto-protocol als referentie voor de uitstoot van broeikasgassen.

Deze getallen zijn exclusief de zogeheten LULUCF-emissies (*Land Use, Land Use Change and Forestry*). Landen zijn voor het Kyoto-protocol verplicht om de totale uitstoot van broeikasgassen op twee manieren te rapporteren: met en zonder het soort landgebruik en de verandering daarin. Dit is namelijk van invloed op de uitstoot van broeikasgassen. Voorbeelden zijn natuurontwikkeling (dat CO_2 bindt) of ontbossing (waardoor CO_2 wordt uitgestoten).

Overige onderdelen inventarisatie
Het RIVM stelt jaarlijks op verzoek van het ministerie van Infrastructuur en Milieu (IenM) de inventarisatie van broeikasgasemissies op. De inventarisatie bevat trendanalyses om ontwikkelingen in de uitstoot van broeikasgassen tussen 1990 en 2011 te verklaren, en een analyse van de onzekerheid in deze getallen. Ook is aangegeven welke bronnen het meest aan deze onzekerheid bijdragen. Daarnaast biedt de inventarisatie documentatie van de gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren.

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 hiermee vergelijkbare Bewakingsmechanisme Broeikasgassen van de Europese Unie.

Trefwoorden: broeikasgassen, emissies, trends, methodiek, klimaat

[2] 1990 for CO_2, CH_4 and N_2O and 1995 for the F-gases

Contents

Samenvatting

Het National Inventory Report (NIR) 2013 bevat de rapportage van broeikasgasemissies (CO_2, N_2O, CH_4 en de F-gassen) over de periode 1990 tot en met 2011. De emissiecijfers in de NIR 2013 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.nlagency.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:

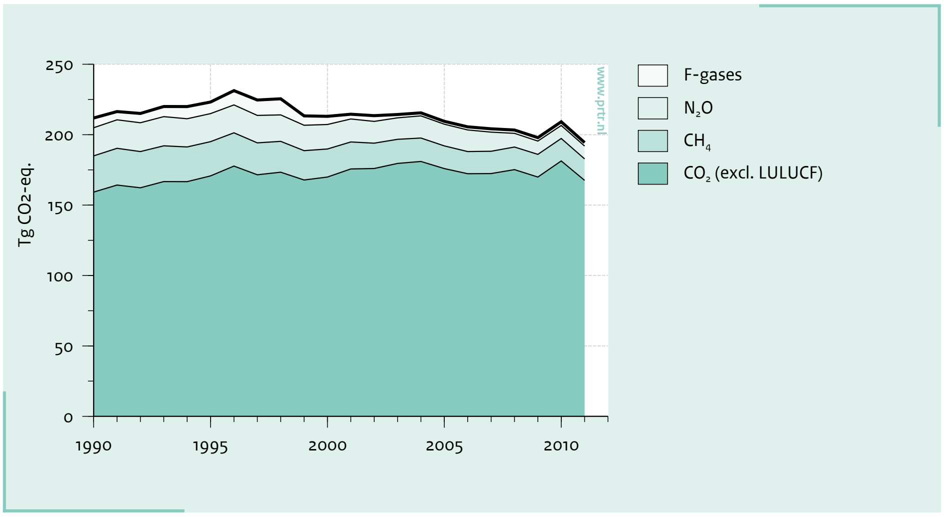
- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2011;
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van de IPCC Good Practice Guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- 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 activiteit data 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 onder meer 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.

Figure ES.1 Broeikasgassen: emissieniveaus en emissietrends (exclusief LULUCF), 1990-2011.



Ontwikkeling van de broeikasgasemissies (in CO_2 eq)
De emissieontwikkeling in Nederland wordt beschreven en toegelicht in dit National Inventory Report (NIR 2013). Figuur ES.1 geeft het emissieverloop over de periode 1990-2011 weer. De totale emissies bedroegen in 2011 circa 194,4 Tg (Mton ofwel miljard kg) CO_2 equivalenten en zijn daarmee circa 9 procent afgenomen in vergelijking met de emissies in het basisjaar (213,2 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 5 procent toegenomen, terwijl de emissies van de andere broeikasgassen met circa 51 procent zijn afgenomen ten opzichte van het basisjaar.

In 2011 daalde de CO_2 emissie met circa 7 procent (ten opzichte van het jaar 2010) ten gevolge van een daling van het brandstofgebruik in de energiesector, de petrochemische industrie en ten behoeve van ruimteverwarming. De emissie van CH_4 daalden in 2011 licht ten opzichte van 2010, met ongeveer 4 procent. De N_2O emissie daalde eveneens in 2011 met circa 1 procent ten gevolge van ontwikkelingen in de landbouw. De emissie van F-gassen daalden in 2011 met -7 procent ten opzichte van 2010. De totale emissie van broeikasgassen in 2011 ligt daarmee 7 procent lager dan het niveau in 2010.

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 procent. 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 procent betrouwbaarheid tussen de 189 en 200 Tg (Mton). De onzekerheid in de emissietrend tussen het basisjaar (1990/1995) en 2011 is geschat op circa 3 procent; dat wil zeggen dat de emissietrend in die periode met 95 procent betrouwbaarheid ligt tussen de -9 en -12 procent.

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.nlagency.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 methodewijzigingen doorgevoerd als follow up van de reviews (EU en UNFCCC) van respectievelijk de NIR 2011 en NIR 2012. 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 Netherlands' 2013 annual submission of its greenhouse gas emissions inventory in accordance with the guidelines provided by the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol (KP) 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 the 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 (ERTs) 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) 2013, therefore, provides explanations of the trends in greenhouse gas emissions, activity data and (implied) emission factors for the period 1990–2011. 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 (biennial edition; in Dutch: 'Balans van de Leefomgeving') prepared by The PBL Netherlands Environmental Assessment Agency 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 (IEFs), 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.

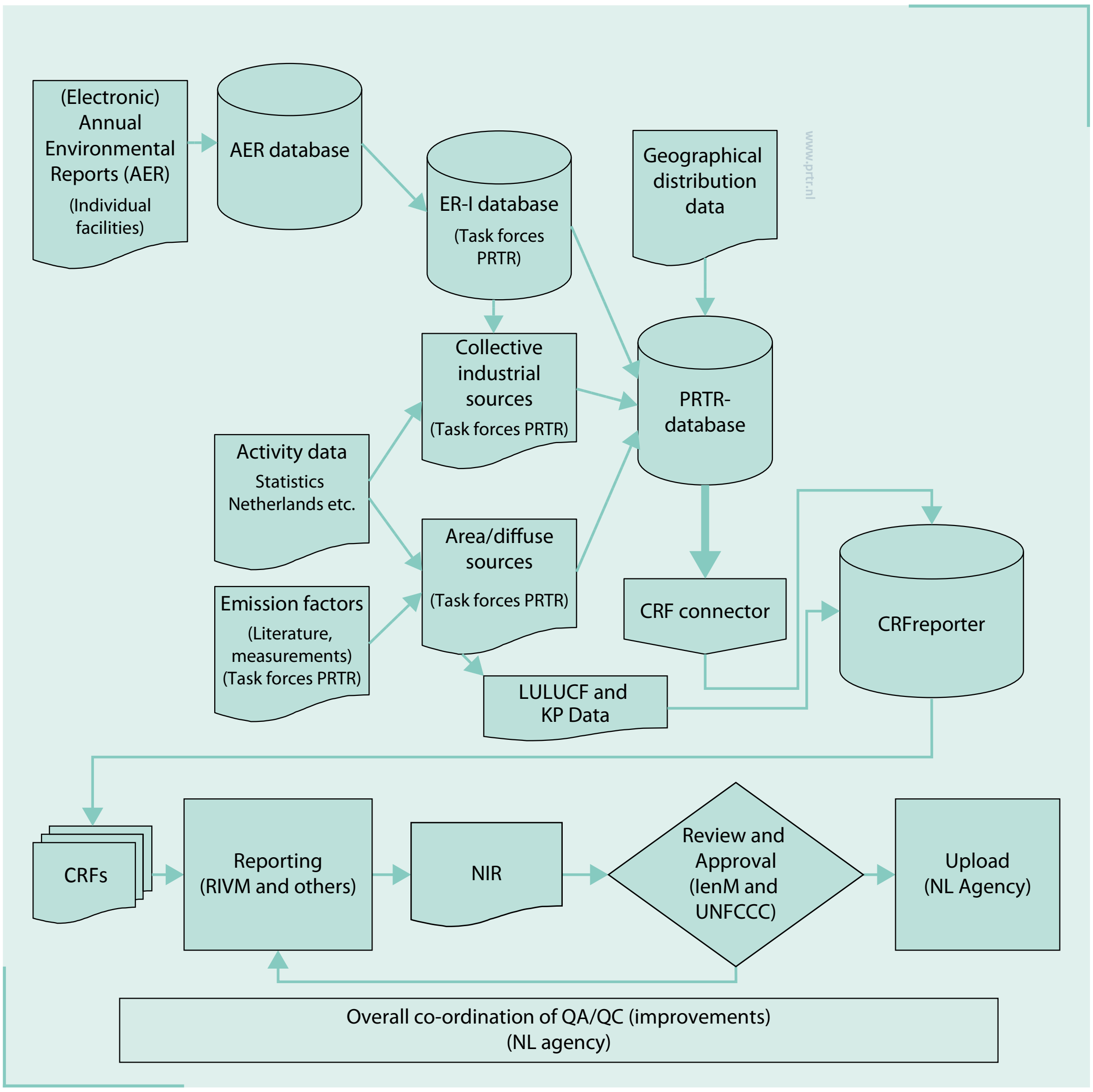
Climate Convention and Kyoto Protocol
This NIR is prepared as a commitment under the UNFCCC and under the Kyoto Protocol. Part 2 of the NIR focuses on supplementary information under article 7 of the Kyoto Protocol. One of the commitments is the development of a National System for greenhouse gas emissions (art. 5.1 of the Protocol). This National System developed in the period 2000–2005 was reviewed by an ERT of the UNFCCC in April 2007 and found to be in compliance with the requirements.

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 per cent of the national total, are 33 sources for annual level assessment and 32 sources for the trend assessment from a total of 72 sources. The two lists can be combined to give an overview of sources that meet either of these two criteria. Next, the IPCC Tier 2 method for identification of key sources is used; this requires incorporating the uncertainty of each of these sources before ordering the list of shares. The result is a list of 44 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 Land use, land use change and forestry (LULUCF) sector (sector 5), after inclusion of nine 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 and 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 NL Agency (formerly known as SenterNovem) to transform the general process of the greenhouse gas inventory of the PRTR into a National System, according to the requirements of 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 emissions 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. The

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



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 (IFs) 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 EU reviews of the NIR 2011 and the UNFCCC desk review 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.

Figure ES.3 An overview of the emission trends for greenhouse gas emissions (excl. LULUCF) 1990-2011.

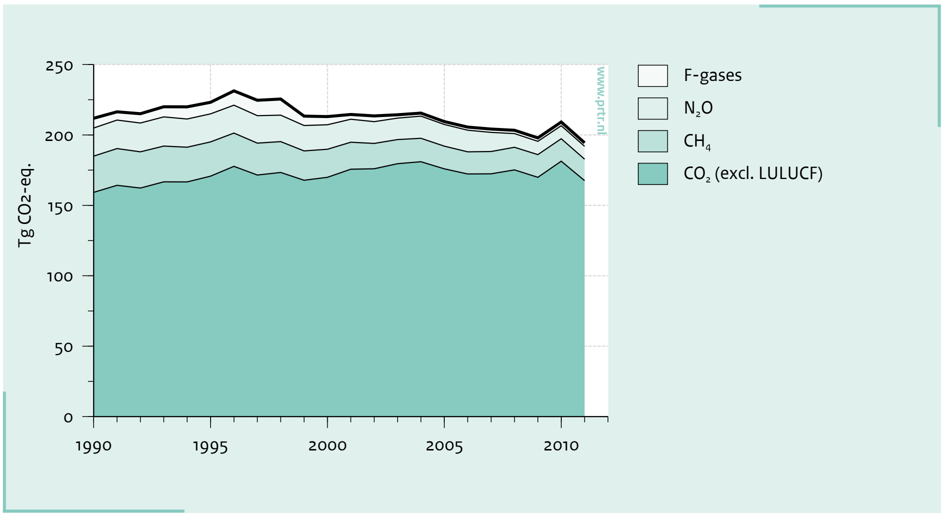


Table ES.1 Summary of emission trend per gas (unit: Tg CO_2 equivalents).

	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**	**20.0**	**6.0**	**1.9**	**0.3**	**216.2**	**213.2**
1990	162.2	159.2	25.7	20.0	4.4	2.3	0.2	214.8	**211.8**
1991	166.9	164.2	26.1	20.3	3.5	2.2	0.1	219.1	**216.4**
1992	165.2	162.3	25.7	20.5	4.4	2.0	0.1	218.0	**215.1**
1993	169.4	166.7	25.4	20.7	5.0	2.1	0.1	222.7	**220.0**
1994	169.4	166.7	24.6	20.0	6.5	2.0	0.2	222.7	**220.0**
1995	173.6	170.7	24.3	19.9	6.0	1.9	0.3	226.0	**223.2**
1996	180.4	177.7	23.6	19.8	7.7	2.2	0.3	234.0	**231.3**
1997	174.5	171.5	22.6	19.5	8.3	2.3	0.3	227.6	**224.7**
1998	176.3	173.4	21.9	18.8	9.3	1.8	0.3	228.4	**225.5**
1999	170.7	167.8	20.8	18.1	4.9	1.5	0.3	216.3	**213.4**
2000	172.9	169.9	19.9	17.4	3.9	1.6	0.3	215.9	**213.0**
2001	178.3	175.7	19.1	16.3	1.6	1.5	0.3	217.1	**214.5**
2002	178.6	176.0	18.0	15.5	1.7	2.2	0.2	216.1	**213.5**
2003	182.5	179.6	17.1	15.3	1.5	0.6	0.2	217.2	**214.3**
2004	183.9	181.0	16.6	15.7	1.6	0.3	0.3	218.4	**215.5**
2005	179.0	175.9	16.1	15.4	1.5	0.3	0.2	212.5	**209.5**
2006	175.4	172.3	15.7	15.3	1.7	0.3	0.2	208.6	**205.5**
2007	175.3	172.4	15.8	13.6	1.9	0.3	0.2	207.1	**204.2**
2008	178.2	175.2	16.1	9.7	1.9	0.3	0.2	206.3	**203.3**
2009	172.8	169.9	16.1	9.4	2.1	0.2	0.2	200.7	**197.9**
2010	184.4	181.4	15.9	9.2	2.3	0.2	0.2	212.2	**209.2**
2011	170.8	167.6	15.3	9.1	2.1	0.2	0.1	197.7	**194.4**

ES2 Summary of national emission- and removal-related trends

In 2011, total direct greenhouse gas emissions (excluding emissions from LULUCF) in The Netherlands were estimated at 194.4 Tg CO2 equivalents (CO2 eq). This is about 9 per cent below the emissions in the base year (213.2 Tg CO2 eq). In The Netherlands, the base year emissions are 1990 for CO2, CH4 and N2O and 1995 for fluorinated gases. CO2 emissions (excluding LULUCF) increased by about 5 per cent from 1990 to 2011, mainly due to the increase in the emissions in the 1A1a (Public electricity) and 1A3 (Transport) categories. CH4 emissions decreased by 41 per cent in 2011 compared with the 1990 level, mainly due to decrease in the Waste sector and the Agricultural sector and in fugitive emissions in the Energy

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	**153.8**	**23.6**	**0.5**	**22.6**	**3.0**	**12.8**	**NA**	**216.2**	**213.2**
1990	153.8	22.2	0.5	22.6	3.0	12.8	NA	214.8	211.8
1991	158.9	21.2	0.5	23.0	2.6	12.9	NA	219.1	216.4
1992	157.5	21.5	0.4	22.9	2.9	12.7	NA	218.0	215.1
1993	162.3	22.3	0.4	22.6	2.7	12.4	NA	222.7	220.0
1994	161.6	24.3	0.4	21.7	2.7	11.9	NA	222.7	220.0
1995	165.7	23.6	0.4	22.2	2.9	11.3	NA	226.0	223.2
1996	173.3	24.8	0.4	21.8	2.7	10.9	NA	234.0	231.3
1997	166.2	26.1	0.3	21.4	3.0	10.6	NA	227.6	224.7
1998	168.1	26.5	0.4	20.4	2.9	10.2	NA	228.4	225.5
1999	162.4	21.2	0.4	20.0	2.9	9.4	NA	216.3	213.4
2000	164.7	20.3	0.3	18.8	2.9	8.9	NA	215.9	213.0
2001	171.0	16.7	0.3	18.5	2.6	8.1	NA	217.1	214.5
2002	171.3	17.1	0.2	17.5	2.6	7.4	NA	216.1	213.5
2003	174.8	15.5	0.2	17.1	2.9	6.7	NA	217.2	214.3
2004	176.1	16.0	0.2	17.1	2.9	6.2	NA	218.4	215.5
2005	171.0	15.8	0.2	17.0	3.0	5.6	NA	212.5	209.5
2006	167.7	15.5	0.2	16.9	3.0	5.2	NA	208.6	205.5
2007	167.6	14.8	0.2	16.7	2.9	4.9	NA	207.1	204.2
2008	171.5	10.2	0.2	16.8	3.1	4.6	NA	206.3	203.3
2009	166.6	10.0	0.2	16.7	2.9	4.4	NA	200.7	197.9
2010	177.9	10.4	0.2	16.6	3.0	4.1	NA	212.2	209.2
2011	163.9	10.4	0.2	16.0	3.3	3.9	NA	197.6	194.4

sector. N2O emissions decreased by 54 per cent in 2011 compared with 1990, mainly due to a decrease in emissions from Agriculture and from Industrial processes, which partly compensated N2O emission increases from fossil fuel combustion (mainly from transport). The emissions of fluorinated greenhouse gases (HFCs, PFCs and SF6) decreased in the period 1995 (chosen as the base year) to 2011 by, respectively, 65 per cent, 91 per cent and 49 per cent. Total emissions of all F-gases decreased by about 70 per cent compared with the 1995 level.

Between 2010 and 2011, CO_2 emissions decreased (excluding LULUCF) by 13.6 Tg. The emissions of CH_4 showed also a decrease of 0.7 Tg between the year 2010 and 2011. In this period the N_2O emission decreased only slightly (0.1 Tg CO_2 eq). Emissions of SF6 and PFCs did not change in 2011. HFCs emissions decreased by 0.1 Tg CO_2.

Overall, total greenhouse gas emissions decreased by about 7 per cent compared with 2010.

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 CO2 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 with 1990. In contrast, emissions from the other sectors decreased compared with the base year, the largest being Industrial Processes, Waste and Agriculture.

Categories showing the largest growth in CO_2 equivalent emissions since 1990 are Transport (1A3) Energy industries (1A1) (+34% and +18%, respectively). Half the marked increase in the Public electricity category (1A2) of almost 30 per cent between 1990 and 1998 was 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 per cent decrease in industry emissions in the early 1990s.

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 CO2 eq emissions results in an overall uncertainty of 3 per cent, based on calculated uncertainties of 2 per cent, 16 per cent, 43 per cent and 40 per cent 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), nor 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 the 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 1990–2011 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 1990–2011 (1995 for F-gases) of ±3 per cent points. This means that the trend in total CO_2 eq emissions between 1990 and 2011 (excluding LULUCF), which is calculated to be a 9 per cent decrease, will be between 12 per cent decrease and 6 per cent decrease. 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 per cent, ±7 per cent, ±8 per cent and ±12 per cent, 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 emissions 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 EFs;
- N_2O from Industrial wastewater (6B1), due to negligible amounts;
- part of CH_4 from industrial wastewater (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), are not included.

For more information on this subject, see Annex 5.

Methodological changes, recalculations and improvements

This NIR 2013 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 in 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 with the NIR/CRF 2012 and based on the results of the UNFCCC reviews, some improvements of the inventory (including minor recalculations) were undertaken in the last year. The biggest improvement in the inventory (as requested in the latest review) decreased national emissions by 1.3 Tg CO2 eq in 2005. In other years the changes in emissions were less significant. 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 2013 compared with the NIR 2012.

Improving the QA/QC system

The QA/QC (quality assurance/quality control) programme is up to date and all procedures and processes meet 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 with 1990, CO and NMVOC emissions were reduced in 2011 by 58 per cent and 70 per cent, respectively. For SO_2 the reduction was 83 per cent and for NO_x the 2011 emissions were 57 per cent lower than the 1990 level. Table ES.4 provides trend data. In contrast to the direct greenhouse gases, precursor emissions from road transport have not been corrected for fuel sales according to 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, 2005 and 2010 to 2011 for all sources.

Table ES.3 Differences between NIR 2012 and NIR 2013 due to recalculations and the resubmitted data from November 2012 (Unit: Tg CO_2 eq, F-gases: Gg CO_2 eq).

Gas	Source	1990	1995	2000	2005	2010
CO_2 (Tg)	NIR 2013	**162.2**	173.6	172.8	178.9	184.4
Incl. LULUCF	NIR 2012	**162.2**	173.6	172.9	179.0	184.2
	Difference	-0.01%	0.0%	0.0%	0.0%	0.1%
CO_2 (Tg)	NIR 2013	**159.2**	170.7	169.9	175.9	181.4
Excl. LULUCF	NIR 2012	**159.2**	170.7	169.9	175.9	181.2
	Difference	0.0%	0.0%	0.0%	0.0%	0.1%
CH_4 (Tg)	NIR 2013	**25.7**	24.3	19.9	16.1	15.9
	NIR 2012	**25.7**	24.3	19.9	17.4	16.8
	Difference	0.1%	0.1%	0.0%	-7.3%	-5.1%
N_2O (Tg)	NIR 2013	**20.0**	19.9	17.4	15.4	9.2
	NIR 2012	**20.2**	20.1	17.6	15.6	9.4
	Difference	-0.9%	-1.1%	-1.1%	-1.2%	-2.0%
PFCs (Gg)	NIR 2013	2264	**1938**	1581	265	209
	NIR 2012	2264	**1938**	1582	266	209
	Difference	0.0%	0.0%	-0.1%	-0.3%	0.0%
HFCs (Gg)	NIR 2013	4432	**6019**	3892	1512	2260
	NIR 2012	4432	**6019**	3892	1523	2282
	Difference	0.0%	0.0%	0.0%	-0.7%	-1.0%
SF_6 (Gg)	NIR 2013	218	**287**	295	240	184
	NIR 2012	218	**287**	297	240	184
	Difference	0.0%	0.0%	-0.5%	0.0%	0.0%
Total	NIR 2013	214.9	226.0	215.9	212.5	212.2
(Tg CO_2 eq.)	NIR 2012	215.0	226.2	216.1	214.0	213.1
Incl. LULUCF	*Difference*	-0.1%	-0.1%	-0.1%	-0.7%	-0.4%
Total	NIR 2013	211.8	223.2	213.0	209.5	209.2
[Tg CO_2 eq.]	NIR 2012	212.0	223.4	213.2	211.0	210.1
Excl. LULUCF	*Difference*	-0.1%	-0.1%	-0.1%	-0.7%	-0.4%

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	2010	2011
Total NO_x	559	464	386	325	258	243
Total CO	1.239	943	817	635	548	526
Total NMVOC	475	337	231	167	143	143
Total SO_2	198	139	79	70	34	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 1994. One of the commitments made by the ratifying parties to the Convention is to develop, publish and regularly update national emissions inventories of greenhouse gases. This national inventory report, together with the CRF, represents the 2011 national emissions 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, which are constituent countries of the Royal Kingdom of The Netherlands. It also excludes the islands Bonaire, Saba and Sint Eustatius, which since 10 October 2010 have been 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 2011 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), 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 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 1990–2011 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 2013 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 had been established in accordance with the guidelines and that it met the requirements. This was also confirmed by later reviews, such as the review of the NIR 2012. The National System has remained unchanged with the exception of an organisational change on 1 January 2010. At that date, co-ordination of the above mentioned PRTR (emissions registration) project shifted from the PBL Netherlands Environmental Assessment Agency to the 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-2013-v1.3.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 1990–2011 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_2013_1_21-21-47 9-4-2013.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, the 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 Communications (VROM 2006b, 2009).

Since 1 January 2010, the RIVM has been assigned by the 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 the 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 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 the registering and reporting of emission data for about 350 policy-relevant compounds and compound groups that are present in air, water and soil. The emission data are produced in an annual (project) cycle (RIVM, 2012). This system is also the basis for the national greenhouse gas inventory. The overall co-ordination of the PRTR is outsourced by the 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 the 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), Rijkswaterstaat Environment, 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 the 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 is responsible for integration and submission to the UNFCCC in its role as NIE. Submission to the UNFCCC takes place only after approval by the 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 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 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 comprises three major steps, which are described in more detail in the following sections.

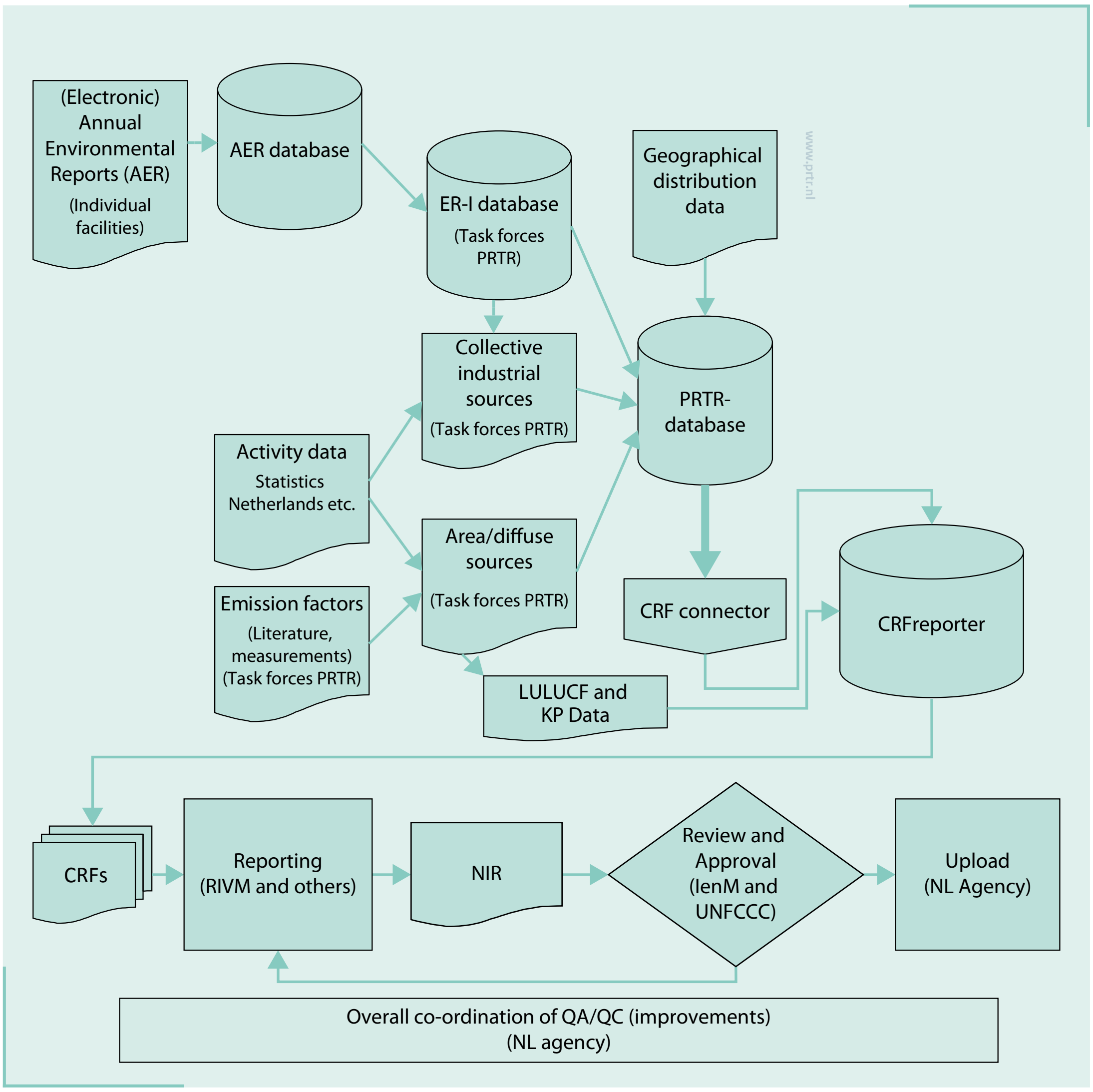
The preparation of the KP-LULUCF inventory is combined with the work for reporting LULUCF by the unit Wettelijke Onderzoekstaken Natuur & Milieu, part of Wageningen UR. The project team LULUCF (which is part of the Taskforce Agriculture) oversees data management, the preparation of the reports for LULUCF, 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

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



of data on sinks, water and waste. The provision of relevant data for greenhouse gases is guaranteed through covenants and an Order in Decree, the latter being under preparation by the IenM. For greenhouse gases, relevant agreements with respect to waste management are in place with CBS and Rijkswaterstaat Environment. An agreement with the Ministry of Agriculture, Nature and Food Quality (LNV, now EZ) 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 EFs 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 the 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 dataset. Based on a written agreement between the EL&I and the RIVM, these activities are also part of the PRTR.

Processing and storage

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

The actual emissions 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, Industrial processes 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 2012, in addition to the RIVM, these included PBL, TNO, CBS, Centre for Water Management, Deltares, Fugro-Ecoplan (which co-ordinates annual environmental reporting by companies), Rijkswaterstaat Environment and two agricultural research institutes: Alterra (sinks) and LEI. The task forces are responsible for assessing emissions estimates based on the input data and EFs provided. The RIVM commissioned TNO to assist in the compilation of the CRFs.

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

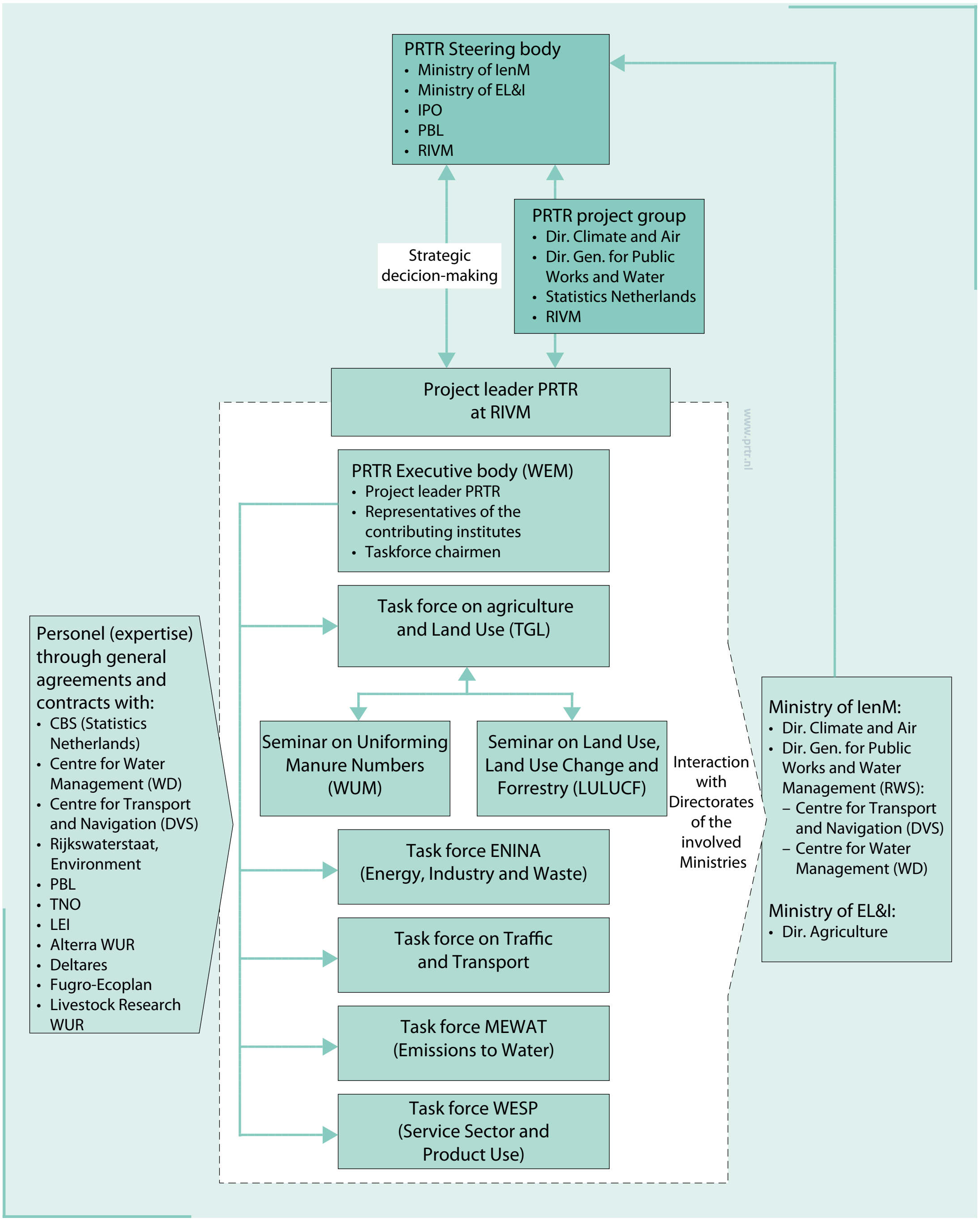
The NIR is prepared by the RIVM with input from experts in the relevant PRTR task forces and from NL Agency. This step includes documentation and archiving. The IenM formally approves the NIR before it is submitted; in some cases approval follows consultation with other ministries. NL Agency is responsible 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 the 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 into the CRF database for all sectors and again checked them. Any unexpected or incomplete values were reported to the LULUCF sectoral expert, checked and if necessary corrected.

Estimates on forest area and changes in forest area were verified against estimates reported by the Food and Agriculture Organisation of the United Nations (FAO). The total area of forest is systematically lower in the FAO estimates. This may be due to differences in methodology for data collection. For a discussion on the differences in the outcomes of forest cover in The Netherlands, see Nabuurs et al. (2005). The net increase in forest area in The Netherlands as reported in FAO statistics is, however, higher than those reported for KP-LULUCF. This indicates that the 1990 estimate in the FAO statistics is low. This comparison indicates that our estimates for re/afforested land give a conservative figure for net forest increase in The Netherlands.

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



The mean C stock in Dutch forests (used as an EF for deforestation under the Kyoto Protocol) 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. A more systematic assessment on these differences between FAO and UNFCCC estimates and their causes is planned for the NIR 2014.

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 protocols,

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 SF_6						
F. Consumption of Halocarbons and SF_6						
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**	**CS**	**D**	**CS**	**D**
A. Forest Land	CS,T1	CS,D	CS	D	CS	D
B. Cropland	CS,T1	CS,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**	**CS,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	PS	CS,T2,T3	D,PS
G. Other	NA	NA	NA	NA	NA	NA

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, in conjunction with relevant experts and institutes, as part of the monitoring improvement programme.

Explanation of codes 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: 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: the CBS/LEI agricultural database, plus data from the annual agricultural census;
- manure production and handling: CBS/LEI national statistics;
- fertiliser statistics: 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), Rijkswaterstaat Environment 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 used by The Netherlands to assess emissions 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, harmonised and validated digital topographical maps of 1990, 2004 and 2009 were used (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 was a map with national coverage that identifies for each pixel whether it was subject to RA or D between 1990 and 2004, 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 were 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 IPCC Good Practice Guidance (IPCC, 2001). To facilitate the identification of key sources, the contribution of source categories to emissions per gas is classified according to 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 with the key source analysis for the NIR 2012, two new key categories are identified:
- 1A3 Mobile combustion: water-borne navigation;
- 4A8 CH_4 emissions from enteric fermentation in domestic livestock: swine.

This is due to the use of new emission data and (in the case of 1A3) uncertainty.

1.5.2 KP-LULUCF inventory

With -458.76 Gg CO_2 the annual contribution of re/afforestation under the Kyoto Protocol is below the smallest key category (Tier 1 level analysis including LULUCF). Deforestation under the Kyoto Protocol in 2011 causes an emission of 838 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, the Act on the Monitoring of Greenhouse Gases also became effective in December 2005. This Act determined the establishment of the National System for the 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 determined 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 the 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 2013

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:
  - The ERT recommended providing more information in the NIR report and protocols, which is now included in background information. As most of the background documentation is in English and is available for review purposes, this background information will not be included in the protocols. This does not change the constant attention of the taskforces to further improve the quality and transparency of the protocols.
  - 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 2013, especially in relation to the documentation of uncertainties in the national emission database.
  - The Netherlands continues its efforts to include the correct codes in the CRF files.
- For the NIR 2013, 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 the 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 1990–2011 (with the exception of LULUCF). After a first check of the emission files by the 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 the RIVM (December 2012; see Box 1.1). The result of this workshop, including actions for the task forces to resolve the identified clarification issues, are documented at the 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 with 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 2013. 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 2012 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 focal points of the QA/QC activities are:

- The *QA/QC programme* (NL Agency, 2012) 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 the RIVM (ISO 9001:2008 system), 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 emissions 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 EFs and only qualified specific EFs from environmental reports are used.)
- *Agreements/covenants* between the 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 all changes in the historical dataset (recalculations) and for the emission trend that exceeds 5 per cent at the sector level and 0.5 per cent at the national total level, where according to the IPCC GPG (chapter 8) only changes in trend greater than 10 per cent need to be checked.
  - Peer reviews of CRF and NIR by NL Agency and institutions not fundamentally involved in the PRTR process;
  - Public review of the draft NIR: Every year, NL Agency organises a public review (via 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 the 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. The planned 2012 audit on agricultural emissions has been postponed to 2013.
  - 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.
  - 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 (as 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*: The 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 the PRTR project to re-assess and update the assessment of uncertainties and the sector-specific QC activities. In the coming years this will lead to a revised uncertainty assessment of Dutch GHG emissions.
- In 2012, a quantitative assessment was made of the possible inconsistencies in CO_2 emissions between data from ETS, NIR and national energy statistics. The figures that were analysed related to about 40 per cent of the CO_2 emissions in The Netherlands in 2011. The differences could reasonably be explained (e.g. different scope) within the given time available for this action (De Ligt, 2012).

1.6.2 Verification activities for the CRF/NIR 2013

Two weeks in advance of a trend analysis meeting, a snapshot from the database was made available by the RIVM in a web-based application (Emission Explorer, EmEx) for checks by the institutes and experts involved (PRTR task forces). This allowed the task forces to check for level errors and consistency in the algorithm/method used for calculations throughout the time series. The task forces performed checks such as for CO_2, CH_4 and N_2O emissions from all sectors. The totals for the sectors were then compared with the previous year's dataset. Where significant differences were found, the task forces evaluated the emission data in more detail. The results of these checks were then subject to discussion at the trend analysis workshop and subsequently documented. Furthermore, the task forces were provided with CRF Reporter software to check the time series of emissions per substance. During the trend analysis, the greenhouse gas emissions for all years between 1990 and 2011 were checked in two ways:

1. emissions from 1990 to 2010 should (with some exceptions) be identical to those reported last year;
2. the data for 2011 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 (IEFs);
   - level values of IEFs.

Exceptional trend changes and observed outliers were 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 the following year's inventory.

The trend verification workshop held on 4 December 2012 showed the following results:
Issues per source category:

- Changes in historical emissions of the Transport category should be addressed in the Energy chapter.
- Because detailed data became available in 2012, the historical emissions of F-gases changed.
- Changes in emissions in sector 4, Agriculture (whole time series), should be explained in chapter 6.
- Description of new source 'Forest fires'.

All above-mentioned checks were included in the annual project plan for 2012 (RIVM, 2011). Furthermore, data checks (also for non-greenhouse gases) were performed. To facilitate the data checks and the trend verification workshop, three types of data sheet were prepared from the PRTR emissions database:

- Based on the PRTR emissions database, a table with a comparison of emissions in 2010 and 2011. In this table, differences of >5 per cent at sector level were marked for documenting trends;
- Based on the PRTR emissions database, to check that no historical data had been accidentally changed, a table with a comparison of the complete inventories of 2012 versus 2013;
- To check that no errors occurred during the transfer of data from the PRTR emissions database to the CRF, a table with a comparison of data from the two sources.

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		RIVM	Input for trend analyses	historische reeksen luchtemissies vergeleken v30 november 2012.xls
Draft CRF	04-12-2012	NIC/TNO	Explanation of recalculations	Recalculations.xls
Comparison sheets dataset years 2010–2011	02-12-2012	RIVM	Input for trend analysis	Verschiltabel voorlopige emissiecijfers 30 november 2012 LUCHT IPCC.xls
List of required actions (action list)	02-12-2012	RIVM	Input for trend analysis	Actiepunten definitieve emissiecijfers 1990-2011 v 2 december 2012.xls
Trend analysis	07-12-2012	Task Forces	Updated Action list	Actiepunten definitieve emissiecijfers 1990-2011 v 7 december 2012.xls
Resolving the issues of the Action list	Until 21-12-2012	Task Forces	Final data set	Actiepunten trendanalyse 2012 definitief v 15 dec 2011.xls
Comparison of data in CRF and EPRTR database	Until 10-01-2013	NIC/TNO	Final CRF sent to the EU	RECALCULATIONS_MK3.xls And NLD-2013-v1.1.xml
Writing and checks of NIR	Until 13-01-2013	Task forces/ NIC/TNO/NIE	Draft texts	S:\ \NI National Inventory Report\NIR 2012\NIR2013-werkversie
Generate tables for NIR from CRF	Until 13-01-2013	NIC/TNO	Final text and tables NIR	Tabellen Hoofdstuk 3 NIR2013.xls NIR2013 Tables and Figures (version 1.6).xls

The data checks were performed by the sector experts and others involved in preparing the emissions database and the inventory. Communications (e-mail) between the participants in the data checks were centrally collected and analysed. This resulted in a checklist of actions to be taken. This checklist was used as input for the trend verification workshop and supplemented with the actions agreed in this workshop. Furthermore, in the trend verification workshop, trends of >5 per cent at sector level were explained. Table 1.2 shows the key items of the verification actions for the CRF/NIR 2013.

The completion of an action was reported on the checklist. Based on the completed checklist and the documentation of trends, the dataset was formally agreed by the two principal institutes: the RIVM and Statistics Netherlands (CBS). The acceptance of the dataset was, furthermore, a subject in the PRTR executive body (WEM).

All documentation (e-mails, data sheets and checklist) are stored electronically on a server at the 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. For these, The Netherlands uses the code 'C' in the CRF. Although this requirement impairs the transparency of the inventory, all confidential data is nevertheless 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 (IPCC, 2001);
- RIVM fact sheets on calculation methodology and data uncertainty (RIVM, 1999);

Table 1.3 Uncertainty of total annual emissions (Tier 2, 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 2011.

IPCC category	Category	Gas	Combined uncertainty as a percentage of total national emissions in 2011
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1.5%
4D1	Direct N_2O emissions from agricultural soils	N_2O	1.0%
1A4a	Stationary combustion: Other: Commercial/ Institutional, gases	CO_2	1.0%
4B1	Emissions from manure management: cattle	CH_4	0.9%
4D2	Animal production on agricultural soils	N_2O	0.6%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	0.5%
4B	Emissions from manure management	N_2O	0.5%
1A1b	Stationary combustion: Petroleum refining: liquids	CO_2	0.5%
2F	Emissions from substitutes for ozone-depleting substances (ODS substitutes): HFC	HFC	0.5%
1A4b	Stationary combustion: Other, Residential, gases	CO_2	0.4%

- Other recent information on the quality of data (Boonekamp et al., 2001);
- A comparison with uncertainty ranges reported by other European countries, which 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 judgements from RIVM/PBL and CBS emission experts (also for new key sources). In this process experts were asked to estimate uncertainties and from the different expert views a consensus estimate was obtained through discussions on the experts views. This was followed by an estimation of the uncertainty in the emissions in 1990 and 2011 according to the IPCC Tier 1 methodology – for both the annual emissions and the emissions trend for The Netherlands. All uncertainty figures should be interpreted as corresponding to a confidence interval of two standard deviations (2σ), or 95 per cent. 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 per cent in 2011, based on calculated uncertainties of 2 per cent, 16 per cent, 43 per cent and 40 per cent 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 per cent.
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 ten sources (excluding LULUCF) contributing most to total annual uncertainty in 2011, ranked 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 2011' in Table A7.1).

Comparing these data with NIR 2012, 4B (emissions from manure management) and 2F (substitutes for ozone depleting substances) have replaced 1A3b (mobile combustion road vehicles: gasoline) and 4B8 (emission from manure management: swine). This is as a result of using the new 2012 emission and uncertainty data.
Table A7.1 of Annex 7 summarises the estimate of the trend uncertainty 1990–2011 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in total

Table 1.5 Ten sources contributing most to trend uncertainty in the national total in 2011

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	1.6%
1A4a	Stationary combustion : Other, Commercial/ Institutional, gases	CO_2	1.2%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	0.8%
4D2	Animal production on agricultural soils	N_2O	0.8%
1A4b	Stationary combustion: Other, Residential, gases	CO_2	0.6%
1A4c	Stationary combustion: Other, Agriculture/ Forestry/Fisheries, gases	CO_2	0.5%
1A1b	Stationary combustion: Petroleum refining: liquids	CO_2	0.5%
2F	Emissions from substitutes for ozone-depleting substances (ODS substitutes): HFC	HFC	0.4%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	0.3%
4D1	Direct N_2O emissions from agricultural soils	N2O	0.3%

CO_2-equivalent emissions (excluding LULUCF) for 1990–2011 (1995–2011 for F-gases) of ±3 per cent. This means that the trend in total CO_2-equivalent emissions between 1990 and 2011, which is calculated to -9 per cent (decrease), will be between -12 per cent and -6 per cent (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 ±2 per cent, ±7 per cent, ±8 per cent and ±12 per cent, respectively. More details on the level and trend uncertainty assessment can be found in Annex 7. Table 1.5 shows the 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, the total error is the root of the sum of squares of the error in the underlying sources. Strictly speaking, this is valid only if the uncertainties meet the following conditions: (a) standard normal distribution ('Gaussian'); (b) 2s smaller than 60 per cent; (c) independent (not-correlated) sector-to-sector and substance-to-substance. It is clear, however, for some sources that activity data or EFs 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 per cent), it is clear that the distribution will be positively skewed.

Even more important is the fact that although the uncertainty estimates have been based on the documented uncertainties mentioned above, uncertainty estimates are unavoidably – and ultimately – based on the judgement of the expert. On occasion, only limited reference to actual data for The Netherlands is possible as support for these estimates. By focusing on the order of magnitude of the individual uncertainty estimates, it is expected that this dataset 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 of 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 per cent) than the uncertainty for the 2004 emissions. Finally, the resulting distribution for total Netherlands CO_2-equivalent emissions turns out to be clearly positively skewed.

As part of the above-mentioned study, the expert judgements and assumptions made for uncertainty ranges in EFs and activity data for The Netherlands were compared with the uncertainty assumptions (and their underpinnings) used in Tier 2 studies carried out by other European countries, such as Finland, the United Kingdom,

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	18.0%	15.0%
Nitrous oxide	45.0%	42.0%
F-gases	27.0%	28.0%
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	+13.0%	2.7%	2.1%
Methane	-32.0%	11.0%	15.0%
Nitrous oxide	-16.0%	15.0%	28.0%
F-gases	-75.0%	7.0%	9.1%
Total	+1.6%	3.2%	4.5%

Norway, Austria and Flanders (Belgium). The correlations that were assumed in the various European Tier 2 studies were also 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 were 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 with the assumptions used in some of the other European studies. This seems quite realistic in view of the state of knowledge on the processes that lead to N_2O emission. Another finding is that correlations (covariance and dependencies in the emissions calculation) seem somewhat under-addressed in most recent European Tier 2 studies and may require more systematic attention in future.
In the assessments described above, only random errors were estimated, assuming that the methodology used for the calculation did not include systematic errors. It is well known that in practice this may well be the case. Therefore, a more independent verification of the emissions level and emissions 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 per cent, 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 56 per cent, 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 completeness

1.8.1 GHG inventory

At present, the greenhouse gas emissions 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

Greenhouse gas emissions (CO_2, CH_4 and N_2O) from forest fires are now estimated for the total time series (as a result of the UNFCCC reviews).

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 is reported as not occurring.

2 Trends in greenhouse gas emissions

2.1 Emissions trends for aggregated greenhouse gas emissions

Chapter 2 summarises the trends in greenhouse gas emissions during the period 1990–2011, by greenhouse gas and by sector. Detailed explanations of these trends are provided in chapters 3–8. In 2011, total direct greenhouse gas emissions (excluding emissions from LULUCF) in The Netherlands are estimated at 194.4 Tg CO_2 eq. This is 8.8 per cent lower than the 213.2 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 1990–2011, emissions of carbon dioxide (CO_2) increased by 5.3 per cent (excluding LULUCF), while emissions of non-CO_2 greenhouse gases decreased by 50 per cent 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 41 per cent, 54 per cent and 70 per cent, respectively.

Emissions of LULUCF-related sources decreased by about 7.4 per cent in 2011 compared with 2010. In 2011, total greenhouse gas emissions (including LULUCF) decreased by 14.5 Tg CO_2 eq compared witho 2010 (197.7 Tg CO_2 eq in 2011).

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 1990–2011, national CO_2 emissions increased by 5.2 per cent (from 159.2 to 167.5 Tg). The Energy sector is by far the largest contributor to CO_2 emissions in The Netherlands (96 per cent), with the categories 1A1 Energy industries (39 per cent), 1A4 Other sectors (23 per cent) and 1A3 Transport (22 per cent) as the largest contributors in 2011.

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 category 1A4 (Other sectors). The relatively low level of CO_2 emissions in 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 CO_2 emissions. In the period 2000–2004, the pre-1999 annual increase in CO_2 emissions from this category (about 1–2 per cent) was observed again. In 2008, imports of electricity decreased.

Figure 2.1 Greenhouse gases: trend and emission levels (excl. LULUCF), 1990–2011.

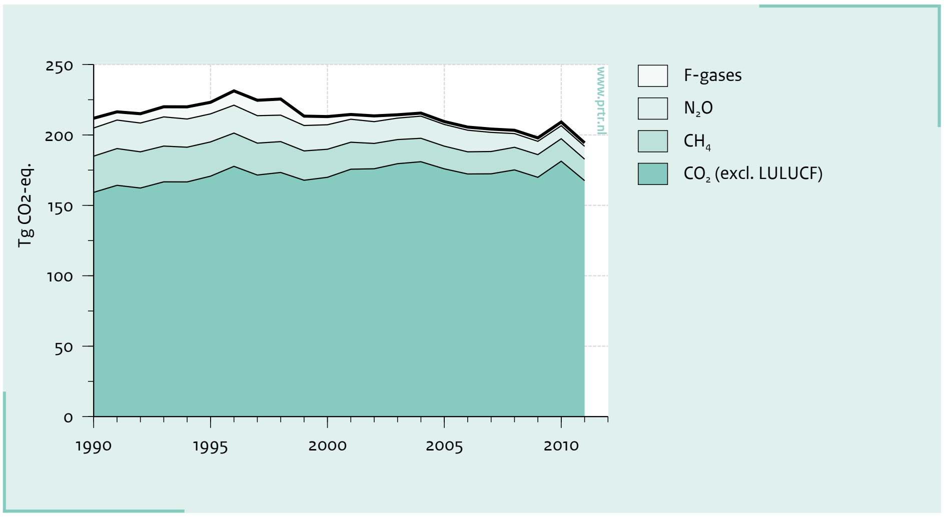
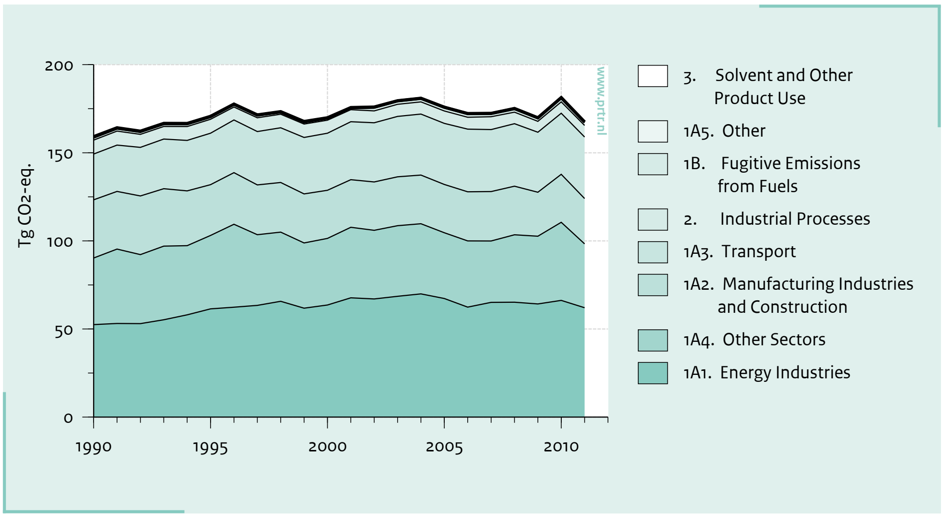


Figure 2.2 CO_2: trend and emission levels of sectors (excl. LULUCF), 1990–2011.



In 2011, CO_2 emissions decreased by 7.4 per cent compared with 2010, mainly due to decreased fuel combustion in the Energy sector.

2.2.2 Methane

Figure 2.3 presents the contribution of the most important IPCC sectors to the trend in total CH_4 emissions. National CH_4 emissions decreased by 41 per cent, from 1.22 Tg in 1990 to 0.73 Tg in 2011 (25.7 to 15.3 Tg CO_2 eq). The Agriculture and Waste sectors (60 per cent and 22 per cent, respectively) were the largest contributors in 2011. Compared with 2010, national CH_4 emissions decreased by about 4.2 per cent in 2011 (0.7 Tg CO_2 eq), due to the decrease of CH_4 emissions mainly in categories 4 (agriculture) and 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 54 per cent, from 64.4 Gg in 1990 to 29.4 Gg in 2011 (20.0 to 9.1 Tg CO_2 eq). The sector contributing the most to this decrease in N_2O emissions is Industrial processes (whose emissions decreased by more than 84 per cent compared with the base year).

Compared with 2010, total N_2O emissions decreased by 2.1 per cent in 2011 (−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, 1990-2011.

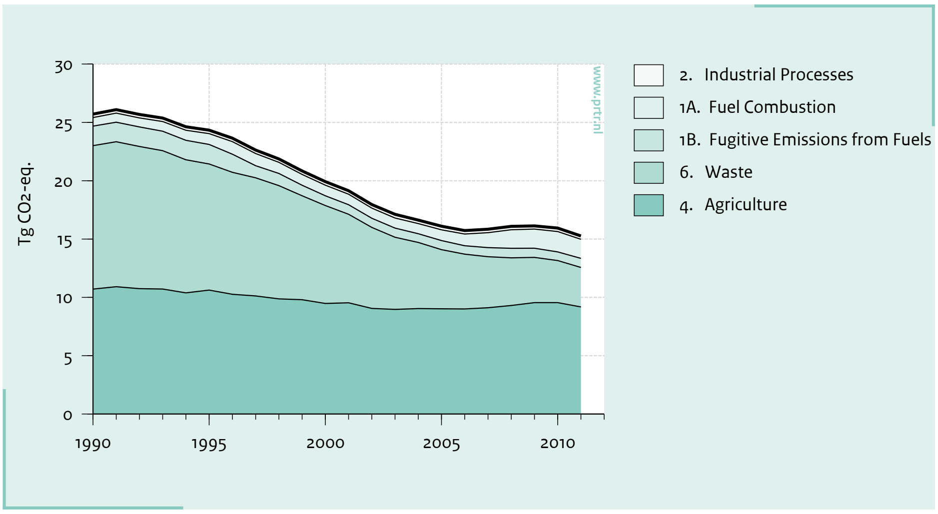
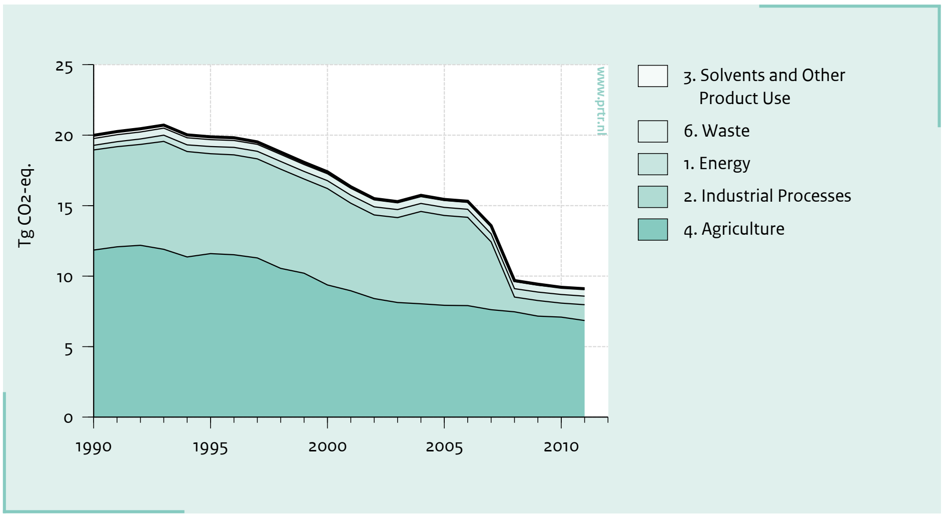


Figure 2.4 N_2O: trend and emission levels of sectors, 1990–2011.



2.2.4 Fluorinated gases

Figure 2.5 shows the trend in F-gas emissions included in the national greenhouse gas inventory. Total emissions of F-gases decreased by 70 per cent between 1995 and 2011, from 8.2 Tg CO_2 eq in 1995 (base year for F-gases) to 2.5 Tg CO_2 eq in 2011. Emissions of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) decreased by approximately 65 per cent and 91 per cent, respectively, during the same period, while sulphur hexafluoride (SF_6) emissions decreased by 49 per cent.
Emissions between 2010 and 2011 decreased by respectively 5.6 per cent, 12 per cent and 20 per cent for HFCs, PFCs and SF_6. The aggregated emissions of F-gases decreased by 7.2 per cent.

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 per cent, based on the IPCC Tier 1 Trend Uncertainty Assessment; see section 1.7. Per individual gas, the trend uncertainty in total emissions of CO_2, CH_4, N_2O and the sum of the F-gases is estimated to be ±2 per cent, ±7 per cent, ±8 per cent and ±12 per cent, respectively. For all greenhouse gases together, the uncertainty estimate in annual emissions is ±3 per cent and for CO_2 ±2 per cent. The uncertainty estimates in annual emissions of CH_4 and N_2O are ±25 per cent and ±50 per cent, respectively, and for HFCs, PFCs and SF_6, ±50 per cent (see section 1.7).

Figure 2.5 Fluorinated gases: trend and emission levels of individual F-gases, 1990–2011.

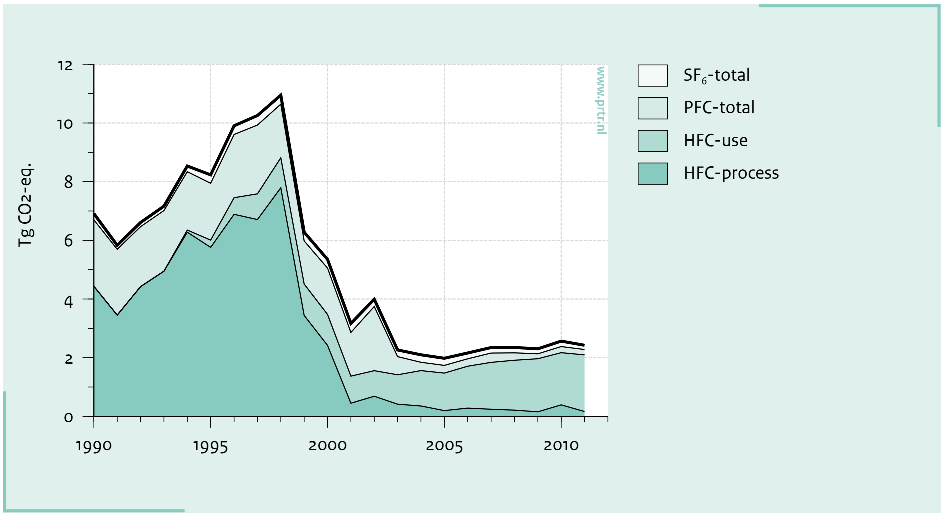
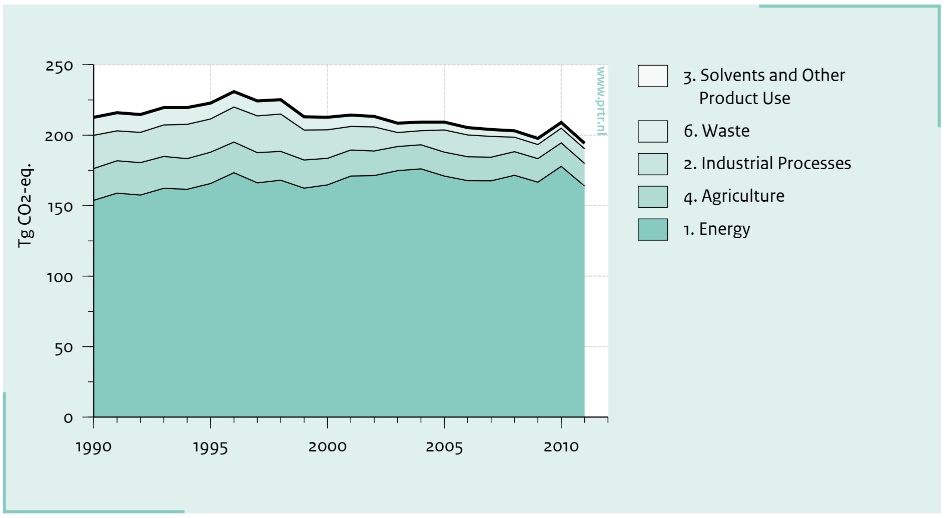


Figure 2.6 Aggregated greenhouse gases: trend and emission levels of sectors (excl. LULUCF), 1990-2011.



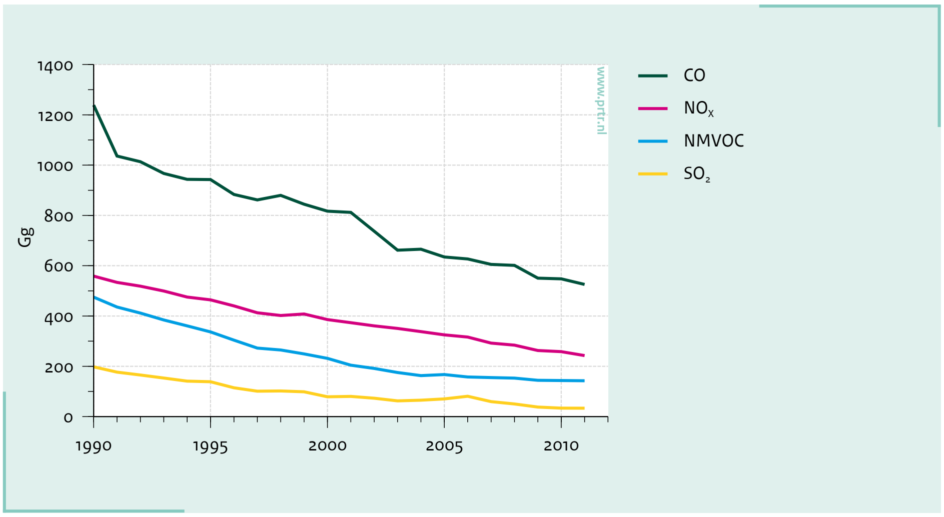
2.3 Emissions trends specified by source category

Figure 2.6 provides an overview of emissions trends per IPCC sector in Tg CO_2 equivalents.
The IPCC Energy sector is by far the largest contributor to total greenhouse gas emissions in the national inventory (contributing 71 per cent in the base year and 83 per cent in 2011; the relative share of the other sectors decreased correspondingly). The emissions level of the Energy sector increased by approximately 6.6 per cent in the period 1990–2011, and total greenhouse gas emissions from the Waste, Industrial processes and Agriculture sectors decreased by 71 per cent, 56 per cent, and 29 per cent, respectively, in 2011 compared with the base year. Compared with 2010, greenhouse gas emissions in the Energy sector decreased by about 14.0 Tg in 2011 as a result of the mild winter in 2011 compared with the cold winter in 2010. Trends in emissions by sector category are described in 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], Industrial processes [2], Solvents and product use [3], Agriculture [4] and Waste [6] are about ±2 per cent, ±11 per cent, ±27 per cent, ±38 per cent and ±28 per cent, respectively; for sector 5 (LULUCF) it is ±100 per cent. 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 ±2 per cent in the 7 per cent increase, for sector 2 (Industrial processes) at ±6 per cent in the 56 per cent decrease, for sector 4 (Agriculture) at ±11 per cent in the 29 per cent decrease and for sector 6 (Waste) at ±5 per cent in the 70 per cent decrease.

2.4 Emissions 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 with 1990, CO and NMVOC emissions in 2011 were reduced by 61 per cent and 71 per cent, respectively. For SO_2, the reduction was as much as 83 per cent; and for NO_x, 2011 emissions were 57 per cent 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 emissions levels. Due to lack of data, the time series for 1991–1994 and 1996–1999 were 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).

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

3
Energy [CRF Sector 1]

Major changes in the Energy sector compared with the National Inventory Report 2012

Emissions:	Compared with 2010 the GHG emissions in the energy sector decreased by 8% due to the economic recession and the mild winter of 2011.
Key sources:	Compared with the previous submission (NIR 2012) there is one new key source: 1A3 Mobile combustion: water-borne navigation (CO_2).
Methodologies:	In the transport category new emission factors for N_2O from road transport were implemented, leading to lower emissions compared with previous submissions.

3.1 Overview of sector

3.1.1 The Dutch energy system

Energy supply and energy demand

As in most developed countries, the energy system in The Netherlands is largely driven by the combustion of fossil fuels (Figure 3.1). In 2011, natural gas constituted about 44.2 per cent of the total primary fuels used in The Netherlands, followed by liquid fuels (38.2 per cent) and solid fossil fuels (9.6 per cent). The contribution of non-fossil fuels, including renewables and waste streams, was small.

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 industries (20.5 per cent) or lost as waste heat in cooling towers and cooling water in power plants (14.5 per cent).

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 datasets for 1990, 1995 and subsequent years, thus creating the existing inconsistency within 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 the 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 shown only 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, Industrial processes and Other (mainly for space heating). Oil products are primarily used in transport, refineries and 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 per cent at the present time. In the 1990–2011 period, total fossil fuel combustion increased by 14 per cent, due to a 10 per cent increase in gas consumption, while liquid fuel use increased by 31 per cent. At the same time, the combustion of solid fuels decreased by 14 per cent.

Total fossil fuel consumption for combustion decreased by about 9 per cent between 2010 and 2011, mainly due to a 13 per cent decrease in gas consumption.

The year 2010 had a cold winter compared with the other years. This caused an increase in the use of gaseous fuel for space heating in 2010. The year 2011 had an average winter and fuel use in 2011 is comparable to fuel use in 2009.

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 (H_2O), 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 emissions inventory, and contributes approximately 96 per cent of CO_2 emissions in the country. The contribution of the Energy sector to total greenhouse gas emissions in the country increased from 72 per cent in 1990 to 84 per cent in 2011. Over 98 per cent of the greenhouse gas emissions from this sector are in the form of CO_2 (see 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;
- 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 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 48 per cent of CO_2 emissions from fuel combustion stems from the combustion of natural gas, 17 per cent from solid fuels (coal) and 33 per cent from liquid fuels. CH_4 and N_2O emissions from fuel combustion contribute 1.8 per cent 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 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

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).

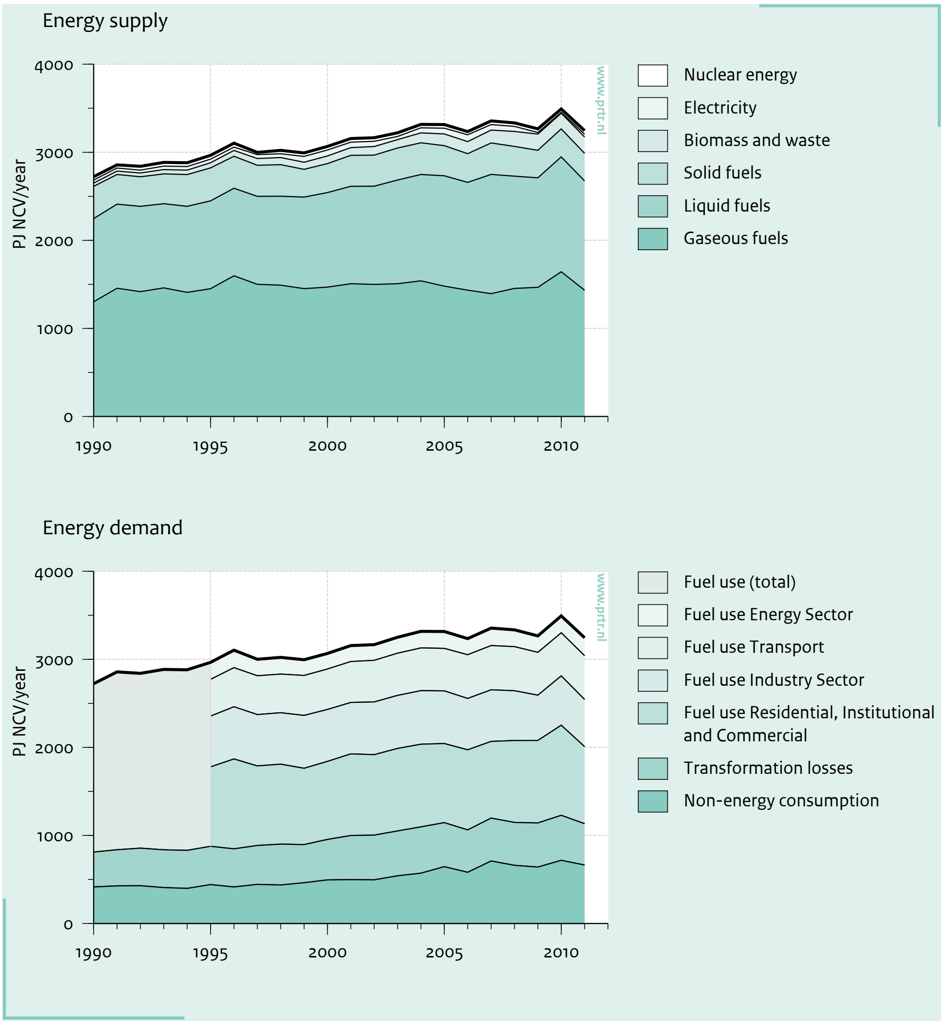


Figure 3.2 Sector 1 'Energy': trend and emission levels of source categories, 1990-2011.

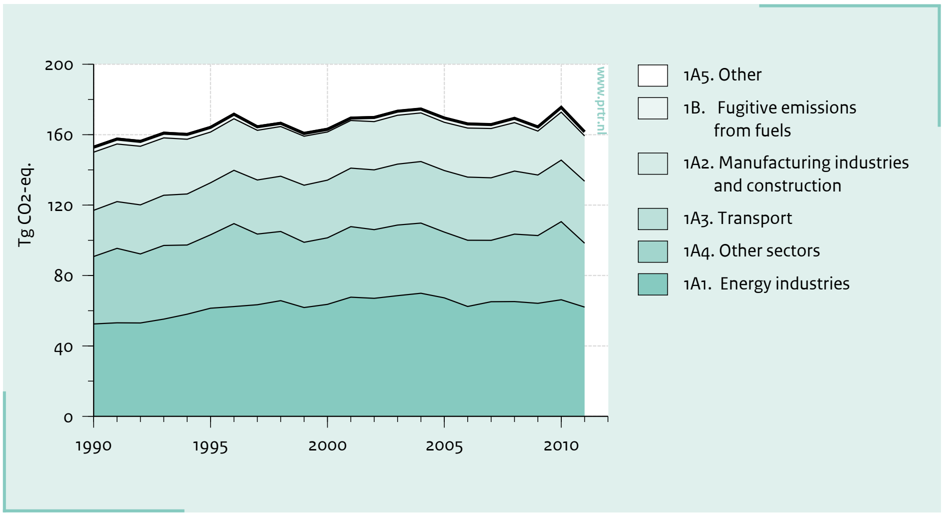


Table 3.1 Contribution of main categories and key sources in CRF sector 1 Energy.

Sector/category	Gas	Key	Emissions in Tg CO_2 eq Base year	2010	2011	Change 2010 - 2011	Contribution to total in 2011 (%) by sector	of total gas	of total CO_2 eq
1 Energy	CO_2		151.0	174.8	160.9	-13.9	98	96	83
	CH_4		2.4	2.5	2.4	-0.1	1.5	16	1.2
	N_2O		0.3	0.6	0.6	0.0	0.4	7	0.3
	All		153.8	177.9	163.9	-14.0	100		84
1A Fuel combustion	CO_2		149.9	172.8	159.3	-13.4	97	95	82
	CH_4		0.7	1.7	1.6	-0.1	1.0	11	0.8
	N_2O		0.3	0.0	0.6	0.0	0.4	7	0.3
	All		150.9	175.1	161.6	-13.6	99		83
1A Emissions from stationary combustion	CH_4	L,T	0.6	1.7	1.6	-0.1	1.0	10	0.8
1A1 Energy industries	CO_2		52.5	66.2	62.1	-4.2	38	37	32
1A1a Public electricity and heat production	CO_2		39.9	54.6	50.5	-4.0	31	30	26
1A1a liquids	CO_2	L1,T1	0.2	0.7	0.9	0.2	0.6	0.5	0.5
1A1a solids	CO_2	L	25.8	24.1	23.3	-0.8	14	14	12
1A1a gas	CO_2	L1,T1	13.3	27.3	23.7	-3.6	14	14	12
1A1a other fuels: waste incineration	CO_2	L,T	0.6	2.5	2.6	0.1	1.6	1.5	1.3
1A1b petroleum refining	CO_2		11.0	9.6	9.9	0.3	6	6	5
1A1b liquids	CO_2	L,T	10.0	6.6	6.3	-0.3	4	4	3
1A1b gases	CO_2	L1,T1	1.0	3.1	3.6	0.5	2	2	1.9
1A1c manufacture of solid fuels and other energy industries	CO_2		1.5	2.0	1.6	-0.4	1.0	1.0	0.8
1A1c gases	CO_2	L	1.5	2.0	1.6	-0.4	1.0	1.0	0.8
1A2 Manufacturing industries and construction	CO_2		33.0	27.2	25.7	-1.5	16	15	13
1A2 liquids	CO_2	L,T1	9.0	9.3	8.6	-0.7	5	5	4
1A2 solids	CO_2	L,T1	5.0	4.1	4.0	-0.1	2	2	2
1A2 gases	CO_2	L,T1	19.0	13.8	13.2	-0.7	8	8	7
1A2a iron and steel	CO_2		4.0	4.4	4.3	-0.1	3	3	2
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	13.2	12.4	-0.8	8	7	6
1A2d pulp, paper and print	CO_2		1.7	1.2	1.1	-0.1	0.7	0.7	0.6
1A2e food processing, beverages and tobacco	CO_2		4.1	3.4	3.4	-0.1	2	2	2
1A2f other	CO_2		5.8	4.8	4.4	-0.4	3	3	2

Sector/category	Gas	Key	Emissions in Tg CO_2 eq Base year	2010	2011	Change 2010 - 2011	Contribution to total in 2011 (%) by sector	of total gas	of total CO_2 eq
1A3 Transport	CO_2		26.0	34.7	34.9	0.2	21	21	18
	N2O		0.1	0.3	0.3	0.0	0.2	3	0
	All		26.3	35.0	35.2	0.2	21		18
1A3a civil aviation	CO_2		0.0	0.0	0.0	0.0	0.01	0.01	0.01
1A3b road	CO_2		25.5	33.9	34.1	0.2	21	20	18
1A3b gasoline	CO_2	L,T1	10.9	12.9	13.1	0.2	8	8	7
1A3b diesel oil	CO_2	L,T	11.8	20.1	20.2	0.0	12	12	10
1A3b LPG	CO_2	L1,T1	2.7	0.9	0.8	0.0	0.5	0.5	0.4
1A3b road	N_2O	T2	0.1	0.3	0.3	0.0	0.2	3	0.1
1A3c railways	CO_2		0.1	0.1	0.1	0.0	0.1	0.1	0.1
1A3d navigation	CO_2	L1,T1	0.4	0.6	0.7	0.0	0.4	0.4	0.3
1A4 Other sectors	CO_2		37.8	44.3	36.3	-8.1	22	22	19
	CH_4		0.5	1.5	1.4	-0.1	0.9	9	0.7
	All		38.3	45.8	37.7	-8.1	23		19
1A4 Liquids (excl. from 1A4c)	CO_2	T	1.4	0.5	0.5	-0.1	0.3	0.3	0.2
1A4a commercial/ institutional	CO_2		8.4	13.1	9.6	-3.5	6	6	5
1a4a gas	CO_2	L,T	7.6	12.9	9.4	-3.5	6	6	5
1A4b residential gas	CO_2	L,T1	19.5	20.8	16.9	-3.9	10	10	9
	CH_4		0.4	0.4	0.3	-0.1	0.2	2	0.2
1A4b gases	CO_2		18.7	20.5	16.6	-3.8	10	10	9
1A4c agriculture/ forestry/fisheries	CO_2		9.9	10.4	9.8	-0.6	6	6	5
1A4c liquids	CO_2	L,T	2.6	1.8	1.7	-0.1	1.1	1.0	0.9
1A4c gases	CO_2	L,T	7.3	8.6	8.0	-0.6	5	5	4
1A5 Other	CO_2		0.6	0.3	0.4	0.0	0.2	0.2	0.2
1B Fugitive emissions from fuels	CO_2		1.2	2.0	1.5	-0.5	0.9	0.9	0.8
	CH_4		1.7	0.7	0.8	0.0	0.5	5	0.4
	All		2.9	2.7	2.3	-0.4	1		1.2
1B1b coke production	CO_2	L2,T2	0.4	1.0	0.6	-0.3	0.4	38	0.3
1B2 Venting/flaring	CO_2	T	0.3	0.0	0.0	0.0	0.0	0.3	0.00
	CH_4	T	1.2	0.2	0.3	0.1	0.2	2.0	0.2
Total national emissions	CO_2		159.3	181.4	167.6	-13.8		100	86.2
	CH_4		25.7	15.9	15.3	-0.7		100	7.9
	N_2O		20.2	9.2	9.1	-0.1		100	4.7
National total GHG emissions (excl. CO_2 LULUCF)	All		213.4	209.2	194.4	-14.8			100

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
2011	Supply	Primary production	0	63	2419
		Total imports	653	7902	690
		Stock change	-4	141	0
		Total exports	-336	-6091	-1676
		Bunkers	0	-783	0
	Gross inland consumption	Gross inland consumption	-313	-1273	-1434
	Demand	Final non-energy consumption	-9	-580	-90

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 with the previous submission, there is one new key source:
1A3 Mobile combustion: water-borne navigation CO_2

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 by specific energy processes with fuel and, in the case of non-CO_2 greenhouse gases, source category-dependent EFs. This sectoral approach (SA) is based on fuel demand statistics. The IPCC Guidance also requires – as a quality control activity – the estimation of CO_2 emissions from fuel combustion on the basis of a national carbon balance, derived from fuel supply statistics. This is the reference approach (RA). In Annex 4, a detailed comparison of the sectoral approach and the reference approach is shown.

Energy supply balance
The energy supply balance for The Netherlands in 1990 and 2011 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; 69 per cent 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 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 gross national consumption.

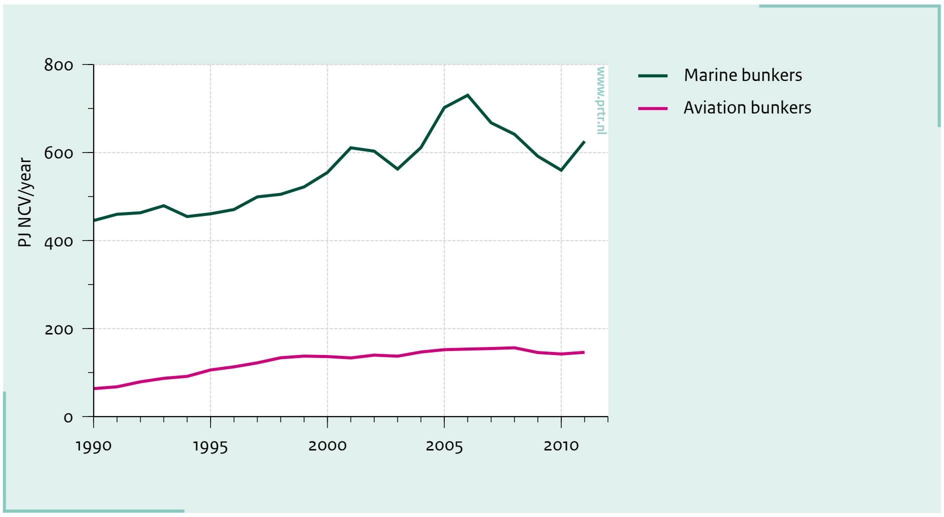
3.2.2 International bunker fuels

The Rotterdam area has four large refineries, producing large quantities of heavy fuel oils. A large proportion 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 fuel delivered to air carriers at 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 2011, 46 per cent of the gross national consumption of petroleum products was used in non-energy applications. These fuels were mainly used as feedstock (naphta) in the petro-chemical industry and in products in many applications (bitumen, lubricants, etc.). Also a fraction of the gross national consumption of

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



natural gas (6 per cent, mainly in ammonia production) and coal (3 per cent, mainly in iron and steel production) was used for non-energy applications and hence not directly oxidised. In many cases, these products are finally 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.

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

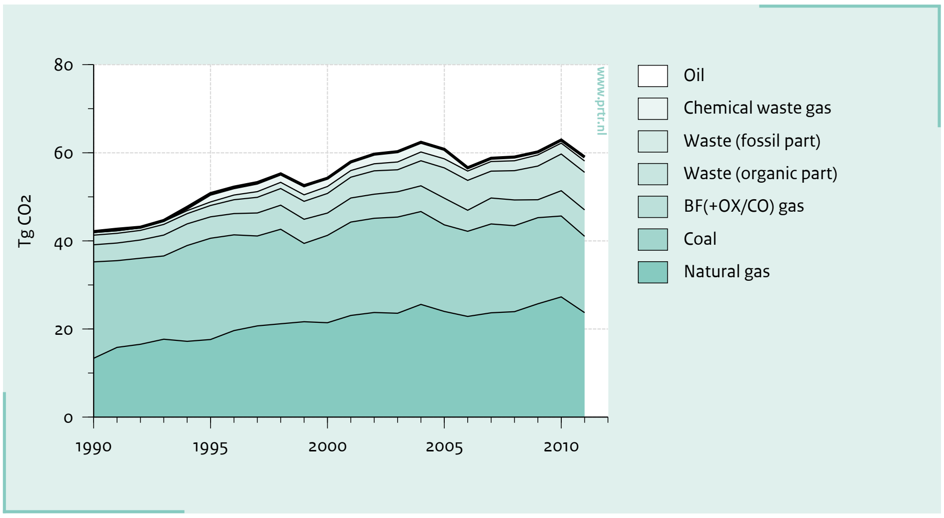
Energy industries are the main source category contributing to the Energy sector, accounting for 37.9 per cent of the greenhouse gas emissions from this sector in 2011. In this category, three source categories are included: 'public electricity and heat production' (1A1a), 'petroleum refining' (1A1b) and 'manufacture of solid fuels and other energy industries' (1A1c). Within these source categories, natural gas and coal combustion by public electricity and heat production and oil combustion by petroleum refining are the 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 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 combined heat and power (CHP) plants. N_2O emissions from Energy industries are not identified as a key source (see table 3.1).
In 2011, CO_2 emissions from category 1A1 contributed 32 per cent of the total national greenhouse gas emission inventory (excluding LULUCF), while CH_4 and N_2O emissions from this same category contributed relatively little to total national greenhouse gas emissions. The share contributed by Energy industries to total greenhouse gas emissions from the Energy sector increased from 34 per cent in 1990 to 38 per cent in 2011 (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 2011, total CO_2 emissions from Energy industries increased by 18 per cent (see figure 3.4). In 2011, CO_2 emissions from Energy Industries decreased 6.3 per cent compared with 2010.

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 proportion of gas-fired cogeneration plants, many of the latter being operated as joint ventures with industries. In comparison with 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 produce heat and/or electricity and the waste incinerated in these installations is therefore regarded as a fuel. In addition, a large proportion of the blast furnace gas and a

Figure 3.4 1A1 'Energy industries': trend and emission levels of source categories, 1990-2011.

Figure 3.5 Trend in sources of CO_2 from fuel use in power plants.



significant part of the 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 2011, 1A1a (public electricity and heat production) was the largest source category within the 1A1 Energy industries category, accounting for 81 per cent of the total greenhouse gas emissions from this category (see Figure 3.4 and Table 3.1). CO_2 emissions from waste incineration of fossil carbon represent 5 per cent of the total greenhouse gas emissions in 1A1a. In 2011, the emissions of CO_2 from the combustion of fossil fuels in this source category decreased by 7.4 per cent compared with 2010.
Between 1990 and 2011, total CO_2 emissions from Public electricity and heat production increased by 26.5 per cent. 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 2.6 Tg CO_2 in 2011 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 content) in combustible waste (see table 8.6 on the

composition of incinerated waste). The decrease in 2006 and 2008 in the IEF 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 EF is applied than for the latter.
Between 1990 and 1998, changed ownership structures 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 per cent 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 to emissions from waste incineration, which are included in this category since they all are subject to heat or electricity recovery, although this is not their main activity. Most of the combustion of biogas recovered at landfill sites is in CHP plants 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 per cent compared with 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 per cent 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 double that in 1998 (10 per cent in 1998 versus 20 per cent in 1999), and to a significant 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 per cent as a direct result of the start-up in 2004 of a large gas-fired 790 MWe cogeneration plant and a 2 per cent 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 is located at Vlissingen), which export about 50 per cent 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 per cent in 1990 and 16 per cent in 2011. However, the combustion emissions from this category should be viewed in relation to the fugitive emissions reported under category 1B2. Between 1990 and 2011 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 fuel consumption for energy 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. In the production of hydrogen, CO_2 is also produced by the chemical processes (CO_2 removal and a two-stage CO shift reaction). Refinery data specifying these fugitive CO_2 emissions are available and have been used for 2002 onwards, when they 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 EFs 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 IEF for CO_2 for total liquid fuel compared with the years prior to 2002 (the EF for refinery gas is adjusted to obtain exact correspondence between total calculated CO_2 emissions and total CO_2 emissions officially reported by the refineries). Beside 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. Therefore, it is assumed for the years up to 2002 that part of the residual refinery gases and other residual fuels are combusted (or incinerated by flaring) but not monitored/reported by the industry and are thus unaccounted for. The CO_2 emissions from this varying fuel consumption are included in the fuel type ‘liquids’. This represents approximately 10 per cent (5–20 per cent) 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 per cent and 55 per cent) of refinery gas in total liquid fuel, which has a low default EF compared with most other oil products and has variable EFs for the years 2002 onward, and by the variable addition of ‘unaccounted for’ liquids, which is used only 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 EFs are, therefore, effect the calculated carbon content of the combusted refinery gas and thus in the IEF 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 that are flared, vented or lost by leakage);
- Fuel combustion for space heating and use in compressors for gas and oil pipeline transmission by gas, oil and electricity transport and distribution companies.

The share of 1A1c (manufacture of solid fuels (coke) and other energy industries; fuel production) in total greenhouse gas emissions from the category 1A1 (Energy industries) is approximately 3 per cent in 1990 and 3 per cent in 2011. This category comprises mostly CO_2 emissions from the combustion of natural gas. The dominating source is 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 that are flared, vented or 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 1.6 Tg CO_2 in 2011, 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 EFs 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 EFs (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 are based on confidential data from individual companies. When necessary, emission data from individual companies are also used; for example, when companies report a different EF for derived gases (see the following section).
For CO_2 and N_2O, IPCC default EFs 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 EFs are used. When available, company-specific or sector-specific EFs have been used, in particular for derived gases such as refinery gas, chemical waste gas and blast furnace gas. If companies report different EFs for derived gases, it is possible to deviate from the standard EF for estimating the emissions for these companies. The CH_4 emission factors are taken from Scheffer and Jonker, 1997. An overview of the EFs used for the most important fuels (up to 95 per cent of the fuel use) in the category 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 IEFs.

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 is other energy industries natural gas directly extracted from the wells used for combustion. For this unprocessed gas a higher EF is used, which explains the higher EF for this category.
- The CO_2 and N_2O emission factors for natural gas deviate from the standard EFs (56.6 kg CO_2/GJ and 0.1 g N_2O/GJ), because this category includes emissions from the

Table 3.3 Overview of emission factors used in 2011 in the category Energy Industries [1A1].

Fuel	Amount of fuel used in 2011 (TJ NCV)	Implied Emission factors (g/GJ)		
		CO_2 (x 1000)	N_2O	CH_4
Natural gas	514,288	56.2	0.14	6.74
Coal	182,087	95.2	1.40	0.44
Waste Gas	94,991	65.7	0.10	3.59
Waste, biomass	37,061	128.5	5.84	0.00
Solid biomass	31,473	109.6	4.00	30.00
Waste, fossil	31,934	80.5	4.33	0.00
Other	38,165	NA	NA	NA

combustion of crude gas ('own' fuel use by the oil and gas production industry for heating purposes), which has a different EF.

- The CO_2 emissions from waste gas are CO_2 emissions occurring in the chemical industry and in refineries. The emissions are partly based on emissions 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 the 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 an SNCR, which have EFs of 9.43 g/GJ and 1.89 g/GJ, respectively. The EF 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 code 'NO' (as the CRF cannot handle 0 (zero) values). The EF of CO_2 is depending on the carbon content of the waste, which is determined annually.

More details on EFs, methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie, Protocol 13-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels and Protocol 13-038: 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 per cent (see section 1.7 for details). The accuracy of fuel consumption data in power generation and oil refineries is generally considered to be very high, with an estimated uncertainty of approximately 0.5 per cent. 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 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 (1 per cent and 10 per cent, 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 applies 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 per cent is assigned. For other fuels, a 10 per cent 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 per cent 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 EF 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 per cent. However, in 1990 and 1998 the EF varies ±0.9 CO_2/GJ (see table 4.1 in Van Harmelen and Koch, 2002); consequently, when the default EF is applied to other years, the uncertainty is apparently larger, about 1 per cent. Analysis of the default CO_2 emission factors for coke oven gas and blast furnace gas reveals uncertainties of about 10 per cent and 15 per cent, 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 per cent, the overall uncertainty in the CO_2 emission factor of solids in power generation is estimated

to be about 3 per cent. 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 per cent 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 per cent and 2 per cent, respectively, are assumed, 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 per cent is assumed, which reflects the limited accuracy of the waste composition and of the carbon fraction per waste stream. The uncertainty in the EFs of CH_4 and N_2O from stationary combustion is estimated at about 50 per cent, which is an aggregate for the various subcategories (Olivier et al., 2009).

Source-specific QA/QC and verification

The trends in fuel combustion in 'public electricity and heat production' (1A1a) are compared with 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 with 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 2012, a quantitative assessment was made of the possible inconsistencies in CO_2 emissions between data from ETS, NIR and national energy statistics. The figures that were analysed concerned about 40 per cent of the CO_2 emissions in The Netherlands in 2011. The differences could reasonably be explained (e.g. different scope) and are reported for earlier years in De Ligt (2012).

More details on the validation of energy data are to be found in the monitoring protocol 13-002: 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 category (1A1).

Source-specific planned improvements

Data on fuel use and emissions for the 1.AA.1.C are retrieved from sector data. Based on the current EFs, it is concluded that the quality is not up to standard and action will be taken to improve data quality and consistency in the next NIR.

3.2.7 Manufacturing industries and construction [1A2]

Source category description

This source category consists of the six categories: 'iron and steel' (1A2a), 'non-ferrous metals' (1A2b), 'chemicals' (1A2c), 'pulp, paper and print' (1A2d), 'food processing, beverages and tobacco' (1A2e) and 'other' (1A2f). 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 not key sources. Natural gas is mostly used in the chemical, food and drinks and other industries; solid fuels (i.e. coal- and coke-derived fuels, such as blast furnace/oxygen furnace gas) are mostly used in the iron and steel industry (1A2a); liquid fuels are mostly used in the chemicals industry (1A2c) and in other industries (1A2f) (see table 3.4).

Another feature of industry in The Netherlands is that it operates a large number of CHP facilities (and also some steam boilers). Several of these facilities have changed ownership over time and are now operated as joint ventures 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 103.7 PJ and natural gas use is 89.1 PJ in 2011. A second important industry is included in 1A2f (other industries) and includes emissions from mineral products (cement, bricks, glass and other building materials), textiles, wood, wood products and the construction industry. Solid fuels (31.1 PJ in 2011) are almost exclusively used in 1A2a (iron and steel). In this industry, a small amount of natural gas is also used. All other industries are almost completely run on natural gas.

In 2011, the share of CO_2 emissions from 1A2 (Manufacturing industries and construction) in the total national greenhouse gas emissions inventory is 13 per cent compared with 15 per cent 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 per cent of the total emissions from manufacturing industry in 2011.

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**	**2011**
Gaseous fuels						
Iron and Steel	11.7	13.0	13.7	12.5	12.0	11.9
Non-Ferrous Metals	3.8	4.3	4.2	4.0	3.6	3.3
Chemicals	166.8	134.8	115.7	99.7	92.7	89.1
Pulp, Paper and Print	30.2	24.4	27.4	29.7	21.0	19.6
Food Processing, Beverages and Tobacco	63.7	68.3	73.7	67.1	59.0	58.6
Other	58.6	63.0	66.8	59.9	55.9	50.3
Liquid fuels						
Iron and Steel	0.3	0.3	0.2	0.2	0.2	0.1
Non-Ferrous Metals	0.0	0.0	0.3	0.0	NO	NO
Chemicals	116.2	82.0	81.7	92.7	112.9	103.7
Pulp, Paper and Print	0.3	0.1	0.1	0.0	0.0	0.0
Food Processing, Beverages and Tobacco	3.1	1.6	0.7	0.7	0.2	0.2
Other	27.7	25.4	25.0	22.1	19.4	18.2
Solid fuels						
Iron and Steel	29.8	35.0	25.2	29.0	27.8	27.4
Non-Ferrous Metals	0.0	NO	NO	NO	NO	NO
Chemicals	12.8	0.2	2.1	1.7	1.2	1.3
Pulp, Paper and Print	0.1	NO	NO	NO	NO	NO
Food Processing, Beverages and Tobacco	2.4	1.3	1.1	0.6	1.0	0.8
Other	3.7	2.2	2.4	1.6	1.7	1.6

In the period 1990–2011, CO_2 emissions from combustion in 1A2 (Manufacturing industries and construction) decreased by 22 per cent (see Figure 3.6). The chemical industry contributed the most to the decrease in emissions in this source category, with its contribution to CO_2 emissions decreasing by 4.7 Tg. Total CO_2 emissions from 1A2 in 2011 decreased 5.4 per cent compared with 2010. This was caused by the economic crisis.

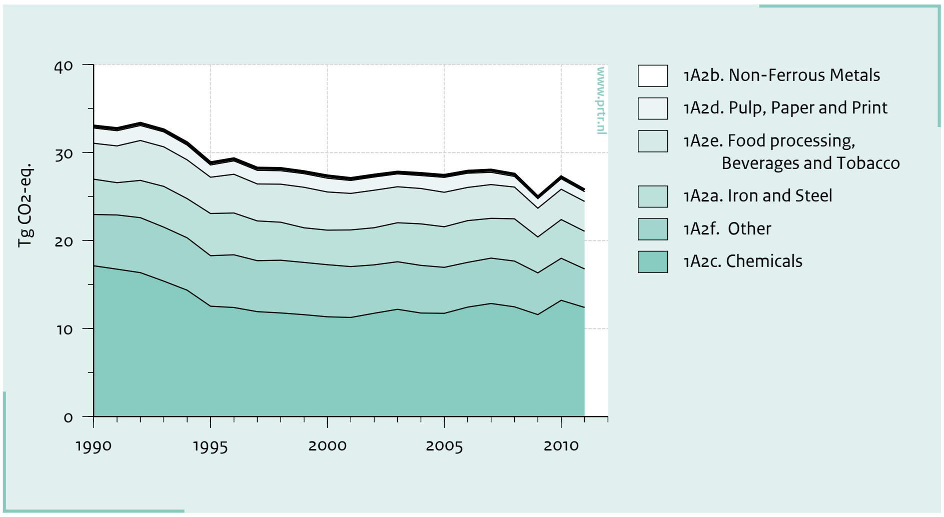
The derivation of these figures, however, should also be viewed in the context of industrial process emissions of CO_2, since the separation of the source categories is not always fixed. Most industry process emissions of CO_2 (soda ash, ammonia, carbon electrodes and industrial gases such as hydrogen and carbon monoxide) are reported in CRF sector 2 (Industrial processes). 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 category 1A2 and not as an industrial process in sector 2.

Iron and steel [1A2a]

This category refers mainly to the integrated steel plant Tata Steel, which produces approximately 6,000 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 emissions from fuel combustion for on-site coke production as well as emissions from the combustion of blast furnace gas and oxygen furnace gas in the steel industry. It also includes emissions from electric arc furnaces at another (small) plant.

The emissions calculation of this category 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 per cent in 1990 and 17 per cent in 2011.
Interannual variations in CO_2 emissions from fuel combustion in the iron and steel industry can be explained as being mainly due to the varying amounts of solid fuels

Figure 3.6 1A2 'Manufacturing Industries and Construction': trend and emission levels of source categories, 1990-2011.



used in this sector. In 2011 CO_2 emissions from solid fuel combustion in the iron and steel industry decreased slightly (0.1 Tg).
The 14 per cent decrease in solid fuel use in 1999 and the 10 per cent decrease in associated CO_2 emissions corresponds with an 8 per cent 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 fairly constant in the period 1990–2011, even though production has increased by about 30 per cent. 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 EFs, respectively, than hard coal and coke. The low IEFs in 1990–1994 compared with later years are due to the higher share of coke oven gas in the solid fuel mix in those years due to coke oven 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 (Metal production). This small source category contributes only 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 EF) and partly due to the small amounts used.

Chemicals [1A2c]

The share of 1A2c (chemicals) in the total CO_2 emissions from 1A2 (Manufacturing industries and construction) decreased from 52 per cent in 1990 to 48 per cent in 2011. The combustion of natural gas and liquid fuels accounts for 41 per cent respectively 58 per cent in the CO_2 emissions from the chemical industry. CO_2 emissions from this source category have decreased by approximately 28 per cent since 1990, which is mainly due to the 34 per cent 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 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 per cent decrease in solid fuel combustion in 1994 and the 28 per cent decrease in liquid fuel combustion in 1995. In these years, the then-existing coal-fired and oil-fired cogeneration plants 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 (Chemical industry) and the re-allocation of CO_2 emissions to the energy industry, the total CO_2 emission level from the chemical industry was fairly constant in the period 1990–2011. 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 a change in its composition. For CO_2 from waste gas from liquid and solid fuels, source-specific EFs 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 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 four largest companies and the amounts used per company in 1990. For CO_2 from phosphorous furnace gas, plant-specific values were 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 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 per cent in 1990 and about 4 per cent in 2011. In line with the decreased consumption of natural gas, CO_2 emissions have decreased by approximately 36 per cent since 1990, of which a substantial fraction is used for cogeneration. The relatively low CO_2 emissions in 1995 can be explained by the 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) in the CO_2 emissions from 1A2 (Manufacturing industries and construction) was 12 per cent in 1990 and 13 per cent in 2011. CO_2 emissions decreased by almost 17 per cent in the period 1990–2011. This is due to a decrease since 2003 of joint ventures of cogeneration plants located in the pulp and paper industry, whose emissions were formerly allocated to 1A2e but are now reported under 'public electricity and heat production' (1A1a).
In 2011, CO_2 emissions from gaseous fuel combustion in this source category decreased by about 1.5 per cent compared with 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, glass and other building materials), textiles, wood and wood products. Also included are emissions from the construction industry, from off-road vehicles (mobile machinery) used for building construction and for the construction of roads and waterways, and from other off-road sources except agriculture (liquid fuels). The last 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 per cent in 1990 and 17 per cent in 2011. Most of the 4.4 Tg CO_2 emissions from this source category in 2011 stem from gas combustion (2.8 Tg), while the remaining CO_2 emissions are mainly associated with the combustion of biomass (1 Tg CO_2) and the combustion of liquid fuels (1.4 Tg CO_2), of which off-road machinery accounts for 1.2 Tg CO_2. CO_2 emissions from this source category have decreased by 25 per cent since 1990. In 2011, total CO_2 emissions from the other manufacturing industries decreased by 8.5 per cent compared with 2010.

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 from fuel combustion in 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 EFs 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 EFs are used. When available, company-specific or sector-specific EFs have been used, in particular for derived gases such as chemical waste gas, blast furnace

Table 3.5 Overview of emission factors used (in 2011) in the sector Manufacturing Industries and Construction [1A2].

Fuel	Amount of fuel used in 2011 (TJ NCV)	Amount of fuel used (PJ NCV)		
		CO_2 (x 1000)	N_2O	CH_4
Natural gas	232,905	56.5	0.10	6.99
Chemical Waste Gas	100,115	69.2	0.10	3.60
Gas/Diesel oil	17,576	74.3	0.60	4.91
Coke Oven Gas	14,784	42.4	0.10	2.80
Blast Furnace Gas	12,309	237.9	0.10	0.35
Other	19,104	NA	NA	NA

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 EFs used for the most important fuels (up to 95 per cent of the fuel use) in the Manufacturing industries and construction category (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.

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 plants is a higher EF used, which explains the higher EF for this sector.
- CO_2 emissions from coke oven gas, blast furnace gas and waste gas are based on emission data from the NEa. Therefore, the IEF is different from the standard country-specific EF.
- 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 EF methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see www.nlagency.nl/nie).
In the iron and steel industry, a substantial proportion 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 the emissions from Tata Steel, this category includes the combustion emissions of a small electric steel producer and – for the period 1990–1994 – those of one small independent coke production facility whose 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 (a by-product of 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. Their 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 category 1A2f are the least accurate.
Details of the method for this source category are described in Protocol 13-002: 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 2 per cent (see section 1.7 for details). The accuracy of fuel consumption data in the manufacturing industries is generally considered to be quite high, about 2 per cent, 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 per cent, based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier et al. (2009). The 5 per cent uncertainty estimate in the CO_2 emission factor for liquids is based on an uncertainty of 10 per cent in the EF for chemical waste gas in order to account for the quite variable composition of the gas and its more than 50 per cent share in the total liquid fuel use in the sector. An uncertainty of 10 per cent is assigned to solids, which

reflects the uncertainty in the carbon content of blast furnace gas/oxygen furnace gas based on the standard deviation in a three-year average. BF/OX gas accounts for the majority of solid fuel use in this category.

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 with trends in the associated activity data: crude steel and aluminium production, indices of food production, pulp and paper production and cement and brick 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 with 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
13-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels.

Source-specific recalculations

No recalculations took place during the preparation of this submission.

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' includes only emissions from domestic civil aviation, i.e. civil aviation with departure and arrival in The Netherlands. Similarly, the source category 'water-borne navigation' includes only 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; 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), while 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) was responsible for 18 per cent of total greenhouse gas emissions in The Netherlands in 2011. Between 1990 and 2011, greenhouse gas emissions from transport increased by 34 per cent to 35.2 Tg CO_2 eq. This increase was mainly caused by an increase in fuel consumption and corresponding CO_2 emissions from road 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 97 per cent of total emissions over the time series.

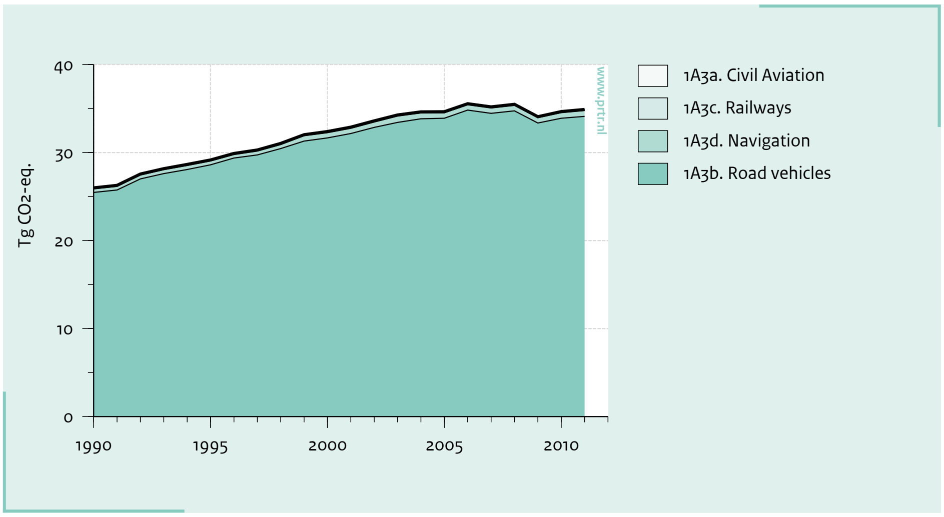
Greenhouse gas emissions from transport increased by approximately 1.8 per cent per year between 1990 and 2006. Between 2006 and 2008 emissions stabilized due to an increase in the use of biofuels in road transport. CO_2 emissions from the use of biofuels are reported separately in the inventory and are not part of the national totals. Greenhouse gas emissions decreased in 2009, mainly due to the economic crisis and the resulting decrease in freight transport volumes. In 2010 and 2011 emissions increased slightly. This was caused by a decrease in the use of biofuels in 2010 and an increase in road transport in 2011.

Civil aviation [1A3a]

The share of 1A3a (civil aviation) in total greenhouse gas emissions in The Netherlands was less than 0.1 per cent in both 1990 and 2011. The reported use of jet kerosene and resulting greenhouse gas emissions by domestic civil aviation in The Netherlands is based on a rough estimate of fuel consumption in 2000, which is applied to the whole time series. Therefore, emissions remain constant over the time series.

In last year's submission, the figures for greenhouse gas emissions resulting from the use of aviation gasoline for

Figure 3.7 1A3 'Transport': trend and emission levels of source categories, 1990-2011.



domestic civil aviation were also based on a rough estimate of fuel consumption in the year 2000. In this year's submission, though, the use of aviation gasoline for domestic civil aviation is derived from Statistics Netherlands (CBS). This is described in more detail in the source-specific recalculations.

The use of aviation gasoline for domestic civil aviation is limited in The Netherlands. Total fuel consumption decreased from 0.16 PJ in 1990 to 0.08 PJ in 2011. Greenhouse gas emissions decreased accordingly during this time.

Road transportation [1A3b]

The contribution of 1A3b (road transportation) to total national greenhouse gas emissions was 12 per cent in 1990 and 17.6 per cent in 2011. Between 1990 and 2011, greenhouse gas emissions from road transport increased from 25.7 to 34.4 Tg CO_2 equivalents. This increase was mainly caused by a large increase in diesel fuel consumption. Between 1990 and 2011, diesel fuel consumption by road transport increased by 112 PJ (71 per cent). This increase was in turn caused by a large growth in freight transportation and the growing number of diesel passenger cars and light duty trucks in the Dutch car fleet. As a consequence, the share of diesel in fuel sales for road transportation (PJ) increased from 45 per cent to 57 per cent between 1990 and 2011, as is shown in Figure 3.8. The share of LPG decreased significantly, while the share of gasoline 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 2011 it was estimated to be 560 TJ. In last year's submission, natural gas use in road transportation was partially reported elsewhere in the inventory. In the current inventory, the estimated use of natural gas in road transport is completely reported under source category 1A3b, as is described the source-specific recalculations.

In 2011, CO_2 emissions from road transport increased by 0.6 per cent (0.2 Tg) compared with 2010, primarily because of a 1.6 per cent (3 PJ) increase in the use of gasoline by road transport. The resulting increase in greenhouse gas emissions was partially compensated by an increase in the use of biofuels in road transport: in 2011 the share of biofuels in total energy use by road transport increased to 2.8 per cent from 2.0 per cent in 2010.

CH_4 emissions from road transport fell from 7.5 Gg in 1990 to 2.1 Gg in 2011, which translates to a decrease of about 72 per cent. Between 2010 and 2011, CH_4 emissions from road transport decreased by approximately 1 per cent (0.02 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 86 per cent between 1990 and 2011, primarily due to the penetration of catalyst- and canister-equipped vehicles in the passenger car fleet. Since the share of CH_4 in total VOC emissions is assumed constant, the decrease in total VOC emissions throughout the time series also results in a decrease in CH_4 emissions. The share of CH_4 in total greenhouse gas emissions by road transport (in CO_2 eq) is very small (0.1 per cent in 2011).
N_2O emissions from road transport increased from 0.3 Gg

in 1990 to 0.9 Gg N_2O in 1997, but have since stabilized at approximately 0.8 to 0.9 Gg. The increase in N_2O emissions up to 1997 can be explained by the increased penetration of petrol cars equipped with a three-way catalyst (TWC) in the Dutch passenger car fleet, as these emit more N_2O than petrol cars without a TWC. The subsequent stabilization of N_2O emissions between 1997 and 2011, despite an increase in vehicle-kilometres in this period, can be explained by a mixture of developments:

- Subsequent generations of TWCs (the second was introduced in 1996) appear to have lower N_2O emissions (Gense and Vermeulen, 2002), causing N_2O emissions from gasoline passenger cars to decrease again after 1997.
- Recent generations of heavy duty diesel trucks, equipped with selective catalytic reduction (SCR) catalysts designed to decrease NO_x emissions, emit more N_2O per vehicle kilometre than older trucks. This has led to an increase in N_2O emissions from heavy duty vehicles, which more or less offsets the decrease in N_2O emissions from petrol-powered passenger cars.

Between 2010 and 2011, 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 small in 2011 (0.8 per cent).

Railways [1A3c]

Between 1990 and 1994, diesel fuel consumption by 1A3c (railways) was approximately 1.2 PJ. Since then, fuel consumption has fluctuated around 1.4 PJ. In 2011, diesel fuel consumption decreased by 4 per cent (0.06 PJ) to 1.37 PJ compared with 2010. Freight transport by rail actually increased in 2011 in The Netherlands (+8 per cent), but due to the increased electrification of rail freight transport this increase in transport volumes did not lead to increased diesel fuel consumption.

The share of 1A3c (railways) in total greenhouse gas emissions from the transport sector is small throughout the entire time series (0.3 per cent).

Water-borne navigation [1A3d]

Total greenhouse gas emissions from domestic water-borne navigation (1A3d) increased from 0.4 Tg CO_2 equivalent in 1990 to 0.7 Tg in 2011. This increase was caused by an increase in freight transport by inland shipping. In 2011, diesel fuel consumption and resulting greenhouse gas emissions increased by 6 per cent compared with 2010, as a result of an increase in transport volumes. After a large decrease in transport volumes in 2009 due to the economic crisis, transport volumes, diesel fuel consumption and resulting greenhouse gas emissions increased again in 2010 and 2011.
The share of domestic water-borne navigation in total greenhouse gas emissions from the transport sector varies between 1.5 and 2 per cent in the time series.

Key sources

CO_2 emissions from gasoline, diesel and LPG use in road transport are assessed separately in the key source analysis. CO_2 emissions from all three fuel types are key sources in the Tier 1 level and the trend assessment. CO_2 emissions from gasoline and diesel use in road transport are also key sources in the Tier 2 level assessment and diesel is a key source in the Tier 2 trend assessment as well. N_2O emissions from road transport are a key source in the Tier 2 trend assessment. N_2O emissions from road transport are rather uncertain due to a lack of recent measurement data, as is described in the uncertainties paragraph below. CH_4 emissions from road transport are not a key source in the inventory.

CO_2 emissions from domestic water-borne navigation are a key source in the Tier 1 level and trend assessment. CO_2 emissions from civil aviation and railways are not a key source. The same holds for the combined N_2O and CH_4 emissions from water-borne navigation, railways and civil aviation.

Methodological issues

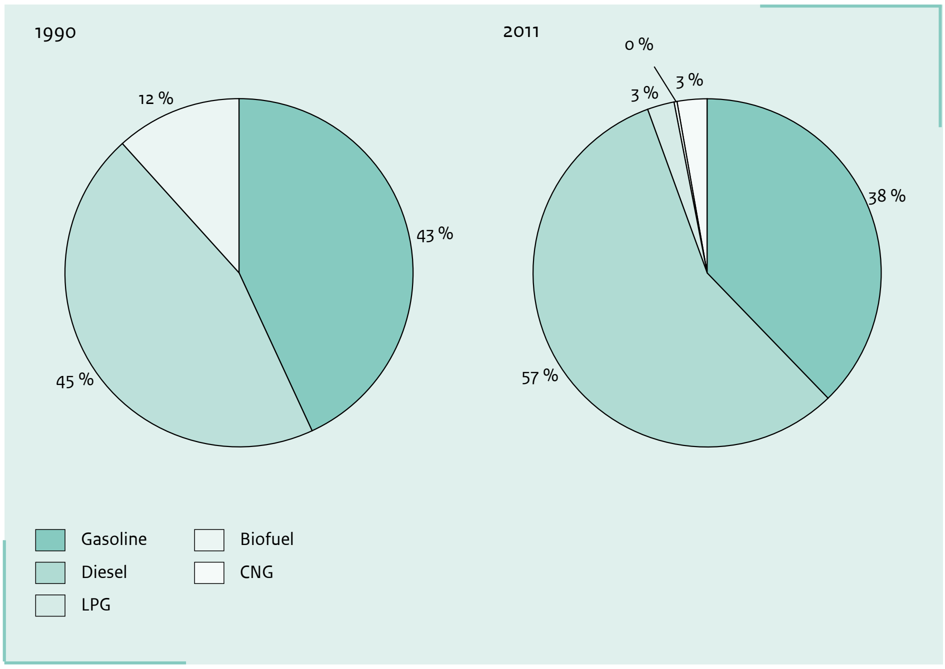
A detailed description of the methodologies and data sources used to calculate transport emissions is provided in Klein et al. (2013) and in the monitoring protocols that can be found at www.nlagency.nl/nie and are listed in section 3.1.

Civil aviation [1A3a]

An IPCC Tier 2 methodology is used for calculating the greenhouse gas emissions of domestic civil aviation. Fuel consumption of jet kerosene by domestic aviation has been roughly estimated based on the 2000 consumption figures for domestic flights in The Netherlands reported by the Civil Aviation Authority Netherlands (Pulles, 2000). Consumption of aviation gasoline as reported in the current inventory is derived from Statistics Netherlands (CBS). Until last year's inventory, the reported use of aviation gasoline for civil aviation was also based on a rough estimate for the year 2000. The new figures are described in more detail in the source-specific recalculations.

The EFs used to calculate CO_2 emissions from kerosene and aviation gasoline are derived from Vreuls and Zijlema (2012). Default IPCC EFs for kerosene and aviation gasoline 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 during landing and

Figure 3.8 Shares of petrol (gasoline), diesel and LPG in fuel sales to 'Road Transport' 1990 and 2011.



take-off (LTO) cycles at Schiphol Airport. The great majority of aircraft activities (>90 per cent) 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 2 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 EFs, as reported in Klein et al. (2013) and in Vreuls and Zijlema (2012). See Annex 2 for details. The country-specific CO_2 emission factors for road transport fuels are derived from analysis of 50 fuel samples taken in 2004 in The Netherlands (Olivier, 2004). The country-specific EFs are slightly higher than the default IPCC EFs as proposed in the 1996 and 2006 IPCC Guidelines but are within the uncertainty range. In a recent report, TNO investigated the need for an update of the measurement programme (Dröge and Coenen, 2011). In the study, TNO recommends using the current country-specific EFs for the entire Kyoto commitment period; therefore, no new measurement programme is currently foreseen.

An IPCC Tier 3 methodology is used for calculating CH_4 emissions from road transport, using fuel sales data from Statistics Netherlands (CBS) 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 derived from Statistics Netherlands (CBS), and VOC emission factors obtained from The Netherlands Organisation for Applied Scientific Research (TNO), as reported in Klein et al. (2013). The calculation methodology for total VOC emissions distinguishes several vehicle characteristics, such as vehicle type, age, fuel type and weight. In addition, the methodology 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 EFs are consequently combined with the fuel sales data from Statistics Netherlands (CBS) 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 EFs for passenger cars and light-duty vehicles using petrol or LPG are partially based on country-specific data (Gense and Vermeulen, 2002). For recent generations of road vehicles, default IPCC EFs are used. A research project conducted by TNO in 2012 showed that recent measurement data for N_2O are scarce; therefore, it is recommended to use defaults instead (Kuiper and Hensema, 2012). This is described in more detail in the source-specific recalculations.

Emissions of all other compounds, including ozone precursors and SO_2, which more directly affect air quality, are calculated bottom-up using data on vehicle-kilometres driven.

Emissions resulting from the use of biodiesels in road transport and ethanol in gasoline are reported separately in the CRF. The emission calculation for biofuels is comparable to that for fossil fuels and is based on sales data of biodiesel and ethanol, as reported by Statistics Netherlands (CBS). Emissions of CH_4 and N_2O from biodiesel and ethanol are calculated using the same EFs as for fossil diesel and gasoline, respectively.

Railways [1A3c]

CO_2 emissions from railways are estimated using an IPCC Tier 2 methodology, based on national fuel sales data and country-specific CO_2 emission factors (Olivier, 2004); see Annex 2 for details. Due to a lack of country-specific CH_4 and N_2O emission factors for railways, CH_4 and N_2O emissions from railways are estimated using a Tier 1 methodology, using IPCC default EFs. Emissions from railways are not a key source in the inventory.

Fuel sales to railways in The Netherlands are reported by Statistics Netherlands (CBS) in the national Energy Balance. Since 2010, these fuel sales data have been derived from Vivens, a recently founded co-operation of rail transport companies that purchases diesel fuel for the railway sector in The Netherlands. Before 2010, diesel fuel sales to the railway sector were obtained from Dutch Railways (NS). NS used to be responsible for the purchases of diesel fuel for the entire railway sector in The Netherlands. In this year's submission, the time series for fuel sales to the railways sector was corrected for the 2006–2009 period, as is described in detail in the source-specific recalculations.

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 on the basis of fuel deliveries to water-borne navigation in The Netherlands and country-specific EFs (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) distinguishes between traffic on the Rhine 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 navigation 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 using the EMS is therefore subtracted from total fuel sales to navigation in order to arrive at 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 ±2 per cent for petrol and diesel and ±5 per cent for LPG. These estimates are derived from Statistics Netherlands (CBS). The uncertainty in the CO_2 emission factors for petrol, diesel and LPG is estimated to be ±2 per cent. For petrol and diesel fuel, the uncertainty in the CO_2 emission factors was previously calculated to be ±0.2 per cent and ±0.4 per cent, 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 per cent 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 ±3 per cent.

The uncertainty in CH_4 emissions from road transport is estimated to be ±50 per cent in annual emissions. The uncertainty in the total VOC emissions of road transport is roughly estimated to be ±30 per cent. The uncertainty in the share of CH_4 in VOC emissions is estimated by Ten Broeke and Hulskotte (2009) to be ±40 per cent for petrol and ±25 per cent 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 total CH_4 emissions from road transport is estimated to be ±70 per cent.
The uncertainty in annual N_2O emissions from road transport is also estimated to be ±70 per cent. Recent measurements of N_2O are scarce; therefore, the current N_2O emission factors are relatively uncertain (±50 per cent).

The uncertainty in fuel used by domestic civil aviation is estimated to be about ±50 per cent for jet kerosene and -10 per cent/+50 per cent for aviation gasoline. Uncertainty for jet kerosene is high due to the lack of recent data on fuel sales specifically for domestic flights. Uncertainty for aviation gasoline is smaller because fuel deliveries are monitored by Statistics Netherlands (CBS). The uncertainty in EFs for jet kerosene is estimated to be ±4 per cent for CO_2, -70 per cent/+150 per cent for N_2O and -60 per cent/+100 per cent for CH_4. The uncertainty in EFs for aviation gasoline is estimated to be ±4 per cent for CO_2, -50 per cent/+100 per cent for N_2O and -99 per cent/+50 per cent for CH_4. The uncertainty estimates are derived from the uncertainty ranges in the 2006 IPCC Guidelines.

The uncertainty in fuel used by rail transport is estimated to be ±5 per cent, whereas the uncertainty in fuel used by domestic water-borne navigation is estimated to be approximately ±20 per cent. Uncertainty in fuel used by rail transport is smaller because fuel sales are reported to Statistics Netherlands (CBS), whereas fuel used by domestic inland navigation is calculated on the basis of transport volumes. The uncertainty in EFs for both rail transport and inland navigation is estimated to be ±2 per cent for CO_2 (in line with the uncertainty in the CO_2 emission factor for road transport diesel) and -70 per cent/+100 per cent for CH_4 and N_2O.

Source-specific QA/QC and verification

The CO_2 emissions from 1A3b (road transportation) are calculated on the basis of fuel sales data. To check the quality of the emissions totals, CO_2 emissions from road transportation are also calculated using a bottom-up approach based on vehicle-kilometres travelled and different fuel consumptions per vehicle-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 in road transport shows good agreement with the petrol sales data from Statistics Netherlands (CBS): differences between both figures vary between ±3 per cent for most of the time series and both time series show similar trends.

The time series for diesel shows larger differences, though, with diesel fuel sales figures being higher than the bottom-up calculated diesel fuel consumption. Differences vary between 13 and 26 per cent, with the difference growing larger in more recent years. The difference between the two 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 be consumed abroad and therefore is not included in the bottom-up calculated diesel fuel consumption. The differences can also 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 2011, fuel sales data for LPG are on average approximately 30 per cent 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 (e.g. 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 (CBS). Currently, a research project is being carried out by TNO and Statistics Netherlands to improve the bottom-up calculation of fuel consumption and resulting 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 by road transport in The Netherlands.

To validate energy use by railways and water-borne navigation, trends are compared with trends in traffic volumes. Trends in energy use by water-borne navigation show rather good agreement with trends in transport volumes. For railways, agreement between energy use and transport volumes is less good. This can be explained by the electrification of rail freight transport. 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 per cent of all locomotives used in The Netherlands were electric, whereas in 2011 the share of electric locomotives increased to over 40 per cent. Therefore, diesel fuel consumption has not increased as much as transport volumes.

Source-specific recalculations

N_2O emission factors for road transport

During the in-country review of the 2011 inventory the ERT noted that the country-specific N_2O emission factors for road transport had not been updated recently. Therefore in 2012 a study was commissioned to update the N_2O emission factors based on recent insights from measurements and literature. In the study, TNO concluded that measurement data for N_2O from road vehicles are scarce. For recent vehicle technologies, no country-specific data are available. Therefore TNO recommends to use IPCC default EFs for new vehicle types. For older vehicle types, country-specific N_2O emission factors are recommended, derived from in-country measurements as reported by Gense and Vermeulen (2002) and Riemersma et al. (2003).

When applying the new N_2O emission factors in the inventory, it was concluded that the results from the in-country measurements for passenger cars had previously been misinterpreted in the inventory. As a consequence, N_2O emissions from passenger cars have been overestimated in previous inventories. In 2001, TNO performed a detailed measurement programme on passenger cars in The Netherlands (Feijen-Jeurissen et al., 2001). The resulting N_2O emission factors, derived from the standardised European Driving Cycle used for type approval testing, were used in the inventory for estimating N_2O emissions from passenger cars (Van den Brink, 2001). In 2002, TNO used the same measurement data to derive real-world N_2O emission factors for passenger cars. They concluded, however, that real-world N_2O emissions are actually lower than those during the standardised European Driving Cycle. As is stated by Gense and Vermeulen (2002): 'the higher engine loads caused by the higher driving dynamics of real-world driving cause a three-way catalyst to heat up more quickly and to reach a higher stabilised temperature. The catalyst remains a shorter period of time in the temperature window favourable for N_2O-formation, which results in a lower N_2O-emission.' As a consequence, Gense and Vermeulen estimate real-world cold start N_2O emissions to be 20 per cent lower than at type approval testing, whereas real-world rural and highway emissions are 32 per cent and 58 per cent lower, respectively, than figures derived from type approval testing.

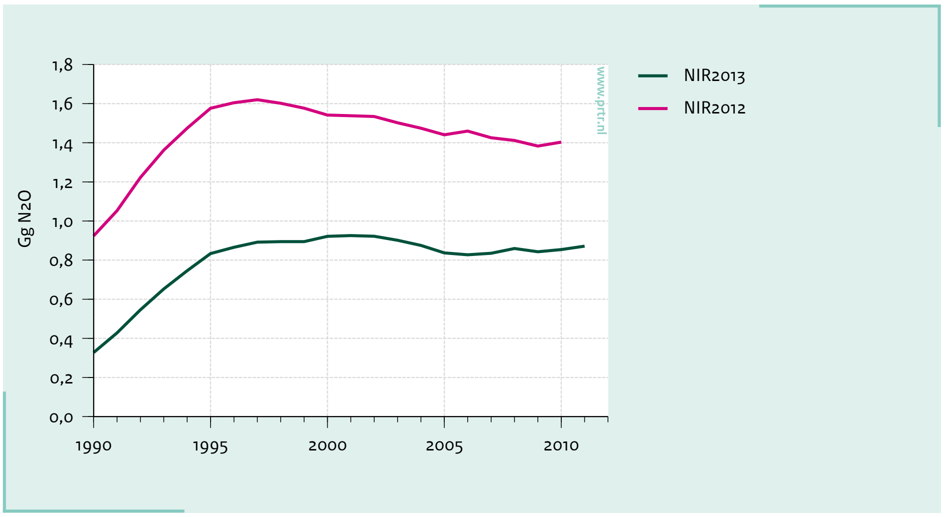
Figure 3.9 shows the old and new time series for N_2O emissions from road transport (1A3b). The trend in the time series is rather similar, especially in earlier years, when the introduction of the three-way catalyst (TWC) in petrol-powered passenger cars led to an increase in N_2O emissions. Because newer generations of TWCs emit less N_2O, N_2O emissions by road transport decreased again after 1998. Since 2005 N_2O emissions have not decreased further, though, in the new time series because N_2O emissions from new generations of heavy duty trucks are higher than previously assumed. Previously, the N_2O emission factors for heavy duty trucks were derived from Riemersma et al. (2003). These EFs did not take into account the introduction of selective catalytic reduction (SCR) technology in recent generations of heavy duty trucks. SCR was first applied in Euro-IV trucks, which entered the Dutch market in 2005 and therefore were not part of the measurement programme in Riemersma et al. (2003). Trucks with SCR show increased levels of N_2O emissions (Kuiper and Hensema, 2012). Therefore N_2O emissions from heavy duty trucks are higher than previously estimated and have been increasing in recent years of the new time series.

Fuel consumption for domestic civil aviation and military aviation

In this year's submission the use of aviation gasoline for domestic civil aviation is derived from Statistics Netherlands (CBS). In previous inventories, the reported use of aviation gasoline was based on a rough estimate of fuel consumption and resulting greenhouse gas emissions in the year 2000. This estimate was used for the entire time series. Statistics Netherlands did report the amount of jet kerosene and aviation gasoline delivered for aviation in The Netherlands, but these figures included fuel deliveries for both civil aviation and military aviation. Because the split between military and civil aviation could not be established until recently, the figures from Statistics Netherlands have not been used in the inventory.

Since 2011, Statistics Netherlands has reported domestic fuel deliveries to military aviation separately from deliveries to civil aviation. Therefore the aviation gasoline figures for domestic aviation are now derived from Statistics Netherlands. Aviation gasoline is used only in small, piston-engine aircraft. The use of aviation gasoline in The Netherlands is small: fuel consumption decreased from 0.16 PJ in 1990 to 0.08 PJ in 2011. Previously the use of aviation gasoline was estimated at 0.32 PJ, which means that the reported greenhouse gas emissions from use of aviation gasoline by domestic civil aviation decreased by approximately 0.01 to 0.02 Gg CO_2 eq throughout the time series.
Statistics Netherlands has also reported deliveries of jet kerosene for domestic civil aviation and for military aviation separately since 2011, though these figures are not yet used in the inventory. A comparison with the figures from the Ministry of Defence showed that domestic deliveries of jet kerosene to the military in The Netherlands in 2011 as reported by Statistics Netherlands were lower. Statistics Netherlands reports deliveries of 1.3 PJ in 2011, whereas the ministry reports 1.7 PJ of domestic fuel deliveries. Statistics Netherlands is currently trying to

Figure 3.9 N_2O emissions from road transport in the current inventory and in last year's inventory.



find an explanation for these differences. Until it does, the jet kerosene figures from Statistics Netherlands for both military and civil aviation will not be used for the inventory.

Fuel sales data for railways

According to the 2011 National Inventory Report, fuel sales to railways in The Netherlands might have been underestimated in recent years. A research project by Ecorys (2010) showed higher diesel fuel sales in 2008 than reported by Statistics Netherlands in the Energy Balance. At the time, fuel sales to railways were still derived from NS, which previously had been the only company responsible for freight transport by rail. Since the liberalisation of the freight transport market, other companies have entered the picture.

Since 2010, Statistics Netherlands has derived its fuel sales data for railways from Vivens, a recently founded co-operation of rail transport companies that purchases diesel fuel for the railway sector in The Netherlands. Vivens has fuel sales data only from 2010 onwards. Applying these figures led to an inconsistency in the time series: diesel fuel sales to the railway sector in The Netherlands in 2010, as reported by Vivens, was 60 per cent (0.5 PJ) higher than diesel fuel sales in 2009, as reported by NS. This increase could only partially be explained by the increase in transport volumes of approximately 15 per cent between 2009 and 2010. It was therefore concluded that the data on fuel sales to railways had been underestimated between 2006 and 2009. This led to a correction of the data in the 2012 Energy Balance, as is shown in Figure 3.10. Based on transport volumes for freight and passenger transport by diesel trains, it is assumed that energy use was more or less constant between 2005 and 2008. In 2009, rail freight transport volumes decreased by approximately 15 per cent due to the economic crisis. It is assumed that fuel consumption by rail freight transport decreased accordingly. From 2010 onwards data from Vivens has been used.

Natural gas in road transport

During the in-country review of the NIR 2011 it was noted by the ERT that emissions resulting from the use of natural gas in road transport were not reported in the inventory. After discussions with Statistics Netherlands (CBS), it was concluded that emissions from the use of compressed natural gas (CNG) 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 natural gas use (30 TJ) and resulting emissions were not reported in the 2011 inventory.

In the Dutch Energy Balance, energy use from natural gas in road transport in 2005 was estimated to be 30 TJ. This estimate was used for subsequent years until 2009 in the Energy Balance. The increase in the use of natural gas in road transport since 2005 was not reported separately in the Energy Balance but was instead reported under 'commercial/institutional'. In the emissions inventory, emissions from natural gas use under 'commercial/ institutional' were reported throughout the time series (under 1A4a) using energy figures from the Energy Balance. The use of natural gas in road transport, reported by Statistics Netherlands under 'commercial/institutional', was thus accounted for in the emissions inventory. The initial 2005 estimate for energy use in road transport (30 TJ) was not included, though, in the emissions inventory.

To correct for the missing emissions, a resubmission of the CRF was made in November 2011. In this resubmission, a preliminary estimate was made of emissions resulting

Figure 3.10 Correction of historic time series for fuel sales to 1A3c (railways) in The Netherlands

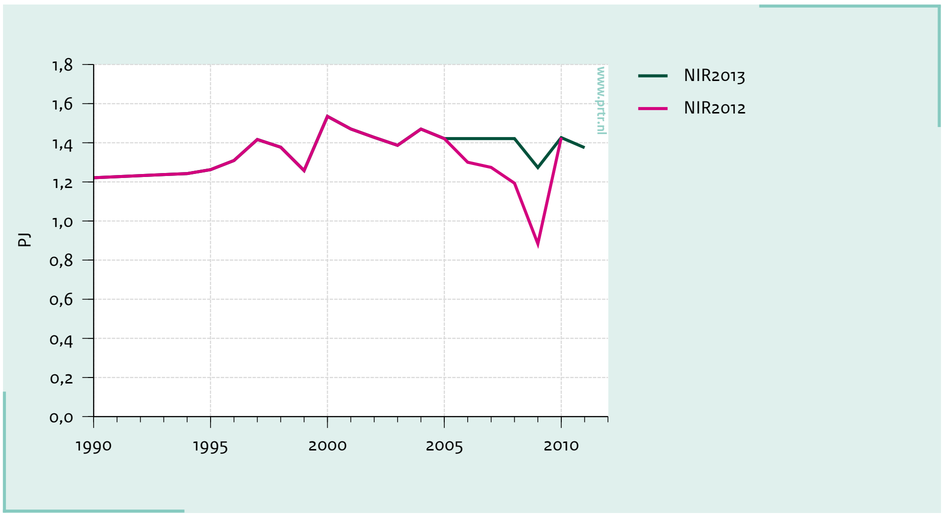
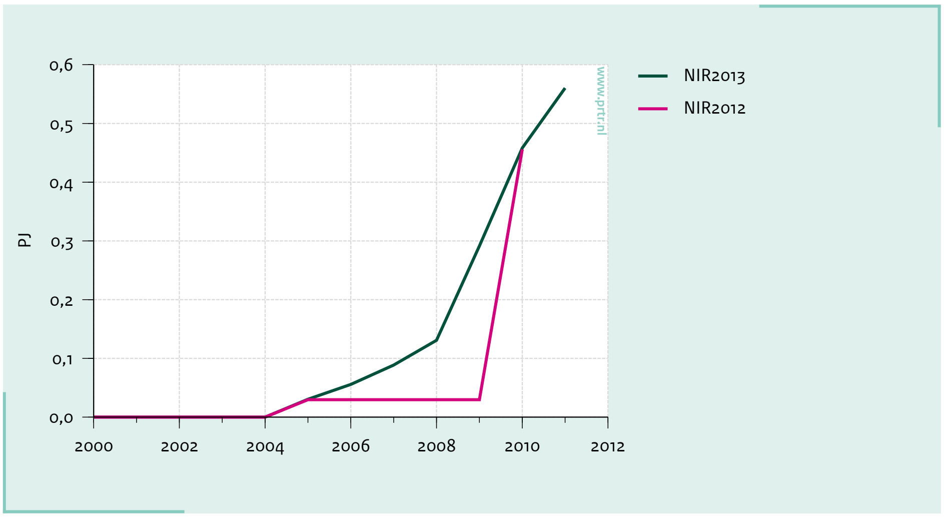


Figure 3.11 Correction of historic time series for CNG use in 1A3b (road transport) in The Netherlands



from the use of natural gas in road transport that were not already reported elsewhere in the inventory, using IPCC default EFs for CH_4 and N_2O and country-specific EFs for CO_2 from natural gas. These preliminary estimates were also used in the 2012 National Inventory Report.

In the 2012 Energy Balance, Statistics Netherlands adjusted the historic time series for natural gas use in road transport. These figures and the resulting emissions are reported in the current submission. Energy use and emissions under 'commercial/institutional' (1A4a) are corrected accordingly. Figure 3.11 shows the old and the new time series for use of CNG in road transport. The new time series shows a major increase in CNG use between 2008 and 2010, which is in line with the increase in the number of CNG buses in The Netherlands over the same period: the number of buses increased from 115 in early 2009 to 478 at the end of 2010. Even though CNG use in road transport has increased significantly in recent years, it is still a small energy source for road transport, accounting for less than 1 per cent of total energy use (Figure 3.8).

Fuel use for domestic inland navigation

The time series for fuel use in domestic inland navigation (1A3d) has been adjusted slightly for the 2005–2010 period in this year's submission. Fuel use for domestic inland navigation is estimated using the Dutch Emission Monitor Shipping (EMS). In this methodology, fuel use and emissions from inland navigation are estimated using a bottom-up approach based on the ton-kilometres travelled by different ship types on the waterways of The Netherlands (Hulskotte, 2012). The total number of vessel kilometres is derived from Statistics Netherlands. The distribution of the kilometres over the different waterways was previously estimated once for the year 2002. This distribution was subsequently applied to the entire time series. Last year, the distribution was updated on the basis of the outcome of a new model called Bivas (Hulskotte, 2012). This led to small changes in the distribution in recent years. As a consequence, total energy use and emissions from domestic inland navigation also changed slightly: energy use in the 2005–2008 period is 1–3 per cent lower than previously reported.

Energy use and greenhouse gas emissions from domestic inland navigation in 2010 are adjusted upwards by 6 per cent compared with last year's submission. This is caused by an adjustment in the traffic volumes as reported by Statistics Netherlands.

Other adjustments of historic time series

Fuel sales data for road transport in 2010 are adjusted slightly compared with last year's submission due to small changes in the national Energy Balance. For last year's submission preliminary figures for 2010 were used. These figures have been adjusted slightly in the 2012 Energy Balance. Total energy use and resulting emissions by road transport in 2010 are 0.4 per cent higher than reported last year.

CH_4 emissions from road transport have been recalculated for the 2000-2010 period using detailed annual mileages for passenger cars derived by Statistics Netherlands. Average annual mileages for passenger cars are estimated based on odometer readings and are reported per fuel type and per age category. In previous years, only one average annual mileage was estimated for all passenger cars older than 8 years. The share of passenger cars 8 years and older in the total number of vehicle kilometres driven by passenger cars in the Netherlands has increased significantly throughout the time series: in early years the share varied between 15 and 20%, whereas in recent years the share in total vehicle kilometres driven was approximately 35 to 40%. The share in CH_4 emissions is even larger with emissions from new vehicle categories dropping significantly due to further tightening of EU emission standard (especially for gasoline and LPG). Emissions per vehicle kilometre vary significantly among this group, therefore a more detailed specification of average annual mileages was required.

In 2012 Statistics Netherlands derived detailed average annual mileages for different age groups. Specific mileages were reported for all ages up until 19 years old (95% of total passenger cars in 2010). For older cars, mileages were reported for 5 year age groups (e.g. 20-24, 25-29 years). The results show a relatively steep drop-off in annual mileages for older passenger cars, especially for gasoline. In previous years, this drop-off in the average annual mileages was underestimated. As a consequence, the mileages of this age group were overestimated. Even though the share of passenger cars 25 years and older in total vehicle kilometres is small, all gasoline cars in this age group are pre-Euro cars and are not equipped with a three-way-catalyst (TWC). Emissions of VOC (including CH_4) per vehicle kilometre therefore are substantially higher than for newer passenger cars equipped with a TWC.

Applying the detailed mileages for the different age groups led to a decrease in VOC emissions and therefore also in a decrease in CH_4 emissions from passenger cars. In recent years of the time series, CH_4 emissions from road transport are 5-9% lower than reported in last year's submission. Emission factors for pre-Euro passenger cars were unchanged and are reported in Klein et al. (2013).

Source-specific planned improvements

In the coming year, The Netherlands plans to improve its bottom-up approach for calculating fuel consumption by road transport in The Netherlands. N_2O and CH_4 emissions from road transport in The Netherlands are calculated using a bottom-up approach based on vehicle-kilometres driven and EFs per vehicle-kilometre. To make sure that the reported N_2O and CH_4 emissions from road transport are consistent with fuel sales data, the bottom-up approach is used only to estimate average CH_4 emission factors per unit of fuel used. These EFs are subsequently combined with fuel sales data to estimate the emissions of CH_4 and N_2O by road transport as reported in the inventory.

To estimate average EFs for CH_4 and N_2O per unit of fuel, both total CH_4 and N_2O emissions and total fuel consumption must be estimated using the bottom-up approach. This approach thus requires specific fuel consumption figures per vehicle-kilometre. These specific fuel consumption figures have not been updated recently, which increases the uncertainty of the N_2O and CH_4 emission figures for road transport.

3.2.9 Other sectors [1A4]

Source category description

Source category 1A4 (other sectors) comprises the following categories:

- 1A4a (commercial and institutional services): This category comprises commercial and public services such as banks, schools and hospitals, and trade, retail and communication; it also includes the production of

Figure 3.12 1A4 'Other sectors': trend and emission levels of source categories, 1990-2011.

drinking water and miscellaneous combustion emissions from waste handling activities and from wastewater treatment plants.

- 1A4b (residential): This category 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 category 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) decreased by 4 per cent in the period 1990–2011 (see Figure 3.12). In 2011, CO_2 emissions from 1A4 decreased by 18 per cent compared with the 2010 level due to the mild winter in comparison with the cold winter of 2010.

The share of CO_2 emissions from 1A4 in total national CO_2 equivalent emissions (excluding LULUCF) was about 18 per cent in 1990 and 19 per cent in 2011. The share of CH_4 emissions from this source category in the national total greenhouse gas emissions is very small (0.7 per cent); the share of N_2O emissions is almost negligible. 1A4b (residential) is the main contributor, contributing approximately 9 per cent to the total national CO_2 equivalent emissions.
About 14 per cent of the total CH_4 emissions in the Energy sector originate from the residential sector (0.3 Tg CO_2 eq, see Table 3.1). Almost 80 per cent of these CH_4 emissions stem from gas combustion, in particular from cooking losses; the remainder is from biofuel combustion. The decreased emissions in 'agriculture' are due to energy conservation measures in the category of greenhouse horticulture, and the fact that CO_2 emissions from off-road machinery used in agriculture and from fisheries are included in category 1A4c (total CO_2 emissions from 1A4c: approximately 10 Tg CO_2).
Within this source category, the combustion of gases and liquids forms a key source of CO_2 emissions. See Table 3.1 for details.

Commercial and institutional services [1A4a]

CO_2 emissions in the 'commercial and institutional services' (1A4a) category has increased since 1990 by 15 per cent. However, when a temperature correction is made, 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 to this category 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). Thus, all uncertainties in the other allocations accumulate in this remaining category, which also results in large interannual changes in the underlying 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 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 wastewater treatment plants (WWTP), which shows a rather smooth increasing trend, and biomass consumption by industrial companies, which is classified in this economic sector – for example, landfill gas used as fuel. According to 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 per cent. 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 13-038 on biomass fuel combustion.
The IEF for CH_4 from national gas combustion is the aggregate of the standard EF 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 accounted for neither in the IPCC default nor in the EFs used by most other countries.
In the 'residential' category, CO_2 emissions have decreased by 13 per cent 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 has decreased more, mainly due to the improved insulation of dwellings and the increased use of high-efficiency boilers for central heating. The year 2011 was relatively mild, which caused a large decrease in fuel consumption compared with the cold year 2010.

Agriculture, forestry and fisheries [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 per cent 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 this category.
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 various 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. It should also be noted that the increased use of internal combustion engines in combined heat power plants operated on natural gas has increased the IEF for methane in this category, as these engines are characterised by high methane emission.
In addition, since the autumn of 2005, CO_2 emissions from the hydrogen production plant in a refinery have begun 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 1 Tg CO_2. In addition, in 2011, the production and use of biogas from the composting of manure in the 'agriculture, forestry and fisheries' category increased from virtually zero to 6.7 PJ. CO_2 emissions from off-road machinery in agriculture in 2011 amount to 1.1 Tg, whereas total greenhouse gas emissions from fisheries amount to about 0.5 Tg CO_2 equivalent. 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 2011 the number of fishing vessels in The Netherlands decreased by 40 per cent according to Statistics Netherlands. The engine power of these ships also decreased by almost 40 per cent. 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 2011, CO_2 emissions from agricultural machinery remained stable compared with 2010.

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 92 per cent 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 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' category (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 varying heating demand due to changes in heating degree days. The fuel consumption data in 1A4a (commercial and institutional services) is determined by

Table 3.6 Overview of emission factors used (in 2011) in the Other Sectors [1A4].

Fuel	Amount of fuel used in 2011 (TJ NCV)	Emission factors (g/GJ) CO_2 (x 1000)	N_2O	CH_4
Natural gas	602,219	56.5	0.10	106.09
Gas/Diesel Oil	23,178	74.3	0.60	4.88
Other	31,513	NA	NA	NA

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 the resulting activity data are the least accurate of all three categories. The EFs 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 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' (1A4c–ii) are calculated on the basis of IPCC Tier 2 methodologies. The fuel use data are combined with country-specific EFs for CO_2 and IPCC default EFs for N_2O and CH_4. The consumption of diesel oil and heavy fuel oil by fisheries is estimated on the basis of statistics on the number of days at sea ('hp days') of four types of Dutch fishing vessel. 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 by 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 13-010 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 average use (hours per year) and 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 EFs used for the most important fuels (up to 95 per cent of the fuel use) in the Other sectors (1A4) is provided in Table 3.6. Since some emission data are used for individual companies, some of these values represent IEFs.

Notes to the implied emission factors:

- The standard CH_4 emission factor for natural gas is 5.7 g/GJ. Only for gas engines is a higher EF used, which explains the higher EF 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 EFs, 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 'services' and – to some extent – 'agriculture' categories (in particular the latest year) is monitored less accurately than the 'residential' sector. Trends of emissions and activity data for these categories should be treated with some caution when drawing conclusions. The uncertainty in total CO_2 emissions from this source category is about 7 per cent, with an uncertainty of the composite parts of about 5 per cent for the 'residential' category, 10 per cent for the 'agriculture' category and 20 per cent for the 'services' category (see section 1.7 and Annex 1 for more details).

The uncertainty in gas consumption data is estimated at 5 per cent for the 'residential' category, 10 per cent for 'agriculture' and 20 per cent for the 'services' category. An uncertainty of 20 per cent is assumed for liquid fuel use for the 'off-road machinery and fisheries' and 'services' categories. 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 per cent. However, the uncertainty in the 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 categories is estimated separately using a trend analysis of sectoral data ('HOME' survey of the 'residential' category and LEI data for 'agriculture').

For natural gas the uncertainty in the CO_2 emission factor is estimated at 0.25 per cent based on the recent fuel quality analysis reported by Heslinga and Van Harmelen (2006) and further discussed in Olivier et al. (2009). For the

Table 3.7 Emission factors used for military marine and aviation activities.

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	10.00	5.80
Total	Emissions in 2011 (Gg)	354.70	0.03	0.02

Source: Hulskotte, 2004a.

CO_2 emission factors for liquids and solids, uncertainties of 2 per cent and 5 per cent, respectively, were assigned. The uncertainty in CH_4 and N_2O emission factors is estimated to be much higher (about 50 per cent).

Since most of the fuel consumption in this source category is for space heating, the gas consumption from Other sectors varies considerably across the years due to variations in winter temperatures. 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 with trends in related activity data: the number of households, number of people employed in the 'services' sector 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 13-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels.

Source-specific recalculations

No recalculations were performed during the preparation of the 2013 submission.

Source-specific planned improvements,

There are no source-specific recalculations envisaged.

3.2.10 Other [1A5]

Source category description

Category 1A5 'Other' includes 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 from fuel combustion from 1A5 (Other). The emissions in this sector are calculated using fuel consumption data for both shipping and aviation that have been obtained from the Ministry of Defence and are the totals for domestic military shipping and aviation activities and so-called multilateral operations. The fuel for aviation consists of a mixture of jet kerosene, F65 and SFC. The sector-specific EFs 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 (Other) is estimated to be about 20 per cent in annual emissions. The uncertainty for CH_4 and N_2O emissions is estimated to be about 100 per cent. The accuracy of fuel consumption data is tentatively estimated at 20 per cent. For EFs, the uncertainties are estimated at 2 per cent for CO_2 and 100 per cent 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

The recalculations of the fuel use for military operations is described in section 3.2.8.

Source-specific planned improvements

Planned improvements are described in section 3.2.8.

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 per cent in 1990 and 1.2 per cent in 2011. Table 3.1 shows that total greenhouse gas emissions in 1B decreased from 2.9 Tg CO_2 eq to 2.3 Tg CO_2 eq between 1990 and 2011.

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 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. There is no methane recovery at abandoned coal mines. Since the pumping of minewater stopped, the mines have been flooded with water; therefore, no emissions are accounted for.
With respect to fugitive emissions from 'charcoal production', The Netherlands had until 2009 one large production location that served most of The Netherlands and also occupied a large share of the market of neighbouring countries. The production at this location stopped in 2010.
The CO_2 emissions in 1B1 remained quite stable between 1990 and 2009. After a peak in 2010, emissions decreased substantially to 0.66 Tg CO_2 eq in 2011.

Methodological issues
The CO_2 emissions related to transformation losses (1B1) from coke ovens are based on national energy statistics of coal inputs and of 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 EFs can be found in the monitoring protocols on the website www.nlagency.nl/nie. As a result of the 2011 in-country review, a mass balance for the year 2009 has been made available. This mass balance is not included in the National Inventory Report due to confidentiality but can be made available for review purposes.

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 per cent. 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
This year there have been no source-specific recalculations in comparison with the previous submission.
Source-specific planned improvements
No source-specific improvements are 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);
- emissions from gas distribution networks (pipelines for local transport) (CO_2, CH_4);
- emissions from oil refining (CH_4);
- emissions from hydrogen plants (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 reports from the plant) and re-allocated from 1A1b to 1B2a-iv for 2002 onwards. CO_2 and CH_4 from gas flaring/venting are identified as key sources (see Table 3.1).
Gas production, of which about 50 per cent 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 less than 5 per cent; in 1990 it was 10 per cent. There is very little oil production in The Netherlands. The EFs of CO_2 and CH_4 from oil and gas production, in particular for venting and flaring, have been reduced significantly. This is due to the implementation of environmental measures to reduce venting and flaring by optimising the utilisation for energy purposes of gas that was formerly wasted.
CO_2 emissions from hydrogen plants remained fairly stable between 2002 and 2011. Emissions from oil and gas transport and gas distribution networks remained fairly stable between 1990 and 2011.

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). Each operator uses its own detailed installation data to calculate emissions and reports those emissions and fuel uses in aggregated form in its electronic annual environmental report (e-MJV). Activity data for venting and flaring are taken from national energy statistics as a proxy and reported in the CRF. The data in the statistics can be adjusted retroactively (changes in definitions/allocation) and these will show up in the CRF.

The IPCC Tier 3 method for CH_4 from Gas distribution due to leakages (1B2) is based on two country-specific EFs: 610 m^3 (437 Gg) methane per km of pipeline for grey cast iron, and 120 m^3 (86 Gg) per km of pipeline for other materials. The EFs 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 recorded the number of leaks found per material, and any possible trends in the EFs are derived from these data. 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 are reported under IPCC category 1A1c. 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 emission of 0.184 Gg CO_2 eq is added to CRF category 1B2biii for the whole time series.

Fugitive emissions of methane from refineries in category 1B2a4 are based on a 4 per cent share in total VOC emissions reported in the annual environmental reports of the Dutch companies (Spakman et al., 2003) and for the most recent years directly from the environmental reports produced by the refineries. The environmental reports show significant annual fluctuations in CH_4 emissions as the allocation of the emissions to either combustion or process is not uniform over the years. For more information, see the monitoring protocols available on www.nlagency.nl/nie. As the environmental reports account only for emissions, activity data for this category are taken from national energy statistics as a proxy and reported in the CRF. The data in the statistics can be adjusted retroactively (changes in definitions/allocation) and these will show up in the CRF.

Uncertainty and time series consistency

The uncertainty in CO_2 emissions from gas flaring and venting is estimated to be about 50 per cent, while the uncertainty in methane emissions from oil and gas production (venting) and gas transport and distribution (leakage) is estimated to be 25 per cent and 25 per cent, respectively, in annual emissions. The uncertainty in the EF of CO_2 from gas flaring and venting (1B2) is estimated at 2 per cent. 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 EFs is estimated to be 25 per cent and 50 per cent, 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 3 methodology for methane emissions from gas distribution is based. A consistent methodology is used to calculate emissions 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

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

Source-specific planned improvements

There are no source-specific improvements planned.

4 Industrial processes [CRF Sector 2]

Major changes in the Industrial processes sector compared with the National Inventory Report 2012

Emissions:	In 2011, the total greenhouse gas emissions of the sector remained at almost the same level as in 2010.
	Because several new sources of detailed information became available, the HFC emissions from Stationary refrigeration, Mobile air-conditioning and Other use (2F2, 2F3, 2F4 and 2F5) have been changed for a number of years. In addition, as a result of corrections in the use of some HFCs in 2F1 (PWC, 2012), HFC emissions have been recalculated for 2010. Finally some minor errors in 2C3, 2E3 and 2F8 were detected and corrected for several years.
Key sources:	There have been no changes in key sources in this sector.
Methodologies:	There have been no methodological changes in this sector.

4.1 Overview of sector

Emissions of greenhouse gases in this sector include all non-energy-related emissions from industrial activities (including construction) and all emissions from the use of the F-gases (HFCs, PFCs and SF_6), including their use in other sectors. From this submission onwards the potential emissions are included in the CRF.
According to the Aarhus Convention, only emissions data are public. Basically this means that unless a company has no objection to publication, production and energy data from individual companies are confidential.
As in the industrial sector, many processes take place in one or two companies and therefore most data of these companies are confidential to the public. The Dutch emission inventory team has access to most of these confidential data. Some of the confidential information can be viewed only at the companies' premises. This includes the following data:

2B2/2B5: - production levels and emission factors;
2E1: - HFC 23 load in the untreated flow; removal efficiency Thermal Converter;
2E3: - production levels and emission factors.

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 from industrial processes in The Netherlands:

- Protocol 13-003: CO_2, CH_4 and N_2O from Process emissions: fossil fuels;
- Protocol 13-014: CO_2, CH_4 and N_2O from Process emissions and product use;
- Protocol 13-015: N_2O from Nitric acid production (2B2);
- Protocol 13-016: N_2O from Caprolactam production (2B5);
- Protocol 13-017: PFCs from Aluminium production (2C3);
- Protocol 13-018: HFC-23 from HCFC-22 production (2E1);
- Protocol 13-019: HFCs from Handling (2E3);
- Protocol 13-020: HFCs from Stationary refrigeration (2F1);
- Protocol 13-021: HFCs from Mobile air-conditioning (2F1);
- Protocol 13-022: HFCs from Other use (2F2–5);
- Protocol 13-024: SF_6 from Other use (2F9);
- Protocol 13-025: SF_6 and PFCs from Semiconductor manufacturing (2F7);
- Protocol 13-026: SF_6 from Electrical equipment (2F8).

Key sources
The key sources in this sector are presented in Table 4.1. Annex 1 presents all sources identified in the Industrial processes sector in The Netherlands.
Nitric acid production is a Tier 1 trend key source for N_2O, due to the reduction achieved in this category, and caprolactam production is a level key source for N_2O. 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 4.1 show the trends in total greenhouse gas emissions from the Industrial processes sector.

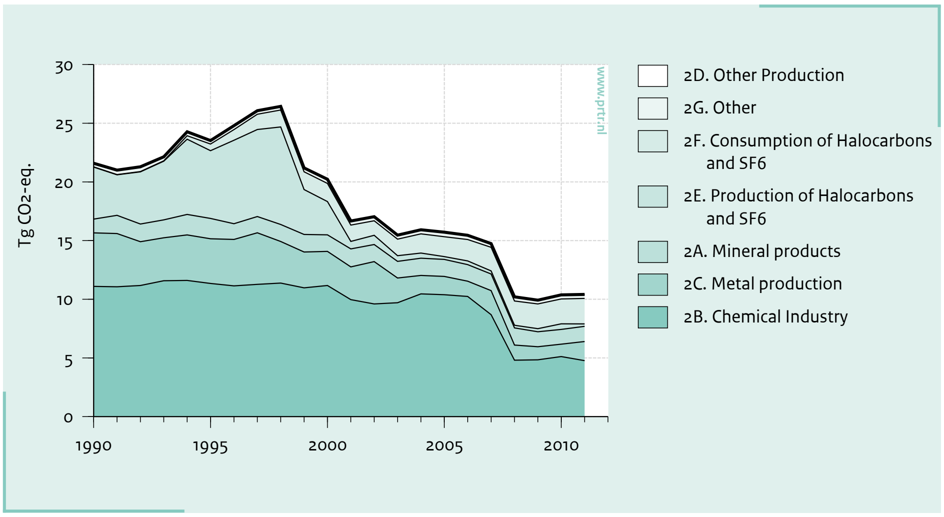
In 2011, Industrial processes contributed 5.4 per cent of the total national greenhouse gas emissions (without LULUCF) in comparison with 11 per cent in the base year. The sector is a major source of N_2O emissions in The Netherlands, accounting for 12 per cent of total national N_2O emissions.

Compared with 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 2011 (-56 per cent). CO_2 emissions from industrial processes decreased by 18 per cent during the period 1990–2011. N_2O emissions decreased by 84 per cent in the same period. Total emissions of fluorinated gases (F-gases) were greatly reduced.

In 2011, total greenhouse gas emissions of the sector remained at the same level as in 2010 (10.4 Tg CO_2 eq in 2010 and 2011). N_2O emissions increased by 0.1 Tg, HFC emissions showed a decrease of 0.13 Tg CO_2 eq, PFC emissions decreased by 0.03 Tg CO_2 eq and SF_6 emissions decreased by 0.04 Tg CO_2, while CO_2 emissions remained at the same level as the previous year.

Category 2B (Chemical industry) contributes most to emissions from this sector. Compared with the base year, the total CO_2 equivalent greenhouse gas emissions of this category declined by 6.3 Tg to 4.8 Tg CO_2 eq in 2011 (-57 per cent).

Figure 4.1 Sector 2 'Industrial processes': trend and emission levels of source categories, 1990 - 2011.



4.2 Mineral products [2A]

4.2.1 Source category description

General description of the source categories

This category comprises CO_2 emissions related to the production and use of non-metallic minerals in:

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

CO_2 emissions from 2A2 (Lime production) is IE (included elsewhere). The production is known to occur only in four plants of the sugar industry and it is not possible to separate 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 (see also 4.2.9).

4.2.2 Key sources

There are no key sources identified in 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 1.30 Tg in 2011 (see Table 4.1). Total CO_2 emissions in category 2A remained at virtually the samel evel as the previous year (1.25 Tg in 2010 and 1.30 Tg in 2011).

4.2.4 Activity data and emission factors

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

Activity data are based on the following sources:

- Cement clinker production (2A1): The environmental reports (AER) of the single Dutch company are used.
- Limestone and dolomite use (2A3): 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) is used. Data on the consumption of 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 (2A4): 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 (2A7): Activity data are based on data from Statistics Netherlands (CBS) and the trade organisation.

The following EFs 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 reliably estimate 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

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

Sector/category	Gas	Key	Emissions base-year	2010	2011	Absolute 2011 - 2010	Contribution to total in 2011 (%)		
			Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq		by sector	of total gas	of total CO_2 eq
2 Industrial processes	CO_2		7.9	6.5	6.6	0.1		4	3
	CH_4		0.3	0.3	0.3	0.00		2	0.1
	N_2O		7.1	1.0	1.1	0.00		12	0.6
	HFC		6.0	2.3	2.1	-0.1		100	1.1
	PFC		1.9	0.2	0.2	-0.03		100	0.1
	SF_6		0.3	0.2	0.1	0.00		100	0.1
	All		23.5	10.4	10.4	0.04		0.00	5
2A Mineral products	CO_2		1.2	1.3	1.3	0.04	12	0.8	0.7
2B Chemical INDUSTRY	CO_2		3.7	3.9	3.4	-0.5	33	2	2
	N_2O		7.1	1.0	1.1	0.00	11	12	0.6
	All		11.1	5.1	4.8	-0.4	46	2	2
2B1 Emissions from ammonia production	CO_2	L1	3.1	3.2	2.7	-0.5	26	2	1
2B1 Emissions from nitric acid production	N_2O	T	6.3	0.3	0.2	0.00	2	3	0.1
2B5 Emissions from caprolactam production	N_2O	L	0.8	0.7	0.9	0.00	8	10	0.4
2B5 Other chemical product manufacture	CO_2	L,T2	0.6	0.7	0.7	0.00	7	0.4	0.4
2C Metal production	CO_2		2.7	1.0	1.5	0.6	15	1	0.8
	PFC		1.9	0.06	0.1	0.02	0.8	45	0.04
	All		4.9	1.1	1.6	0.6	16		0.8
2C1 Iron and steel production (carbon inputs)	CO_2	L1,T1	2.3	0.7	1.1	0.4	11	0.7	0.6
2C3 PFC emissions from aluminium production	PFC	T	1.9	0.06	0.1	0.02	1	45	0.04
2D Other production	CO_2		0.1	0.03	0.02	-0.01	0.2	0.01	0.01
2E Production of halocarbons and SF_6	HFC		5.8	0.5	0.2	-0.3	2	10	0.1
2E1 HFC-23 emissions from HCFC-22 manufacture	HFC	T	5.8	0.4	0.2	-0.2	2	8	0.1
2F Consumption of halocarbons and SF_6	HFC	L,T	0.2	1.8	1.9	0.15	18	90	1.0
	PFC		0.04	0.2	0.1	-0.05	1	55	0.1
	SF_6		0.3	0.2	0.1	0.00	1	100	0.1
	All		0.6	2.1	2.2	0.1	21		1.1
2G. Other	CO_2		0.2	0.3	0.3	0.00	3	0.2	0.2
	N_2O		0.00	0.01	0.01	0.00	0.1	0.1	0.01
	All		0.3	0.3	0.3	0.00	3	0.2	0.2
Total national emissions	CO_2		159.2	181.4	167.6	-13.8			
	CH_4		25.7	15.9	15.3	-0.7			
	N_2O		20.0	9.2	9.1	-0.1			
	HFCs		6.0	2.3	2.1	-0.1			
	PFCs		1.9	0.2	0.2	-0.03			
	SF_6		0.3	0.2	0.1	-0.04			
National total GHG emissions (excl. CO_2 LULUCF)	All		213.2	209.2	194.4	-14.8			

* The base year for F-gases (HFC, PFC and SF_6) is 1995.

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 EF for 1998–2011 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 EFs are found in Protocols 13-003 and 13-014 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 cement clinkers. The methodology for carbon 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.

This methodology is also included in a monitoring protocol applied for emissions trading. This protocol is approved by the Dutch Emissions 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 of this company. The verified CO_2 emissions are also reported in the AER.
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 for clinker production. Table 4.2 shows the trend in the implied CO_2 emission factor (IEF) for clinker production during the period 2002–2011 (IPCC Default = 0.51 t/t clinker).

- 2A3 (Limestone and dolomite use): 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).
  From 2000 onwards, data reported in the annual environmental reports of Tata Steel (Corus) are used to calculate the CO_2 emissions from 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 * f(limestone) * $EF_{limestone}$, where f is the fractional purity.
  No activity data are available to estimate other sources of limestone and dolomite use.

Table 4.2 Implied emission factor for CO_2 from clinker production (Units: t/t clinker) (2A1).

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
CO_2	0.54	0.54	0.54	0.52	0.51	0.48	0.48	0.52	0.50	0.52

- 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 on the basis of the non-energy use of coke, assuming the 100 per cent oxidation of carbon.

- 2A7 (Other): CO_2 emissions from this source category refer principally to glass production. Emissions are estimated on the basis of gross glass production data and country-specific EFs.

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 by IPCC source category.

Uncertainty estimates used in the Tier 1 analysis are based on the judgement of experts, since no detailed information is available for assessing the uncertainties of the emissions reported by the facilities (Cement clinker production, Limestone and dolomite use, and Soda ash production). The uncertainty in CO_2 emissions from cement clinker production is estimated to be approximately 10 per cent in annual emissions; for Limestone and dolomite use and Other sources the uncertainty is estimated to be 25 per cent, 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 per cent). The uncertainties of the IPCC default EFs used for some processes are not assessed. However, as these are minor sources of 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

- No recalculations have been made.

4.2.9 Source-specific planned improvements

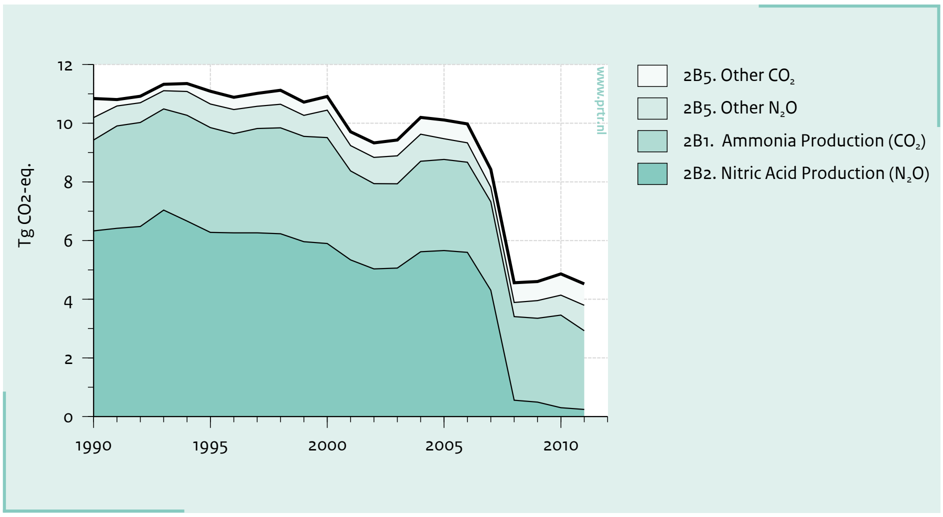
In the last submission, The Netherlands had plans to set up a CO_2 calculation for Asphalt roofing and Asphalt for road paving in the coming years.
Direct greenhouse gas emissions, e.g. CO_2 or CH_4, associated with the production and use of asphalt are negligible since the majority of the light hydrocarbon compounds were extracted during the refining process to produce commercial fuels (IPCC, 2006).
This improvement is not implemented.

4.3 Chemical industry [2B]

4.3.1 Source category description

The national inventory of The Netherlands includes emissions of greenhouse gases related to four source categories belonging to 2B (Chemical industry):
- 2B1 (Ammonia production): CO_2 emissions: in The Netherlands, natural gas is used as feedstock for ammonia production. CO_2 is a by-product of the chemical separation of hydrogen from natural gas. During the process of ammonia (NH_3) production, hydrogen and nitrogen are combined to react together to manufacture ammonia.
- 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 (2012) 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 (Other chemical product manufacture): CO_2 and N_2O emissions from:
  - Industrial gas production: Hydrogen and carbon monoxide are produced mainly from natural gas used as chemical feedstock but they can also be produced from petroleum coke and coke, during which processes CO_2 is produced.
  - Carbon electrode production: Carbon electrodes are produced from petroleum coke and coke used as feedstock, during which processes CO_2 is produced.
  - 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 a

Figure 4.2 2B Chemical industry: trend and emission levels of source categories, 1990-2011.



by-product.

- Caprolactam production: N_2O emissions result from the production of caprolactam.
- Ethylene oxide production: CO_2 emissions result from the production of ethylene oxide.

Adapic acid (2B3) and calcium carbide (included in 2B4) are not produced in The Netherlands. CO_2 emissions resulting from the use of fossil fuels as feedstocks for the production of silicon carbide, carbon black, ethylene and methanol are included in the Energy sector (1A2c; see section 3.2.7 for details).

4.3.2 Key sources

Ammonia production and Other chemical product manufacture are identified as key sources of CO_2 emissions, while Caprolactam production is identified as a key source of N_2O emissions. Since 2008, Nitric acid production has not been a Tier 2 level key source of N_2O emissions; due to emissions reductions in 2007 and 2008, it has been devalued to a trend key source (see Table 4.1).

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 1990–2011. Table 4.1 gives an overview of shares in emissions of the main categories.

Emissions from this category contributed 5 per cent of the total national greenhouse gas emissions (without LULUCF) in the base year and 2 per cent in 2011. Caprolactam production and Nitric acid production are the most important sources of N_2O emissions from industrial processes in The Netherlands.

The contribution of N_2O emissions from 2B (Chemical industry') was 2.4 per cent of the total national greenhouse gas emission inventory in the base year and 0.6 per cent in 2011.

From 1990 to 2008, total greenhouse gas emissions in 2B (Chemical industry) decreased by 54 per cent or 6.0 Tg CO_2 eq, mainly due to the reduction of N_2O emissions from the production of nitric acid. During the period 2009–2011, total greenhouse gas emissions in 2B remained at almost the same level as in 2008.

Table 4.3 shows that N_2O emissions from the chemical industry remained fairly stable between 1990 and 2000 (when there was no policy aimed at controlling these emissions).

Nitric acid production [2B2]

Until 2002, N_2O emissions from nitric acid production were based on IPCC default EFs. N_2O emission measurements made in 1998 and 1999 have resulted in a new EF of 7.4 kg N_2O/ton nitric acid for total nitric acid production. Plant-specific EFs for the period 1990–1998 are not available. Because no measurements were taken and the operational conditions did not change during the period 1990–1998, the EFs obtained from the 1998/1999 measurements have been used to recalculate the emissions for the period 1990–1998. Technical measures (optimising the platinum-based catalytic converter alloys) implemented at one of the nitric acid plants in 2001 resulted in an emission reduction of 9 per cent compared with 2000. The decreased emission level in 2002

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

Year	B2 Nitric acid production	B5 Other	Total
1990	6,330	766	7,096
1991	6,417	681	7,098
1992	6,479	672	7,151
1993	7,037	619	7,656
1994	6,665	812	7,477
1995	6,278	805	7,083
1996	6,262	822	7,084
1997	6,262	759	7,021
1998	6,231	802	7,033
1999	5,962	716	6,678
2000	5,898	936	6,834
2001	5,341	863	6,204
2002	5,032	897	5,929
2003	5,060	954	6,014
2004	5,617	923	6,540
2005	5,659	705	6,364
2006	5,597	662	6,259
2007	4,305	497	4,802
2008	558	481	1,039
2009	493	603	1,096
2010	301	681	982
2011	243	870	1,113

compared with 2001 is related to the decreased production level of nitric acid in that year. In 2003, emissions and production did not change, 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 per cent compared with 2006. In 2008, the full effect – a reduction of 90 per cent compared with 2006 – of the measures is reflected in the low emissions. 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 another, emissions decreased in 2010. The reduction in 2011 is caused by the improved catalytic effect in two of the plants.

Table 4.4 gives an overview with detailed information per plant that explains the significant reduction in 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 included 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 2012, the companies again sent their verified emissions reports (2011 emissions) to the NEa.

The reported and verified (by an independent verifier) emissions (2011) sent by the companies to the NEa were checked against those reported in the CRF tables (2011). No differences were found between the emission figures in the CRF and the verified emissions in the emission reports under EU-ETS.

Caprolactam production [2B5]

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 emissions fluctuations during the period 2003–2010 are mainly caused by the uncertainty of the measurements within the plant. During that period, annual emissions were based on only a few emission measurements per point per year. In 2011 the emissions increased because they are now based on long-term measurements instead of a few emission measurements per point in the previous period. Based on the 2011 measurements and the production indices, the next submission will include an investigation as to whether it is possible to improve the whole emission time series.

CH_4 emissions [2B4/2B5]

CH_4 emissions in these categories (2B4 and 2B5) are non-key sources and did not change much over time (level approximately 300 Gg CO_2 eq for all years).

4.3.4 Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocols 13-003, 13-014, 13-015 and 13-016 on the website www.nlagency.nl/nie.

Activity data are based on the following sources:

- Ammonia production: Activity data on the use of natural gas are obtained from Statistics Netherlands (CBS).
- Nitric acid production: Activity data are confidential. Emissions are reported by the companies.
- Carbide production: Silicon carbide production figures are derived from the Environmental Report (MJV) of the relevant company.
- Other: Activity data on caprolactam production are confidential. Only emissions are reported by the companies. This year a production index series for the

Table 4.4 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
2011	0	12.3	67	40	250	415
Abatement efficiency 2007 – 2008 [2]	80.40 %	99.94 %	69.68 %	99.997 %	92.84 %	84.80 %

[1] As well as in two Dutch plants, EnviNOx process variant 1 systems are in operation – with similar, very high N_2O abatement rates (99% and above) – in other nitric acid plants (for example, in Austria).

[2] Abatement efficiency relates to IEFs. Because the IEFs are confidential, they are not included in this table.

period 1990–2011 was received from the company. For ethylene oxide production only capacity data are available; therefore, a default capacity utilisation rate of 86 per cent 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 EFs used to estimate greenhouse gas emissions from the different source categories originate from:
- Ammonia production: a country-specific CO_2 emission factor;
- Nitric acid production: plant-specific N_2O emission factors (which are confidential);
- Silicon carbide production: The IPCC default EF is used for CH_4.
- Other: Plant-specific N_2O emission factors are used for Caprolactam production (confidential). A default EF 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 EF of 1 t/t Norit is used, derived from the carbon losses from peat uses.

4.3.5 Methodological issues

For all the source categories of the chemical industry, the methodologies used to estimate 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 EFs can be found in the protocols 12-002, 13-014, 13-015 and 13-016 described on the website www.nlagency.nl/nie, as indicated in section 4.1. The main characteristics are:
- 2B1 (Ammonia production): A method equivalent to IPCC Tier 1b is used to calculate the CO_2 emissions from Ammonia production in The Netherlands. The calculation is based on the following formula:

  CO_2 Emission(kg) = [Consumption of Natural gas (GJ) * Emission factor (kg/GJ)] -/- CO_2 storage

  Data on the use of natural gas are obtained from Statistics Netherlands (CBS). Because there are only two ammonia producers in The Netherlands, the consumption of natural gas is confidential information to the public.

One of the ammonia/urea producers in The Netherlands also operates a melamine plant, where a part of the produced urea is used as input. For that reason the C stored in the melamine is subtracted from the CO2 emissions from the ammonia production. Until last year, an average storage factor – 17 per cent of the total CO2 emissions from the ammonia production – was used. Since then, the Dutch inventory team has access to the data relating to the produced urea which is used as input in the melamine plant.This information is now used in the calculation .
- 2B2 (Nitric acid production): An IPCC Tier 2 method is used to estimate N2O emissions. The EFs 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 emissions 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 emissions data reported by the manufacturing industry (based on measurements). EFs 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 EFs. These refer to the production of:
  - Industrial gases: CO_2 emissions are estimated on the basis of the use of fuels (mainly natural gas) as chemical feedstock. An oxidation fraction of 20 per cent is assumed, based on reported data in environmental reports from the relevant facilities.
  - Carbon electrodes: CO_2 emissions are estimated on the basis of fuel use (mainly petroleum coke and coke). A small oxidation fraction (5 per cent) is assumed, based on reported data in the environmental reports.
  - Activated carbon: CO_2 emissions are estimated on the basis of the production data for Norit and by applying an EF of 1 t/t Norit. The EF 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 on the basis of an extrapolation of the production level of 33 Tg reported in 2002. This is considered to be justified because this source contributes relatively little to the national inventory of greenhouse gases.
  - Ethylene oxide: CO_2 emissions are estimated on the basis of capacity data by using a default capacity utilisation rate of 86 per cent and applying an EF 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 EFs are used.

4.3.6 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 categories.

No accurate information is available for assessing the uncertainties of the emissions reported by the facilities that 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 per cent and 70 per cent, respectively. The uncertainty in the annual emissions of N_2O from Caprolactam production is estimated to be approximately 30 per cent.

Since the N_2O emissions of HNO_3 production in The Netherlands is included 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 per cent.

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

No recalculations have been made.

4.3.9 Source-specific planned improvements

Efforts will be made to recalculate the total time series for the N_2O emissions from caprolactam production based on the 2011 plant-specific long-term measurements and the production indices.

4.4 Metal production [2C]

4.4.1 Source category description

The national inventory of The Netherlands includes emissions of greenhouse gases related to three source categories 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, resulting in the by-products blast furnace gas and oxygen furnace gas. A small percentage of these gases is emitted (lost) and the rest is subsequently used as fuel for energy purposes. Only the carbon losses are reported in category 2C1. In addition, CO_2 is produced during the conversion of pig iron to steel. These emissions are also reported in this category.
  The process emission from anode use during steel production in the electric arc furnace (EAF) is also included in this category.
- As mentioned in 3.2.7 (1A2a), 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.
- 2C3 Aluminium production: CO_2 and PFC emissions: In The Netherlands aluminium is produced by two primary aluminium smelters Zalco, previously Pechiney (partly closed by the end of 2011), 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 C_2F_6) from the aluminium industry are formed during the phenomenon known as the 'anode effect' (AE), which occurs when the concentration of aluminium oxide in the reduction cell electrolyte drops below a certain level.

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. Magnesium and aluminium foundries (2C4), 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 4.1).

4.4.3 Overview of shares and trends in emissions

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

Total CO_2 emissions from 2C1 (Iron and steel production) decreased by 1.2 Tg during the period 1990–2011. In 2011, CO_2 emissions increased by 0.4 Tg compared with 2010 due to a higher production level in 2011.
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 4.5 shows the trend in CF_4 and C_2F_6 emissions for aluminium production during the period 1990–2011. The largest company produces approximately two-thirds of the total national production. The emissions decreased by 96 per cent between 1995 and 2011. In 1998, the smaller 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 emissions in 2002 was 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 13-002, 13-014 and 13-017 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 and emissions data 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);
- Anode use in the electric arc furnace (EAF): EF= 5 kg CO_2/ton steel produced);
- Aluminium production: EF (consumption of anodes) = 1.45 tons CO_2 per ton aluminium (plant specific; IPCC default = 1.5 t/t aluminium).

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

Table 4.5 Emissions for CF_4 and C_2F_6 from aluminium production (2C3) (Units: Gg CO_2 eq)

Year	PFK14 (CF_4)	PFK116 (C_2F_6)	Total
1990	1,803	444	2,246
1991	1,789	435	2,224
1992	1,626	393	2,019
1993	1,650	391	2,041
1994	1,583	375	1,958
1995	1,535	365	1,901
1996	1,711	393	2,104
1997	1,828	414	2,243
1998	1,345	370	1,715
1999	998	326	1,323
2000	1,045	342	1,387
2001	999	327	1,326
2002	1,534	532	2,066
2003	342	97	439
2004	88	18	106
2005	73	15	87
2006	50	9	59
2007	81	16	97
2008	59	12	72
2009	36	7	43
2010	50	8	58
2011	70	12	82

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 EFs are found in protocols 13-003, 13-014 and 13-017 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 content 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 EFs 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 fuel 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) were used to calculate the CO_2 emissions from the conversion of 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 EF, 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 EF 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 1990–2011. 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 by IPCC source category. The uncertainty in annual CO_2 emissions is estimated to be approximately 6 per cent and 5 per cent for Iron and steel production and Aluminium production, respectively, whereas the uncertainty in PFC emissions from Aluminium production is estimated to be 20 per cent. The uncertainty in the activity data is estimated at 2 per cent for Aluminium production and 3 per cent for Iron and steel production. The uncertainty in the EFs for CO_2 (from all sources in this category) is estimated at 5 per cent and for PFC from Aluminium production at 20 per cent.

Time series consistency

The time series are based on consistent methodologies for the sources in this category.

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

As a result of internal QA/QC procedures, minor errors in the PFC emissions from 2C3 (Aluminium production) were detected and corrected for the period 1999–2007 and for 2009.

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 to either 0.1 or 0.0 Tg (see Table 4.1).

4.5.4 Activity data and emission factors

Detailed information on the activity data and emission factors can be found in monitoring protocol 13-003 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 EFs can be found in protocol 13-003 on the website www.nlagency.nl/nie, as indicated in section 4.1. CO_2 emissions are calculated on the basis of the non-energy use of fuels by the food and drink industry as recorded in the national energy statistics, multiplied by an EF. The EF is based on the national default carbon content of the fuels (see Annex 2), on 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 by IPCC source category. The uncertainty in the emissions of this category is estimated to be 5 per cent. Since this is a very small emission source, the uncertainties in this category are not analysed 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.

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

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 includes emissions of greenhouse gases related to the following source categories in this category:

- 2E1 (Production of HCFC-22): HFC-23 emissions: Chlorodifluormethane (HCFC-22) is produced at one plant in The Netherlands. Tri-fluormethane (HFC-23) is generated as a by-product during the production of

chlorodifluormethane 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 trades in HFCs. Beside 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 emissions) is a trend key source; see Table 4.1.

4.6.3 Overview of shares and trends in emissions

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

Total HFC emissions in category 2E were 5.8 Tg in 1995 and 0.2 Tg CO_2 eq in 2011, with HFC-23 emissions from HCFC-22 production (2E1) being the major source of HFC emissions. HFC emissions from Handling activities (2E3) contributed 18 per cent of the total HFC emissions from this category in 2011.

Table 4.6 shows the trend in HFC emissions from the categories HCFC-22 production and HFCs from handling activities for the period 1990–2011. The emissions of HFC-23 increased about by 35 per cent in the period 1995–1998, due to the increased production of HCFC-22. However, in the period 1998–2000, emissions of HFC-23 decreased by 69 per cent 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 factor, 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 HCFC-22 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 HCFC-22 was much higher in 2010, resulting in higher HFC-23 emissions in 2010, compared with 2009. Mainly because the removal efficiency of the TC was much higher than in 2010, the emissions of HFC-23 declined by 57 per cent in 2011.

The significant emissions fluctuations in category 2E3 during the period 1992–2011 can be explained by the large variety in handling activities, which depended on the demand of the costumers.

Table 4.6 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)

Year	2E1: HFC-23	2E3: HFCs	Total
1990	4,432	NO	4,432
1991	3,452	NO	3,452
1992	4,423	25	4,447
1993	4,947	51	4,998
1994	6,278	129	6,407
1995	5,759	12	5,771
1996	6,887	224	7,110
1997	6,709	707	7,416
1998	7,791	519	8,310
1999	3,440	384	3,825
2000	2,421	418	2,838
2001	450	192	641
2002	685	98	783
2003	415	72	487
2004	354	83	437
2005	196	39	235
2006	281	37	318
2007	243	25	267
2008	212	18	230
2009	154	109	263
2010	391	90	480
2011	166	38	205

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.
  - Amount of 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 emissions of F-gases from this category are based on the following:
- Production of HCFC-22: The removal efficiency of the TC [kg HFC-23 processed in TC/kg HFC-23 in untreated flow/year] is confidential.
- Handling activities (HFCs): The EFs used are plant-specific and confidential, and they are based on 1999 measurement data. More detailed information on the activity data and EFs can be found in the monitoring protocols 13-018 and 13-019 on the website www.nlagency.nl/nie.

4.6.5 Methodological issues

The methodologies used to estimate the greenhouse gas emissions from this category are in compliance with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the method used and EFs can be found in the protocols 13-018 and 13-019 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 from 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 the 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 by IPCC source category.
The uncertainty in HFC-23 emissions from HCFC-22 production is estimated to be about 15 per cent. For HFC emissions from Handling activities the uncertainty is estimated to be about 20 per cent. The uncertainty in the activity data and the EF for Handling activities is estimated at 10 per cent and 20 per cent, respectively. These figures are all based on the judgements 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

As a result of internal QA/QC procedures, minor errors in the unspecified HFC emissions from 2E3, Handling activities, were detected and corrected for 2003–2005 and 2007.

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 includes actual and potential 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 from 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;
- 2F9 Other: HFC emissions from 2F2, 2F3, 2F4 and 2F5.

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 2F2–5 (included in 2F9) and of the SF_6 emissions of 2F7 and 2F8 is reported (included in 2F9).
In past submissions only a table with the potential emissions from Stationary refrigeration and air-conditioning (2F1) was included. From this submission onwards the potential emissions for the period 1990–2011 are included in the CRF. These emissions are determined according to the Tier 1a method (Revised Reference Manual 1996, 2.17.3.2). Because the consumption data of PFCs and SF6 are confidential, only the HFC emissions (2F1 and 2F9) are reported.

4.7.2 Key sources

Emissions from Substitutes for ozone-depleting substances (2F) are identified as a key source of HFCs.

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 per cent in the base year 1995 and 88 per cent in 2011. This corresponds to 2.1 Tg CO_2 eq and accounts for 1.0 per cent of the national total greenhouse gas emissions in 2011.

The level of HFC emissions increased by a factor of 8 in 2011 compared with 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. Actual emissions of SF_6 remained fairly stable during the period 1995–2011. Table 4.7 gives an overview of the trends in actual emissions from 1990 to 2011.

4.7.4 Activity data and emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 13-020 and 13-016 on the website www.nlagency.nl/nie.

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

- Consumption data of HFCs (Stationary refrigeration, Aerosols and Foams) have been obtained from the annual report by 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 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 emissions from these sources.
- Semiconductor manufacturing: Emission factors are confidential information of the only company.
- Sound-proof windows: EF used for production is 33 per cent (IPCC default); EF (leak rate) used during the lifetime of the windows is 2 per cent 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-categories Stationary refrigeration, Mobile air-conditioning, Aerosols, Foams and Semiconductor manufacturing.

The country-specific methods for the sources Sound-proof windows and Electron microscopes are equivalent to IPCC Tier 2 methods. 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 EFs can be found in the protocols 13-020 and 13-016 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 by IPCC source category. The uncertainty in HFC emissions from HFC consumption is estimated to be 50 per cent and the uncertainty in PFC emissions is estimated to be about 25 per cent. The uncertainty in the activity data for the HFC sources and for PFC sources is estimated at 10 per cent and 5 per cent, respectively; for the EFs the uncertainties are estimated at 50 per cent and 25 per cent. All these figures are based on the judgements of experts.

The uncertainty in SF_6 emissions from SF_6 consumption was estimated to be 50 per cent. For the activity data and the EFs for the SF_6 sources, the uncertainty was estimated

Table 4.7 Actual emission trends specified per compound from the use of HFCs, PFCs and SF_6 (2F) (Units: Gg CO_2 eq).

Year	HFC134a	HFC143a	HFC125	HFC152a	HFC32	Other HFCs	HFC Total	PFC use	SF_6 use	Total HFCs/ PFCs/SF_6
1990	NO	NO	NO	NO	NO	NO	NO	18	218	237
1991	NO	NO	NO	NO	NO	NO	NO	21	134	155
1992	NO	NO	NO	NO	NO	NO	NO	24	143	167
1993	NO	NO	NO	NO	NO	NO	NO	28	150	178
1994	73	NO	NO	NO	NO	NO	73	32	191	296
1995	222	7	8	NO	1	10	248	37	287	572
1996	490	26	25	NO	3	21	565	51	295	912
1997	766	46	41	NO	5	18	876	101	325	1,302
1998	892	62	52	NO	6	10	1,022	114	305	1,440
1999	920	76	63	NO	5	5	1,069	147	295	1,512
2000	825	110	90	NO	7	21	1,053	193	295	1,542
2001	600	147	122	NO	8	44	921	163	308	1,392
2002	463	182	152	NO	9	68	873	120	249	1,242
2003	493	220	183	NO	10	97	1,003	180	225	1,408
2004	547	259	215	NO	11	174	1,205	179	253	1,637
2005	544	294	243	NO	11	184	1,277	178	240	1,695
2006	574	329	272	NO	12	240	1,427	194	199	1,821
2007	652	364	301	NO	13	267	1,597	222	188	2,006
2008	696	394	325	NO	13	273	1,701	180	184	2,065
2009	672	418	342	NO	13	364	1,809	125	170	2,105
2010	660	428	355	NO	13	324	1,779	151	184	2,115
2011	676	430	364	NO	14	444	1,928	101	147	2,175

to be about 50 per cent and 25 per cent, 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 per cent. For the activity data and the EFs for the SF_6 sources the uncertainty is estimated to be about 30 per cent and 15 per cent, 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

Because several new sources with detailed information have become available, the emissions of the following sources have been recalculated:

- Stationary refrigeration: For HFC134a a more accurate split of the usage figures (PWC, 2012) into Stationary refrigeration, Mobile air-conditioning and Seagoing shipping became available for the period 2006–2010.
- Mobile air-conditioning: Detailed data about delivery vans and lorries per year became available for the period 2000–2010.
- Other HFCs: A more accurate split of the usage figures into Foam blowing, Fire extinguishers, Aerosols and Solvents became available for the period 2003–2010.

Because of corrections in the consumption data of some HFCs in 2F1 (Stationary refrigeration) in the annual report by PriceWaterhouseCoopers (PWC, 2012), HFC emissions have been recalculated for 2010.
As a result of internal QA/QC procedures, minor errors in the SF6 emissions from 2F8 (Electrical equipment) were detected and corrected.

The results of the recalculation and changes were corrected in this submission (see table 4.8).

4.7.9 Source-specific planned improvements

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

Table 4.8 Effects of changes in the use of HFCs and SF_6 (2F) 1990-2010 (Units: Gg CO_2 eq)

		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HFCs	NIR 2012	NO	248	1,053	922	874	1,060	1,200	1,280	1,409	1,576	1,692	1,777	1,802
	NIR 2013	NO	248	1,053	921	873	1,003	1,205	1,277	1,427	1,597	1,701	1,809	1,779
	Difference	**NO**	***0***	***0***	***0***	***-1***	***-57***	***4***	***-3***	***18***	***21***	***10***	***32***	***-23***
SF_6	NIR 2012	218	287	297	315	262	225	253	240	199	188	184	170	184
	NIR 2013	218	287	295	308	249	225	253	240	199	188	184	170	184
	Difference	***0***	***0***	***-1***	***-7***	***-13***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***

4.8 Other industrial processes [2G]

4.8.1 Source category description

The national inventory of The Netherlands includes 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. No other fuels are included in this category. Oxidation of mineral turpentine is included in sector 3 (Solvent and other product 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 farily constant between 1990 and 2011.

4.8.4 Activity data and emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 13-003 and 13-014 on the website www.nlagency.nl/nie.
The activity data used are based on the following sources:
- Fireworks: data on annual sales from trade organisation;
- Candles: average annual use of 3.3 kg per person (www.bolsius.com);
- Production of drinking water: Volume Statistics Netherlands (CBS);
- Fuel use: 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 $CH_4/10^6$ m^3;
- Use of fuels for production of lubricants: ODU factor of 50 per cent (IPCC default);
- Production of waxes: ODU factor of 100 per cent (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 EFs can be found in protocols 13-003 and 13-014 on the website www.nlagency.nl/nie, as indicated in section 4.1:
- Fireworks and candles: Country-specific methods and EFs are used to estimate emissions of CO_2, CH_4 and N_2O.
- Degassing of drinking water: A country-specific methodology and EF 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 EFs.

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 by 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 per cent (5 per cent in activity data and 20 per cent in EF), 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 per cent (10 per cent in activity data and 50 per cent in EF). The uncertainty in N_2O emissions is estimated at 70 per cent (50 per cent in activity data and 50 per cent in EF). All figures are based on the judgements of experts, since no specific monitoring data or literature are available for the current situation in The Netherlands.

Time series consistency

Consistent methodologies and activity data have been used to estimate the emissions from 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

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 with the National Inventory Report 2012

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

5.1 Overview of sector

Emissions of greenhouse gases in this sector include indirect emissions of CO_2 related to the release of non-methane volatile organic compounds (NMVOC) through the use of solvents and a wide range of other fossil carbon-containing products (e.g. paints, cosmetics and 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 of cream).
The Netherlands has three source categories in this Common Reporting Format (CRF) sector:
- 3A, 3B, 3D (Solvent and other product use): indirect CO_2 emissions (related to NMVOC);
- 3D1 (Anaesthesia): N_2O emissions;
- 3D3 (Aerosol cans): N_2O emissions.

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

The following emissions from the manufacturing industry are 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 other product use in The Netherlands: Protocol 13-014: CO_2, N_2O andCH_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 other product use in The Netherlands were 0.5 Tg CO_2 eq in 1990 and 0.2 Tg CO_2 eq in 2011.
Total emissions of the sector declined by 58 per cent between 1990 and 2003 and decreased further to 68 per cent in 2011. CO_2 emissions from the sector decreased by 59 per cent between 1990 and 2011, 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 per cent from 1990 to 2011 due to better dosing in hospitals and other medical institutions. The emissions of N_2O from food aerosol cans decreased by 82 per cent in this period. Total N_2O emissions from this category have declined by 81 per cent since 1990.
The enormous decrease (92 per cent) in 2010 in N_2O emissions from 3D3 was caused by the tremendous reduction in the sales of food aerosol cans compared with 2009.

Key sources
Solvent and other product use is a minor source of greenhouse gas emissions. No key sources are included in this sector. The largest 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 Solvent and other 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 by solvents from the use of industrial, commercial and household paints. 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 the cleaning and degreasing of surfaces, the dry-cleaning of clothing and textiles and the degreasing of leather.

5.2.2 Activity data and emission factors

Detailed information on the activity data and emission factors of NMVOC estimates can be found in the monitoring protocol 13-014 on the website www.nlagency.nl/nie.
Activity data: Consumption data and the NMVOC content 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

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

Sector/category	Gas	Key	Emissions base year	2010	2011	Absolute 2011–2010	Contribution to total in 2011 (%)		
			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	0.2	0.1	-0.03		0.1	0.1
	N_2O		0.2	0.03	0.03	0.01		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	34	0.03	0.03
3A Paint application	All		0.2	0.1	0.1	0.00	34		0.03
3B Degreasing and drycleaning	CO_2		0.00	0.00	0.00	0.00	1.3	0.00	0.00
3B Degreasing and drycleaning	All		0.00	0.00	0.00	0.00	1.3		0.00
3D Other	CO_2		0.1	0.1	0.1	-0.03	45	0.04	0.04
	N_2O		0.2	0.03	0.03	0.01	21	0.4	0.02
3D1 Anaesthesia	N_2O		0.3	0.1	0.1	-0.03			0.1
3D3 Aerosol cans	N_2O		0.2	0.02	0.03	0.01	18	0.3	0.01
3D Other	All		0.02	0.00	0.00	0.00	3	0.05	0.00
Total National Emissions	CO_2		159.2	181.4	167.6	-13.8		100	
	N_2O		20.0	9.2	9.1	-0.1		100	
National Total GHG emissions (excl. CO_2 LULUCF)	All		213.2	209.2	194.4	-14.8			

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 content of these products has remained stable. Emission factors: It is assumed that all NMVOC in the products 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 content of NMVOC emissions is documented in the monitoring protocol 13-014 on the website www.nlagency.nl/nie.

5.2.3 Methodological issues

The country-specific carbon content of NMVOC emissions from 3A (Paint application), 3B (Degreasing and dry-cleaning) and 3D (Other product use) is 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 content 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 products is very low due to the high share of chlorinated solvents (mainly tetrachloroethylene used for dry-cleaning). The emissions are then calculated as follows:

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

The proportion of organic carbon (of natural origin) in 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 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 expert judgement, the uncertainty in NMVOC emissions is estimated to be 25 per cent and the uncertainty in carbon content is estimated at 10 per cent, resulting in an uncertainty in CO_2 emissions of approximately 27 per cent.

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 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 solvent 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 emission factors

Detailed information on the activity data and emission factors of N_2O estimates are found in the monitoring protocol 13-014 on the website www.nlagency.nl/nie.
Activity data: The major hospital supplier of N_2O for anaesthetic use reports the consumption data of anaesthetic gas in The Netherlands annually. The Dutch Association of Aerosol Producers (NAV) reports data on the annual sales of N_2O-containing spray cans. Missing years are then extrapolated on the basis of thse 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 EF used for N_2O in anaesthesia is 1 kg/kg gas used. Sales and consumption of N_2O for anaesthesia are assumed to be equal each year. The EF 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 13-014 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 Dutch emissions of greenhouse gases. For N_2O emissions, the uncertainty is estimated to be approximately 50 per cent based on the judgement of experts.
Uncertainty in the activity data of N_2O use is estimated to be 50 per cent and that of the EF to be less than 1 per cent (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 with 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 with the National Inventory Report 2012

Emissions: Methane (CH_4) and nitrous oxide (N_2O) emissions from agriculture decreased by 3.8 per cent and 3.4 per cent, respectively, between 2010 and 2011, translating into 3.7 per cent of the total CO_2 eq produced by this sector.

The main reason for the lower CH_4 emissions is lower emission factors for manure management in pigs. These are calculated from (amongst other factors) the organic matter content of manure, for which new data shows lower values over all pig categories. On the other hand, CH_4 emissions from manure management in cattle increased, as result of higher organic matter content in (rose) veal manure and the increasing tendency to keep grazing animals indoors. Consequently, more manure is excreted in the stable, at far higher CH_4 emission factors, than in the meadow.

At the same time, less grazing reduces N_2O emissions, as (contrary to CH_4) stable manure has a lower N_2O emission factor than meadow manure. The resulting shift in emissions from source category 4D (Agricultural soils) to 4B (Manure management) thus has a positive balance for N_2O emitted. Finally the implementation of abatement techniques within animal housing increased further in 2012, resulting in less indirect N_2O emissions following deposition of ammonia (NH_3) and nitric oxide (NO).

Key sources: Compared with the NIR 2012, "4A8 CH_4 emissions from enteric fermentation domestic livestock: swine" is a new key source (L2).

Methodologies: An error correction was made in the calculation of emission factors for CH_4 from manure management. The density used was incorrect and has been adjusted, increasing emissions by 1.2 per cent for the whole time series.

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 and fisheries; see section 3.2.9) and in 5 (Land use, land use change and forestry; see 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 and burning in the field are prohibited by law and therefore negligible in practice.

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

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

The following protocols (on www.nlagency.nl/nie) describe the methodologies, activity data and EFs applied in estimating N_2O and CH_4 emissions from the Agriculture sector in The Netherlands:
- Protocol 13-027: CH_4 from Enteric fermentation (4A);
- Protocol 13-028: N_2O from Manure management (4B);
- Protocol 13-029: CH_4 from Manure management (4B);
- Protocol 13-030: N_2O from Agricultural soils: indirect emissions (4D);
- Protocol 13-031: 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 Agriculture source categories to the total national greenhouse gas inventory. This table also presents the key sources identified in the Agriculture sector as specified by trend or level, or both.

CO_2 equivalent emissions from sector 4 Agriculture contributed 8.2 per cent to total national emissions (without LULUCF) in 2011, compared with 10.6 per cent in 1990. In 2011, emissions of CH_4 and N_2O from agricultural sources accounted for 60 per cent and 75 per cent, respectively, 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 29 per cent between 1990 and 2011, from 22.6 Tg CO_2 eq in 1990 to 16.0 Tg CO_2 eq in 2011 (see also Figure 6.1). This decrease was largely the result of reduced numbers of livestock, a decreased application of animal manure and a decreased use of synthetic fertilisers.

Compared with 2010, animal numbers have remained fairly stable except for a 4.3 per cent decrease in poultry (counteracting last year's increase). The opposite is seen in goats, where a 7.8 per cent increase offsets the 5.6 per cent decrease of last year. Moreover, fewer sheep (-3.6 per cent) and cattle (-2.3 per cent) were kept, the latter mostly for meat. Since EFs for CH_4 emissions from enteric fermentation in cattle remained almost unchanged and the contribution of this animal category to the total is large, this completely reflects the somewhat lower emissions in CRF category 4A. New data became available on the organic matter content of manure, indicating lower values for pigs. This has resulted in lower calculated EFs and therefore CH_4 emissions from Manure management (4B). The increasing tendency to keep grazing animals indoors has continued, thus increasing emissions in source category 4B but lowering N_2O emissions in category 4D (Agricultural soils). Stable manure has far higher CH_4 and considerably lower N_2O emissions than meadow manure. Implementation of abatement techniques in animal houses also increased further, reducing indirect N_2O emissions from atmospheric deposition of NH_3 and NO.

Overview of trends in activity data

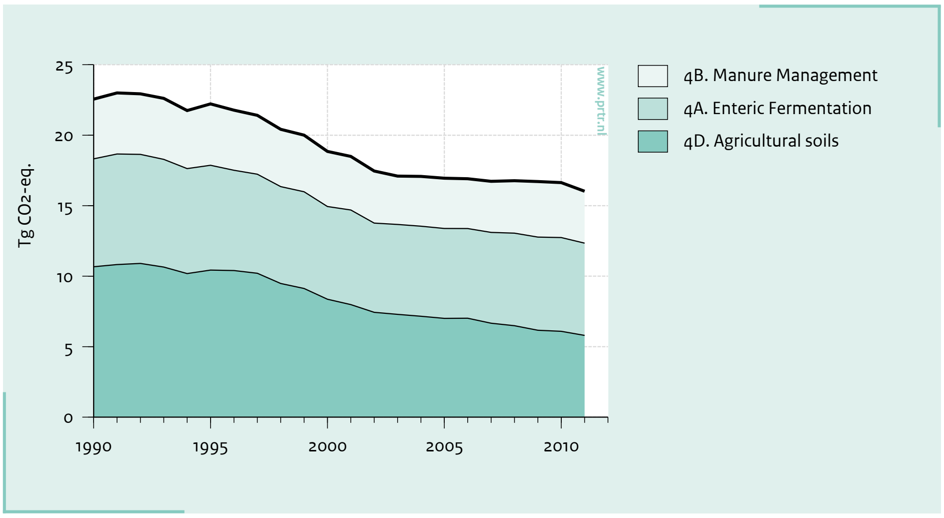
Livestock numbers are the primary activity data used in the calculation of CH_4 and N_2O and are taken from the annual agricultural survey performed by Statistics Netherlands (CBS). Data can be found on the website www.cbs.nl, in Annex 8 Table A8.1 and in background documents (e.g. Van der Hoek and Van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

The number of privately owned horses is estimated by the Product Boards for Livestock, Meat and Eggs (PVE, 2005) to be around 300,000. As information on activity data is scarce, this estimation is used for the whole time series. Because The Netherlands chooses not to report emissions in the Common Reporting Format (CRF) sector 7 (Other), the estimation is being added to the numbers from the

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	2010 Tg CO_2 eq	2011 Tg CO_2 eq	Absolute 2011–2010 Tg CO_2 eq	Contribution to total in 2011 (%) by sector	of total gas	of total CO_2 eq
4 Agriculture	CH_4		10.7	9.5	9.2	-0.37	57	60	4.7
	N_2O		11.9	7.1	6.9	-0.2	43	75	3.5
	All		22.6	16.6	16.0	-0.6			8.2
4A Enteric fermentation	CH_4		7.7	6.6	6.5	-0.10	41	43	3.4
4A1 Cattle	CH_4	L,T1	6.8	5.9	5.8	-0.10	36	38	3.0
4A8 Swine	CH_4	L2	0.4	0.4	0.4	0.01	2	3	0.2
4A2-7, 10-13 Other animals	CH_4		0.4	0.4	0.4	-0.01	2	3	0.2
4B Manure management	CH_4		3.1	2.9	2.6	-0.26	16	17	1.4
	N_2O	L	1.2	1.0	1.1	0.05	7	12	0.5
	All		4.2	3.9	3.7	-0.21			1.9
4B1 Cattle	CH_4	L,T	1.6	1.7	1.8	0.06	11	12	0.9
4B8 Swine	CH_4	L,T	1.2	1.1	0.8	-0.3	5	5	0.4
4B9 Poultry	CH_4	T2	0.3	0.05	0.04	0.01	0.3	0.3	0.02
4B2-7, 10-13 Other animals	CH_4		0.03	0.03	0.02	-0.01	0.2	0.2	0.01
4D Agriculture soils	N_2O		10.7	6.1	5.8	-0.3	36	64	3.0
4D1 Direct soil emissions	N_2O	L,T	4.1	3.3	3.2	-0.05	20	36	1.7
4D2 Animal production on agricultural soils	N_2O	L,T	3.1	1.3	1.1	-0.20	7	12	0.6
4D3 Indirect emissions	N_2O	L,T	3.4	1.5	1.4	-0.04	9	16	0.7
National Total GHG emissions (excl. CO_2 LULUCF)	CH_4		25.7	15.9	15.3	-0.7		100	
	N_2O		20.0	9.2	9.1	-0.1		100	
	All		213.2	209.2	194.4	-14.8			100

Figure 6.1 Category 4 'Agriculture': trend and emission levels of source categories, 1990-2011.



agricultural census. It is subsequently used in calculations and reported as part of agriculture.

For cattle, three categories are distinguished (option B in the CRF):

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

Table 6.2 Numbers of animals in 1990-2011 (1,000 heads) (www.cbs.nl).

Animal type	1990	1995	2000	2005	2010	2011
Cattle	4,926	4,654	4,070	3,799	3,975	3,885
- Adult dairy cattle	1,878	1,708	1,504	1,433	1,479	1,470
- Adult non-dairy cattle	120	146	163	152	115	105
- Young Cattle	2,929	2,800	2,403	2,214	2,381	2,311
Sheep	1,702	1,674	1,308	1,363	1,130	1,088
Goats	61	76	179	292	353	380
Horses	370	400	418	433	441	436
Pigs (*1000)	13.9	14.4	13.1	11.3	12.3	12.4
Poultry (*1000)	94.9	91.6	106.5	95.2	103.4	98.9
Other animals	659	527	641	745	1001	1,016

Between 1990 and 2011, (dairy) cattle, pig and sheep numbers decreased by 21 per cent, 11 per cent and 36 per cent, respectively. Poultry and horse numbers increased by 4 per cent and 18 per cent, respectively, over the same period, while goat numbers increased more than fivefold. Within the 'other animals' category, the numbers of rabbits and fur-bearing animals are reported to have increased by 54 per cent over the 1990–2011 period.

For mature dairy cattle, the decrease in numbers was associated with an increase in milk production per cow between 1990 and 2011. The increased milk production per cow is the result of both genetic changes (due to breeding programmes for milk yield) as well as the increase in feed intake and higher quality of cattle feed. Total milk production in The Netherlands is determined mainly by European Union (EU) policy on milk quotas, which have remained mostly unchanged. In order to comply with the milk quota, animal numbers of mature dairy cattle therefore had to decrease to counteract the effect of increased milk production per cow. In the last few years, increase of Dutch milk quotas have again led to an increase in the number of mature dairy cattle. Between 1990 and 2011 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 government measures such as the partial purchase of the pig and poultry production rights (ceilings for total phosphate production by animals) and lowering the maximum application standards for manure and synthetic fertilisers. 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 per cent as a direct result of the avian flu outbreak. In the following years, the population recovered, reaching a level only slightly below the 2002 number in 2011.

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 tended to redirect 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 animals (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. In addition to 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 accompanied by high methane production by methanogens in the rumen.

Of the animal categories within the CRF, camels and llamas do not occur in The Netherlands. Numbers of buffalo, mules and donkeys are small and therefore not estimated within the inventory. Enteric fermentation from poultry is not being reported due to the negligible amount of CH_4 production in this animal category. The IPCC Guidelines do not provide a default EF either, nor do other parties estimate enteric CH_4 emissions from poultry.

6.2.2 Overview of shares and trends in emissions

In 2011 Enteric fermentation accounted for 41 per cent of the total greenhouse gas emissions from the Agriculture sector in The Netherlands (see Table 6.1). Cattle accounted for the majority (88 per cent) of CH_4 emissions from enteric fermentation that year. Swine contributed 6 per cent and Other animals (consisting of sheep, goats and horses) accounted for the remaining 6 per cent.

CH_4 emissions from Enteric fermentation decreased from 7.7 Tg CO_2 eq to 6.5 Tg (-14 per cent) between 1990 and 2011, which is fully explained by a decrease in CH_4 emissions from. Although EFs for Enteric fermentation in cattle increased during this period, the reduction in cattle numbers has more than compensated for 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 and or a change in EF. Detailed information on data sources for activity data and EFs can be found in the following monitoring protocol: Protocol 13-027: CH_4 from Enteric fermentation (4A).

All relevant documents concerning methodology, EFs 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 Table A8.1 of Annex 8, a more detailed breakdown of animal numbers is presented for the reference years.

Cattle

The EFs for cattle are calculated annually for several sub-categories 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 on the basis of total milk production and feed composition. For young cattle the energy requirement is calculated on the basis of total weight gain and feed composition.

The intake of grass silage, maize silage, wet by-products, concentrates and grass products is estimated from national statistics found at www.cbs.nl. 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/head/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 (laboratory in the Dutch agricultural and horticultural sector with roughage sampling and analytical services, delivering data that can be taken as representative of average Dutch farming conditions; www.blgg.com). Data used between 1990 and 2008 are published by Bannink (2011).

Young cattle and non-dairy cattle

The methane 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 can be found at www.cbs.nl and gross energy intake figures can be found in Annex 8, Table A8.2. The equation for calculating the EF (in kg per animal per year) is:

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

where

EF = Emission factor (kg CH_4/animal/year);

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	2010	2011
Mature dairy cattle	110	116	120	126	129	128
Mature non-dairy cattle	65	66	67	71	72	73
Young cattle	37	37	35	34	34	34

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

	1990	1995	2000	2005	2010	2011
Milk production	6,003	6,596	7,416	7,568	8,075	8,063
EF for methane	110	116	120	126	129	128

MCF= Methane conversion factor (the fraction of the gross energy of feed intake converted to CH_4); 0.04 for white veal calves and 0.06 for the other categories of young cattle and mature non-dairy cattle (IPCC, 2001).

GE intake = Gross Energy intake (MJ/animal/day); = dry matter intake (kg DM/animal/day) × 18.45 MJ/kg DM (IPCC, 2001)

Tables A8.2 and A8.3 show the gross energy intake and EFs as calculated for cattle.

Trends in cattle emission factors

Table 6.3 shows the EFs of the three cattle categories reported. The EF for young cattle is an average of several sub-categories (Annex 8, Table A8.3).

For both mature dairy cattle and mature non-dairy cattle, EFs increased primarily as a result of an increase in total feed intake during the period 1990–2011. 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 EF between 1990 and 2011 can be explained by a decrease in the average total feed intake due to a shift towards meat calves in the population of young cattle (Annex 8, Table A8.1).

Comparison of cattle emission factors with IPCC defaults

Table 6.4 shows that the mature dairy cattle EF follows the increasing trend in milk production. Compared with the IPCC default EF of 118 kg CH_4 per cow per year (at a milk production rate of 6,700 kg/cow/year), the EF used in The Netherlands is slightly lower.

In 1997, for instance, a milk production of about 6,800 kg/cow/year led to an EF of 117 kg CH_4/cow/year, less than 1 per cent lower than the default of 118 kg CH_4/cow/year. An explanation of the difference can be found in the data on feed intake and the dietary and nutrient composition of dietary components as input to an alternative country-specific model that predicts the methane EF for mature dairy cattle (Bannink, 2011). With increasing milk production per cow, a decrease in the amount of CH_4 emissions per unit of milk produced (from 0.018 to 0.016 kg CH_4/kg milk) can be seen.

The higher EF for mature non-dairy cattle (compared with 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 EF for young cattle compared with the IPCC default value (Annex 8, Table A8.1).

Other livestock

For swine, sheep, goats and horses, IPCC default EFs are used (1.5, 8, 5 and 18 kg CH_4/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 emissions is lower due to a gradual increase in calculated EFs.

For more information on methods and the calculation used, see sections 6.2.4 and 6.2.5.

6.2.4 Methodological issues

A detailed description of the method used, data sources and EFs is found in the protocol on www.nlagency.nl/nie, as indicated in section 6.1. In 2009, a recalculation was carried out with regard to feed intake and resulting cattle EFs for the whole time series (CBS, 2009 and Bannink, 2011).

Emission factors used for the source categories swine, sheep, horses and goats are IPCC default Tier 1 EFs (IPCC, 1997). As these factors are averages over all age groups, they have to be multiplied by the total number of animals in their respective categories. This is in contrast to the calculations for sector 4B (Manure management), where the young animals have been included in the manure production of the mother animal. For this reason, the activity data used in the two calculations is different. The other livestock categories (sheep, goats, horses and swine) have a share in total CH_4 emissions from enteric fermentation of less than 10 per cent. According to the IPCC Good Practice Guidance, no Tier 2 method is needed if the share of a source category is less than 25 per cent of the total emissions from a key source category.

As already mentioned in section 6.2.1, enteric fermentation emissions from poultry are not estimated due to negligible amounts and lack of data on CH_4 emission factors for this animal category.

Emissions from enteric fermentation are ultimately calculated from activity data on animal numbers and the appropriate EFs:

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

6.2.5 Uncertainty and time series consistency

Uncertainty
The Tier 1 uncertainty analysis shown in Annex 7 provides estimates of uncertainty by IPCC source category. The uncertainty of CH_4 emissions from enteric fermentation in cattle is based on the judgements of experts and is estimated to be about 16 per cent in annual emissions for mature dairy cattle, using a 5 per cent uncertainty for animal numbers (Olivier et al., 2009), and 15 per cent for the EF (Bannink, 2011). For the other cattle categories, this is 21 per cent, based on 5 per cent uncertainty in activity data and 20 per cent on the EF. The uncertainty in the EF for swine and other animals is estimated to be 50 per cent and 30 per cent, 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 EFs. The animal population data are collected in an annual census and published by Statistics Netherlands (CBS) over a long period (several decades). Emission factors are either constant (IPCC default) or 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. 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 the requirements set by the Farm Accountancy Data Network (FADN) of the European Union, from 2010 on a new definition for farms has been used. Before this, the criterion for inclusion in the agricultural census was three Dutch size units (NGE); this has been changed to 3,000 Standard Output (SO). As the influence on measured population is very slight, the official statistics were not recalculated and therefore the inventory also remained unchanged for historic years.

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

None.

6.2.8 Source-specific planned improvements

Within the calculation of the CH_4 emission factor for mature dairy cattle (Bannink, 2011), a subdivision is made between the NW and SE parts of the country. The reason is that feed rations differ considerably between the two regions, especially with regard to the amount of maize. As a result, EFs for the NW and SE will also differ significantly from the national average being used until now.

It is planned to start making this distinction for the whole time series, in order to acknowledge these regional differences. On the national scale this could induce slight differences, due to the rounding of numbers.

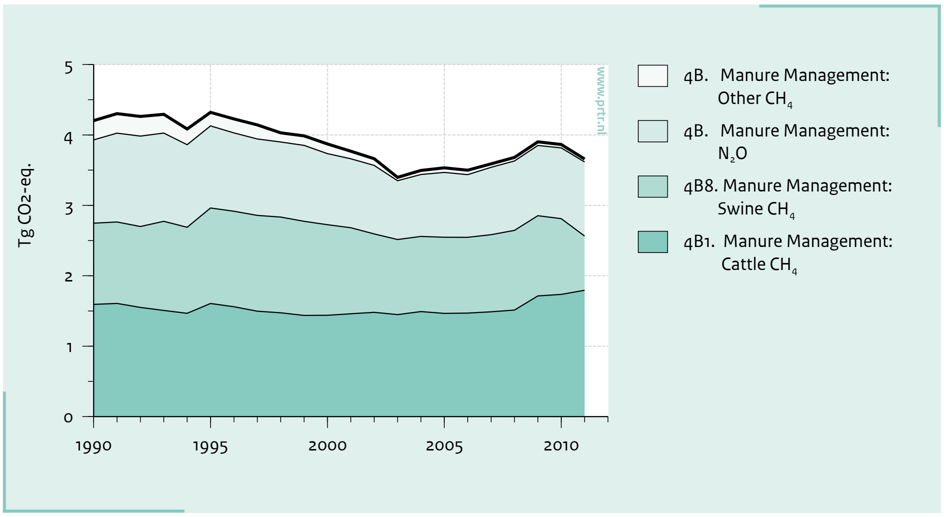
6.3 Manure management [4B]

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, horses and other animals (rabbits and fur-bearing animals). These emissions are related to the quantity and composition of the manure, and to manure management system types and the conditions therein. For instance, aerobic conditions in a manure management system will generally increase N_2O emissions and decrease CH_4 emissions compared with an anaerobic situation. Furthermore, longer storage times and higher temperatures will increase CH_4 emissions.

Of the animal categories within the CRF, camels and llamas do not occur in The Netherlands. Numbers of buffalo, mules and donkeys are small and therefore not included in the inventory. Three animal manure management systems are distinguished for emissions 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

Figure 6.2 Category 4B Manure management: trend and emission levels of source categories, 1990-2011.



taken into account in the source category 4B (Manure management; see section 6.1), but are included in the source category 4D (Agricultural soils; see section 6.4).

6.3.2 Overview of shares and trends in emissions

In 2011, manure management accounted for 23 per cent of the total greenhouse gas emissions from the Agriculture 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 2011 contributed 11 per cent and 5 per cent, respectively, of total greenhouse gas emissions in the Agriculture sector. Poultry is a minor key source for CH_4 emissions from Manure management. Furthermore, N_2O emissions from Manure management contribute 7 per cent of total greenhouse gas emissions from the Agriculture sector.

CH_4 from Manure management

Between 1990 and 2011, emissions of CH_4 from Manure management decreased by 14 per cent. Emissions from cattle increased by 13 per cent, while swine and poultry emissions decreased by 33 per cent and 84 per cent during this period. With cattle being kept indoors more, a larger proportion of manure excretion was taking place in the stable at far higher EFs. In poultry, the decrease was mostly associated with changing husbandry, from battery cage systems with liquid manure to ground housing or the aviary system with solid manure. For pigs, lower animal numbers were the main driver of the decrease.

From the decrease in animal numbers and manure production for swine (Annex 8, Tables A8.1 and A8.8) an overall decrease in CH_4 emissions is to be expected over the time series. However the decrease is countered by an increase in EF (Annex 8, Table A8.7). The EF has increased with the fraction of manure stored under higher temperatures, i.e. in the stable. For young and mature dairy and non-dairy cattle, emissions do decrease as a result of lower animal numbers and only a small increase in EF. For poultry, the large decrease in CH_4 emissions between 1990 and 2011 can be explained only by the shift towards the solid manure management system with an associated lower EF.

When comparing 2011 with 2010, emissions of CH_4 from Manure management show a 9 per cent decrease. New measurements of the organic matter content of manure (Commissie Bemesting Grasland en Voedergewassen, 2012) have given rise to most of the shifts, since these are reflected directly in the EFs being calculated. Lower values are seen for pigs and horses, and higher for rose veal (as a part of young stock) and fur-bearing animals (as part of other animals). In poultry, three effects lead to lower emissions, namely a decrease in the organic matter content of broiler manure, fewer laying hens kept and the ongoing shift to solid manure within the latter category. On the other hand, emissions from cattle increase as a result of a growing tendency to keep animals indoors: a larger proportion of the manure is excreted in the stable, at far higher EFs.

N_2O from Manure management

The emissions of N_2O from Manure management decreased by 10 per cent between 1990 and 2011, from 1.2 to 1.1 Tg CO_2 eq (table 6.1). Decreasing animal numbers have been the cause of this trend: from 2007 on it has changed back into an increase. The decrease in nitrogen (N) excretion in the stable is only partly counteracted by an increase in EF.

Compared with 2010, N_2O from Manure management increased by 4.8 per cent, which is explained by rapid changes in shares of housing systems for laying hens. Anticipating the ban on battery cage systems effective from 2012, farmers changed their management towards ground housing or the aviary system. In the process they switched from solid manure without bedding (on which birds do not walk), to solid with bedding (on which the birds do walk). Following the Good Practice Guidance 2001, the EF increased from 0.5 per cent to 2 per cent in this case. Lower numbers of laying hens only partly compensated for the effect.

6.3.3 Activity data and emission factors

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

- Protocol 13-029: CH_4 from Manure management (4B);
- Protocol 13-028: N_2O from Manure management (4B).

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

CH_4 emission factors for Manure management

The CH_4 EF for Manure management is calculated annually for all animal categories. A Tier 2 approach is used based on country-specific data on manure production per animal, and 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.

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 * 0.67

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

The Dutch approach differs from the IPCC default in that it uses OM content instead of volatile solids (VS) content. The reason lies in country-specific Bo values also being expressed in terms of OM content. 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 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 were used. The IPCC Guidelines recommend an MCF value of 0.01 for stored solid cattle manure and 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 method applied by The Netherlands for CH_4 calculations differs slightly from the IPCC method, it is in accordance with the IPCC GPG2000. The Netherlands uses a country-specific EF 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 EF 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).

For comparison, table 6.5 shows the IEFs for manure management in animal categories contributing the most to CH_4 emissions. These are expressed as kg CH_4 per animal per year, and were calculated by dividing total emissions by animal numbers in a given category.

Trends in implied emission factor

Mature dairy cattle

The IEF for Manure management of mature dairy cattle increased between 1990 and 2011 because the increased milk production during that period (yable 6.4) was accompanied by an increase in manure production per cow and an increase in organic matter content of cattle manure. Both developments resulted 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

Table 6.5 CH_4 implied emission factor (kg/head/year) for Manure management as specified by animal category, 1990-2011.

Animal type	1990	1995	2000	2005	2010	2011
Cattle						
- mature dairy cattle	28.04	30.84	33.55	37.95	43.09	43.09
- mature non-dairy cattle	3.27	3.58	3.50	3.50	3.50	3.53
- young cattle	7.79	8.32	7.27	6.71	7.77	9.41
Swine*	3.95	4.49	4.67	4.55	4.18	2.95
Swine excl piglets	6.30	7.34	7.64	7.63	7.19	5.14
- fattening pigs	5.03	6.15	6.40	6.40	5.86	4.20
- breeding swine	11.52	12.39	13.01	13.11	13.55	9.64
Poultry	0.14	0.10	0.06	0.03	0.02	0.02
Other animals	0.13	0.12	0.10	0.09	0.11	0.17

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

meadow). The share of the amount of liquid stable manure increased between 1990 and 2011, while simultaneously the amount of manure produced in the meadow during grazing reduced (Annex 8, Table A8.8). This was a consequence of the increase in the average time dairy cattle were 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 EF for CH_4 emissions, the new practice to keep the herd in the stable during the whole year increased methane emissions per head (Annex 8, Table A8.7; Van der Hoek and Van Schijndel, 2006).

Poultry

For poultry, the substantial decrease in the CH_4 IEF of Manure management between 1990 and 2011 mainly explains the CH_4 emissions 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 2011 from approximately 40 per cent to more than 99 per cent. So the liquid manure system was almost completely replaced by the solid manure system. Compared with the liquid manure system, the CH_4 emission factor for the solid system is about 15 times lower (Annex 8, Table A8.7). Overall, this leads to a substantially decreased IEF, which even in combination with a 9 per cent increase in animal numbers fully explains the decrease in CH_4 emissions (Van der Hoek and Van Schijndel, 2006).

Swine

Compared with 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, Tables A8.4 and A8.5). There are interannual changes not explained by this. These changes can be explained by looking at the EFs of the 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 also accounted for). Thus, presenting the underlying IEFs gives a better understanding of the interannual changes.

For fattening pigs, the 22 per cent increase in IEF between 1990 and 1995 is explained by a 4 per cent decrease in manure production per animal combined with a 20 per cent increase in the organic matter (OM) content of the manure and a higher storage temperature. The 4 per cent increase in IEF between 1995 and 2000 is explained by an 8 per cent increase due to higher storage temperature counteracted by a 4 per cent 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 did manure volume decrease, but also an increase in the OM concentration of manure occurred. A higher OM content results in a higher EF.

The interannual changes in the IEF for breeding pigs' manure are explained by interannual changes in the relative numbers of the different swine categories. Furthermore, between 1999 and 2000, a 2 per cent 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.

Table 6.6 N_2O implied emission factor for Manure management and total N-excretion per animal manure management system, 1990-2011 (Units: mln kg/year and kg N_2O/kg manure).

	1990	1995	2000	2005	2010	2011
Total N-excretion	514.5	516.1	432.6	393.6	423.3	423.2
- liquid system	412.4	411.8	337.7	305.2	326.8	329.4
- solid storage	102.1	104.3	94.8	88.4	96.5	93.8
N_2O emission manure management	3.81	3.76	3.26	2.97	3.24	3.39
N_2O IEF manure management	0.0074	0.0073	0.0075	0.0075	0.0077	0.0080

Comparison with IPCC default methane emission factor
The EFs per animal type used by The Netherlands cannot be compared directly with 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 the amount of VS produced per animal per day (kg per head per day) used 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 IPCC default EFs. More details are presented in Annex 8.

Compared with 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 an MCF of 1.5 per cent 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 for Manure management
Emissions of N_2O from manure management are calculated within the NEMA model, where EFs 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 2011, 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 emissions 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 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.

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/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 per cent. The uncertainty in the amount of animal manure (10 per cent) is based on a 5 per cent uncertainty in animal numbers and a 5–10 per cent uncertainty in excretion per animal. The

resulting uncertainty of 7–11 per cent was rounded off to 10 per cent. The uncertainty in the CH_4 emission factors for Manure management, based on the judgements of experts, is estimated to be 100 per cent (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 the requirements set by the Farm Accountancy Data Network (FADN) of the European Union, from 2010 on a new definition for farms has been used. Before, the criterion for inclusion in the agricultural census was three Dutch size units (NGE); this has been changed into 3,000 Standard Output (SO). As influence of this change in definition on measured population is very slight, the official statistics were not recalculated and therefore the inventory also remained unchanged for historic years.

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

In the past submissions a constant density of methane of 0.662 kg/m3 was used in the calculation of EFs for CH4 emissions from Manure management. This differs from the value of 0.67 in the IPCC Guidelines, and the reason could not be ascertained from the literature. It was thus deemed an error, which has been corrected in the current submission, increasing the whole time series by 1.2 per cent.

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 per cent of the total liquid stable manure was 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 initial research (Hoeksma et al., 2012) indicate that further investigation is needed.

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 2011, agricultural soils contributed 36 per cent of total greenhouse gas emissions in the Agriculture sector. Direct and indirect N_2O emissions and emissions from animal production in the meadow contributed 20 per cent, 9 per cent and 7 per cent respectively, of total greenhouse gas emissions in the Agriculture sector.

Total N_2O emissions from Agricultural soils decreased by 46 per cent between 1990 and 2011 (see figure 6.3). Direct emissions decreased by 22 per cent, while emissions from animal manure produced in the meadow and indirect emissions decreased by 65 per cent and 57 per cent, respectively.

These decreases were 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 the policy to reduce ammonia emissions.

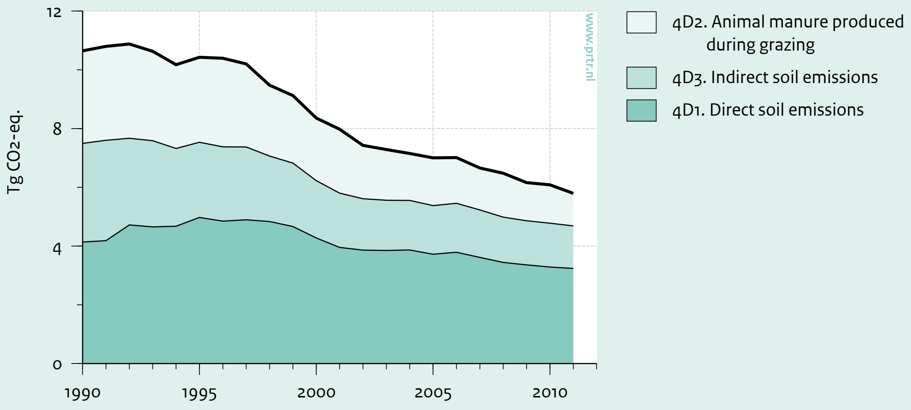
6.4.3 Key sources

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 emission factors

Detailed information on data sources (for activity data and emission factors) can be found in the following monitoring protocols:
- Protocol 13-030: N_2O from Agricultural soils: indirect emissions (4D);
- Protocol 13-031: N_2O from Agricultural soils: direct emissions and grazing emissions (4D).

Figure 6.3 Category 4D Agricultural soils: trend and emission levels of source categories, 1990-2011.



More details and specific data (activity data and EFs), including data sources (EFs), are included in background documents. All relevant documents concerning methodology, EFs 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 EFs 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. Between 70 per cent and 85 per cent of the manure N collected in the stable and in storage is applied to soils. A growing proportion of the manure N (from 1 per cent in 1990 to 7 per cent in 2011) is exported; while approximately
10–20 per cent 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 40 per cent between 1990 and 2011. 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 manure production rights and maximum nutrient application standards for manure and fertiliser.

Of the manure N applied to the soil between 1990 and 2011, the part emitted as ammonia (NH_3) decreased from 45 per cent to 12 per cent, 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 grassland 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 2011 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 per cent to 12 per cent.

Part of the total nitrogen flow to the soil is subject to leaching and run-off and until 2009 the IPCC default 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 and NO 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 manure and synthetic fertiliser application, softened by an increase in IEF because of the incorporation into soil.

Emission factors

An overview of the EFs used is presented in table 6.8. IPCC default EFs are included for comparison.

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

	1990	1995	2000	2005	2010	2011	Change 1990–2011
Nitrogen fertiliser consumption	412.4	405.8	339.5	279.2	219.5	214.1	-48%
Nitrogen excretion by animals	710.4	696.0	565.2	494.9	504.6	492.1	-31%
Nitrogen excretion in animals houses	514.5	516.1	432.6	393.6	423.3	423.2	-18%
of which in solid form	102.1	104.3	94.8	88.4	96.5	93.8	-8%
of which in liquid form	412.4	411.8	337.7	305.2	326.8	329.4	-20%
Nitrogen in net manure exported abroad	5.9	22.4	18.0	26.2	36.1	36.6	520%
Available manure for application (N-excretion in animal houses – total N-emissions in animal houses – export)	410.3	399.8	336.3	299.0	293.4	289.5	-29%
Nitrogen excretion in meadow	195.9	179.9	132.5	101.2	81.3	68.9	-65%
Nitrogen in sewage sludge on agric. land	5.0	1.5	1.5	1.2	0.9	0.9	-82%
Total nitrogen supply to soil (manure + fertiliser + sewage sludge - export)	1121.9	1080.9	888.2	749.1	688.8	670.5	-40%
Nitrogen fixation in arable crops	7.8	4.9	4.7	4.5	4.4	4.2	-46%
Nitrogen in crop residues left in field	36.4	34.9	34.1	32.1	25.5	25.8	-29%
Nitrogen in histosols	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	8.8	9.1	-24%
NO-N emission from synthetic fertilisers	4.9	4.9	4.1	3.4	2.6	2.6	-47%
NH_3-N emission in animal houses	72.3	70.5	56.3	46.2	45.1	42.4	-41%
NO-N emission in animal houses	2.4	2.4	2.1	1.9	2.1	2.2	-8%
NH_3-N emission from manure application	182.6	63.7	51.0	44.5	34.5	34.5	-81%
NO-N emission from manure application	4.9	4.8	4.0	3.6	3.5	3.5	-29%
NH_3-N emission in meadow	15.2	13.7	4.5	3.0	1.8	1.3	-91%
NO-N emission in meadow	2.4	2.2	1.6	1.2	1.0	0.8	-67%
Atmospheric deposition agr. NH_3-N NO-N	296.6	174.1	134.0	115.1	99.5	96.4	-68%
Nitrogen lost through leaching and run off	157.1	140.5	106.6	89.9	82.7	80.5	-49%

Table 6.8 Emission factors for direct N_2O emission from soils, expressed as kg N_2O-N per kg N supplied

Source	IPCC default	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 andVan der Sluis, 2011.

Table 6.9 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
2011	0.009

Implied emission factors

Table 6.9 shows the IEFs for N_2O emissions from agricultural soils for the application of animal manure. A 117 per cent increase in IEF occurred in the period 1990–2011, 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 per cent decrease in N manure input to soil (see table 6.7), this explains the 53 per cent increase in N_2O from manure application.

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).

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 a lower EF and incorporation into soil with a higher EF. The higher value for incorporation is explained by two mechanisms. Incorporation of animal manure into the soil produces less ammonia 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 N flows in order to make them more transparent. At the same time, EFs have been updated on the basis of laboratory and field experiments quantifying the effect of manure application technique on N_2O emission (Velthof et al., 2010; Velthof and Mosquera, 2011; Van Schijndel and 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 the total animal production multiplied by a country-specific EF to yield the emisson; 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 '$frac_{leach}$' 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 for using 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 EF 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 per cent. 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 the requirements set by the Farm Accountancy Data Network (FADN) of the European Union, from 2010 on a new definition for farms has been used. Before, the criterion for inclusion in the agricultural census was three Dutch size units (NGE); this has been changed into 3,000 Standard Output (SO). As influence on measured population is very slight, the official statistics were not recalculated and therefore the inventory also remained unchanged for historic years.

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

None.

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 with the National Inventory Report 2012

Emissions:	The emissions data from LULUCF for 2011 are about 8 per cent higher than those from 2010. The present value for 2010 is about 1 per cent higher than in the previous NIR (2012) due to the inclusion of wildfires in forests for the first time.
Key sources:	No changes compared with NIR 2012
Methodologies:	To increase completeness this year CO_2, CH_4 and N_2O emissions from wildfires in forests (forest fires) are included for the first time. This has resulted in a very minor decreased sink of CO_2 and increased emissions of CH_4 and N_2O in Forest land.

7.1 Overview of sector

This chapter describes the 2011 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 per cent), settlements (13 per cent) and forestry (10 per cent, including trees outside forests); 2 per cent comprises dunes, nature reserves, wildlife areas and heather. The remaining area (19 per cent) 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 per cent of the land area. The Netherlands has an intensive agricultural system with high inputs of nutrients and organic matter. The majority of agricultural land is used as grassland (51 per cent), for arable farming (25 per cent) or to grow fodder maize (12 per cent), and the remaining land is fallow or used for horticulture, fruit trees, etc. About 80 per cent of grassland is permanent grassland (of which 5 per cent are high nature value grasslands); the remaining 20 per cent is temporary grassland, on which grass and fodder maize are cultivated in rotation. Since 1990, the agricultural land area has decreased by about 5 per cent, mainly because of conversion to settlements/ infrastructure and nature. The LULUCF sector in The Netherlands is estimated to be a net source of CO_2 , amounting in 2011 to some 3.3 Tg CO_2 equivalent. The fact that the LULUCF sector is a net source is due to the large amount of carbon emitted from drained peat soils, which exceeds the sequestration of carbon in forestry. The LULUCF sector is responsible for 1.7 per cent of total greenhouse gas emissions 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).

7.2 Methods

The methodology of The Netherlands to assess the emissions 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 (5A); Cropland (5B); Grassland (5C); Wetlands (5D); Settlements (5E) and Other land (5F). There is also a category Other (5G), 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 forests; and the category Grassland is the aggregation of the main subdivisions Grassland 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. 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. Based on studies by Hanegraaf et al. (2009) and Reijneveld et al. (2009) The Netherlands assumes that mineral soils are not a net source of CO_2 emissions over the period 1990–2011. This is a conservative approach.
To meet the requirement of 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), a background study by Lesschen et al. (2012, in Dutch) 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 more aggregated and complete reporting, The Netherlands, for now, reports the country's mineral soils as one aggregated sink of uncertain magnitude, which is conservatively reported as zero (the cultivated organic soils are reported separately).
Methodological improvements are currently being carried out following the same procedure as used for KP-LULUCF and are expected to be included in the NIR 2014. This will lead to small CO_2 sources for certain land use conversions and small sinks for certain other conversions, and we assume that the net emission is around zero.

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 temporal and spatial

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*

Note: For comparison with CRF tables, map dates are 1 January of 1990 and 2004, i.e. the areas for 2004 correspond to the areas reported in CRF tables for the 2003 inventory year.

Table 7.1b 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 7.2 Land Use and Land Use Change Matrix aggregated to the six UNFCCC land use categories (in ha) for the period 2009–2012 .

	BN 2009						
BN 2012	Forest land	Cropland	Grassland	Wetland	Settlement	Other land	*Total*
Forest land	386,774	1,382	5,296	280	3,693	143	*397,568*
Cropland	292	849,063	63,928	106	2,620	1	*916,010*
Grassland	3,850	65,088	1,292,646	5,780	13,874	304	*1,381,542*
Wetland	497	1,076	6,366	804,454	1,820	534	*814,747*
Settlement	4,016	8,237	22,623	865	566,974	82	*602,797*
Other land	143	16	628	457	142	37,448	*38,835*
Total	*395,573*	*924,863*	*1,391,488*	*811,941*	*589,123*	*38,512*	*4,151,500*

Note: The areas for 2009 are based on the 2009 land use map, while the 2012 (1 January) data are based on linear extrapolation of the land use changes between 2004 and 2009.

development in land use and 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 information on land use changes. Land use change matrices were based on the changes in land use over the period 1990–2004 (table 7.1a) and 2004–2009 (table 7.1b). These were checked in detail (Kramer et al., 2009; Van den Wyngaert et al., 2012) and omissions due to methodology (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 (table 7.2).

Table 7.3 provides an overview of the completeness of reporting of The Netherlands. In response to the in-country review in September 2011, and to increase completeness, CO_2, CH_4 and N_2O emissions from wildfires in forests (forest fires) were included this year for the first time (see also section 7.4 Recalculations).

Table 7.3 Pools for which emissions are reported in the National System per land use (conversion) category.

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.

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 (Arets et al., 2013) and in updates of the two protocols (see also the website www.nlagency.nl/nie):

- Protocol 13-032: CO_2 from Forest land (5A);
- Protocol 13-033: CO_2 from total Land use categories (5B–G).

Table 7.4 shows the sources and sinks in the LULUCF sector in 1990 and 2011. For 1990 and 2011, the total net emissions are estimated to be approximately 3.0 Tg CO_2 and 3.3 Tg CO_2 respectively, the major source being CO_2 emissions from the decrease in carbon stored in organic soils and peat lands: 4.5 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: -2.4 Tg CO_2, which includes emissions from Forest land remaining forest land (5A1) and Land converted to forest land (5A2). Sector 5 (LULUCF) accounted for 1.7 per cent of total national CO_2 emissions in 2011.

7.4 Recalculations

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

1. Emissions from the liming of agricultural soils in Other (5G). In the previous NIR, fertiliser data were not available for 2010 and therefore 2010 emissions were set equal to 2009 emissions. Fertiliser data have since become available and have been used to calculate the 2010 emissions.
2. During a QA/QC check an error was found in the EF applied to carbon stock change (gain) in living biomass for conversion from settlements to grassland (5C.2.4) and from other land to grassland. Instead of applying the default EF for grasslands (i.e. 6.8 Mg C ha^{-1}), the EF for cropland was applied (5 Mg C ha^{-1}). This correction resulted in minor recalculations for all inventory years.
3. To increase completeness, CO_2, CH_4 and N_2O emissions from wildfires in forests (forest fires) were included this year for the first time. This resulted in a decreased sink of CO_2 and increased emissions of CH_4 and N_2O in Forest land. See section 7.5.9 and table 7.6 for emissions from forest fires during the full 1990–2010 period.

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, 30 per cent being coniferous, 22 per cent broad-leaved and the remaining area a mixture of the two. 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 sub-categories: 5A1 (Forest land remaining forest land) and 5A2 (Land converted to forest land). The first sub-category includes estimates of changes in the carbon stock from different carbon pools in the forest.

The second sub-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 listed separately under the information items.

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

Sector/category	Gas	Key	Emissions base year	2010	2011	Absolute 2011–2010	Contribution to total in 2011 (%)		
Key sources		Level, Trend	Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq	by sector	of total gas	of total CO_2 eq
5 Total Land use Categories	CO_2		3.0	3.0	3.3	0.3	100	1.9	1.7
5A Forest land	CO_2		-2.4	-2.7	-2.4	0.3	-75	-1.4	-1.2
5A1 Forest land remaining Forest Land	CO_2	L,T	-2.4	-2.1	-1.9	0.2	-58	-1.1	-1.0
5A2 Land converted to Forest Land	CO_2	L2,T	0.1	-0.5	-0.5	0.0	-17	-0.3	-0.3
5B Cropland	CO_2		0.1	0.2	0.2	0.0	5.0	0.1	0.1
5B1 Cropland remaining Cropland	CO_2		IE	IE	IE				
5B2 Land converted to Cropland	CO_2		0.1	0.2	0.2	0.0	5.0	0.1	0.1
5C Grassland	CO_2		4.5	4.5	4.5	0.0	137	2.6	2.3
5C1 Grassland remaining Grassland	CO_2	L,T	4.2	4.2	4.2	0.0	130	2.5	2.1
5C2 Land converted to Grassland	CO_2		0.2	0.2	0.2	0.0	7.2	0.1	0.1
5D Wetlands	CO_2		0.1	0.1	0.1	0.0	4.1	0.1	0.1
5D1 Wetlands remaining Wetlands	CO_2		NE	NE	NE	0.0	0.0	0.0	0.0
5D2 Land converted to Wetlands	CO_2		0.1	0.1	0.1	0.0	4.1	0.1	0.1
5E Settlements	CO_2		0.5	0.8	0.8	0.0	25	0.5	0.4
5E1 Settlements remaining Settlements	CO_2		NE	NE	NE	0.0	0.0	0.0	0.0
5E2 Land converted to Settlements	CO_2	L,T	0.5	0.8	0.8	0.0	25	0.5	0.4
5F Other land	CO_2		0.02	0.03	0.03	0.0	0.8	0.0	0.0
5F1 Other land remaining other Land	CO_2		0.00	0.00	0.00	0.0	0.0	0.0	0.0
5F2 Land converted to Other Land	CO_2		0.02	0.03	0.03	0.0	0.8	0.0	0.0
5G Other	CO_2		0.2	0.1	0.1	0.0	2.2	0.0	0.0
Total national emissions (incl. CO_2 LULUCF)	All		162.2	184.4	170.8	-13.6		100	86
National Total GHG emissions (incl. CO_2 LULUCF)	CO_2		214.8	212.2	197.6	-14.5			100

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 for assessing emissions 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, harmonised and validated digital topographical maps of 1990, 2004 and 2009 were used (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 used on the activities and land use categories, covers the entire territorial (land and water) surface area of The Netherlands; see also section 7.3.

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 the 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 immediate 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 definition (stricter than the IPCC's) 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 per cent 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 FAO reporting standards 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) – 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 on the basis of 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 basic 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 EFs can be found in the protocol 13-032 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 and scaled to the national scale (Van den Wyngaert et al., 2012).

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, then the height and expected volume in the following year. Based on the expected volume for the following year and the number of trees, the average tree volume for the following year is derived. The next step is the calculation of the average diameter of the trees in the following 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 was 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 per cent year^{-1}), and the current stock of dead wood volume is assumed to be 6.6 per cent 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 were used to calculate the net carbon flux to dead wood:

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

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

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

ΔC_{FFDW}	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 (0.2)

Litter

Analysis of carbon stock changes has shown that there is 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 on the basis of 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 basic 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 of newly re/afforested plots. Detailed descriptions of the methods used and EFs can be found in the protocol 13-032 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 on the basis of 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 20 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 confusing effects of the age distribution of the NFI plots (some of which are not afforested but regenerating after a clearcut).
4. The EF 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 20 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 Cropland and Grassland converted to forest land, biomass loss in the 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 by 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

Total emissions from the dead wood component after deforestation are calculated by multiplying the total area deforested by 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

Total emissions from the litter component after deforestation are calculated by multiplying the total area deforested by 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., 2012). 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 of providing 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 with 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 describe the state of the Dutch forests, they were applied in the calculations for Forest land remaining forest land, Land converted to forest land and Forest land converted to other land use. HOSP data, which includes plot level data (in total 2,007 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 dataset. MFV plot level data (in total 3,622 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.

Forest fires

Controlled biomass burning does not occur in The Netherlands, and therefore is reported as not occurring (NO).

For wildfires in forests (forest fires) no recent statistics are available on the occurrence and intensity of forest fires in The Netherlands. From the submission of the 2013 NIR onwards, emissions of CO_2, CH_4 and N_2O from forest fires are reported according the Tier 1 method as described in the GPG 2003 (GPG 2003, equations 3.2.19 and 3.2.20).

The area of burned forest is based on a historical series from 1980–1992, for which the annual number of forest fires and the total area burned is available (Wijdeven et al., 2006). For the years 1990–1992, reported areas are used (40 ha in 1990, 33 in 1991 and 24 in 1992). From 1993 onwards, the average annual area from the period 1980–1992 is used. This is 37.77 ha.

7.5.6 Implied emission factors

7.5.6.1 Forest land remaining forest land

The IEF of Forest land remaining forest land decreased from 2.84 Mg C ha^{-1} in 1990 to 2.66 Mg C ha^{-1} in 2011. 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 1999.

Emissions from forest fires

CO_2, CH_4 and N_2O emissions from forest fires are based on the average annual carbon stock in living biomass, litter and dead wood. These values change yearly depending on forest growth and harvesting. The default combustion efficiency (fraction of the biomass combusted) for 'all other temperate forests' is used (0.45, GPG 2003, table 3A.1.12). For calculation of non-CO_2 emissions, default emission ratios were used (0.012 for CH_4 and 0.007 for N_2O, GPG 2003, Table 3A.1.15).

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	2010	2011
5A Forest Land	-2,350	-2,494	-2,478	-2,567	-2,685	-2,434
5A1 Forest Land remaining Forest Land	-2,407	-2,494	-2,351	-2,187	-2,138	-1,893
Living biomass (FAD)	-3,754	-3,509	-3,505	-3,309	-3,209	-3207
Harvest	1,746	1,257	1,247	1,237	1,183	1,425
Living biomass (TOF)	-212	-180	-160	-135	-121	-120
Dead Wood (including losses when forests are converted to TOF)	-191	-68	60	12	2	1
5A2 Land converted to Forest Land	56	0	-127	-380	-547	-541

Emissions from fertiliser use in forests
N_2O emissions might occur as a result of using fertiliser in forests or of drainage. Neither management practice is much applied in forestry in The Netherlands. Thus, it is assumed that N_2O emissions from fertiliser are irrelevant in forests.

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 from 1990 to 2010. The IEF for the conversion of cropland and grassland 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 EFs 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 2011. The EF for litter is 29.0 Mg C ha-1 in 1990 and increases to 35.9 Mg C ha-1 in 2011 (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 2011. The systematic increase in average standing carbon stock reflects the fact that annual increment exceeds annual harvests in The Netherlands.

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 uncertainty by IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the LULUCF sector. The analysis combines uncertainty estimates of 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 CO_2 emissions from 5A1 (Forest land remaining forest land) is calculated at 67 per cent. The uncertainty in CO_2 emissions from 5A2 (Land converted to forest land) is calculated at 63 per cent. See Olivier et al. (2009) for details.

The uncertainty in IEFs of 5A1 (Forest land remaining forest land) concerns both forest and trees outside forests. As the methodology and datasets used are the same for both sources, the uncertainty calculation is performed for forests and the result is considered to be representative of trees outside forests as well. The uncertainty in the IEF of increment in living biomass is calculated at 13 per cent (rounded to 15 per cent in the calculation spreadsheet). The uncertainty in the IEF of decrease in living biomass is calculated at 30 per cent. The uncertainty in the net carbon flux from dead wood is calculated at 30 per cent (rounded to 50 per cent 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} with a range from 2,100 Gg CO_2 year^{-1} to 2,800 Gg CO_2 year^{-1} over the period 1990–2011 (see table 7.5; highest values in years not shown). The data in category 5A1 show the net result of the sequestration in live trees, in trees outside forests, dead wood and litter and emissions from harvesting. The figures for live trees change only slightly over time, with no clear direction. Emissions from harvesting increase from 2009 onwards, which is in line with increased wood harvesting levels. The figures for afforestation show a steadily decreasing net source in 1990 to quasi neutral in 1995 and the net sink further increasing up to 2009, then stabilising as the 20-year transition period has ended. In 2011 the sequestration level reached a level of 541 Gg CO_2 year^{-1}.

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 by IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the LULUCF sector. The analysis combines uncertainty estimates of 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 per cent. See Olivier et al. (2009) for details.

Uncertainty in IEF 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 uncertainty figures are used in the Tier 1 calculation spreadsheet.

Time series consistency
The updated time series for category 5A2 shows a steadily decreasing net source from 1990, when forests are extremely young and biomass losses from cropland and grassland dominate the values, to quasi neutral in 1995 and the net sink increasing up to 2009, then stabilising as the 20-year transition period has ended (Figure 7.2). In 2011 the sequestration level reached a level of 541 Gg CO_2 year^{-1}.

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 by IPCC source category. The Netherlands uses a Tier 1 analysis for the uncertainty assessment of the LULUCF sector. The analysis combines uncertainty estimates of 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 per cent. 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 1,262 Gg CO_2 year^{-1} in 2011.

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 with more than one sub-category). This will be improved in the next submission (2014), which will also feature the implementation of a new land use change matrix.

Map and land use matrices in Tables 7.1 an 7.2 of the NIR are dated 1 January, while the areas in the CRF tables 5 are dated 31 December. Thus, the areas in the land use matrices for 2004 correspond to the areas reported in CRF tables for the 2003 inventory year. During the QC the areas were compared for all years.

7.5.9 Source-specific recalculations

To increase completeness, CO_2, CH_4 and N_2O emissions from wildfires in forests (forest fires) were included this year for the first time. This resulted in a decreased sink of CO_2 and increased emissions of CH_4 and N_2O from Forest land (see table 7.6 for emissions from forest fires during the full 1990–2010 period).
The emissions from wildfires in forests are fully ascribed to Forest land remaining forest land. Table 7.6 shows that the magnitude of the emissions from wildfires in forests, of about 8 Gg CO_2 eq, corresponds to only 0.3 per cent of the total emissions from Forest land.

7.5.10 Category-specific planned improvements

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

7.6 Cropland [5B]

7.6.1 Source category description

The source category 5B (Cropland) includes only emissions of CO_2 from 5B2 (Land converted to cropland). As cropland emissions in The Netherlands mainly consists of annual crops emissions from living biomass, emissions from 5B1 (Cropland remaining cropland) are not estimated, while emissions from all cultivated organic soils, including category 5B1 are reported under 5C1 (Grassland remaining grassland).

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 for the Forest land category (IPCC, 2003).

7.6.2 Activity data and (implied) emission factors

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

Table 7.6 Increased emissions of CO_2, CH_4 and N_2O as a result of forest fires, resulting in an equal reduction of the CO_2 sink of forest land

Year	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2 eq)	N_2O (Gg)	N_2O (Gg CO_2 eq)	Total (Gg CO_2 eq)
1990	5.50	0.026	0.54	0.00018	0.055	6.10
1991	4.64	0.022	0.46	0.00015	0.046	5.14
1992	3.23	0.016	0.34	0.00011	0.034	3.61
1993	5.23	0.026	0.55	0.00018	0.055	5.83
1994	6.08	0.027	0.56	0.00018	0.057	6.70
1995	6.21	0.027	0.57	0.00019	0.058	6.84
1996	6.34	0.028	0.58	0.00019	0.059	6.98
1997	6.47	0.028	0.59	0.00019	0.060	7.13
1998	6.60	0.029	0.60	0.00020	0.061	7.27
1999	6.73	0.029	0.62	0.00020	0.063	7.40
2000	6.69	0.029	0.61	0.00020	0.062	7.37
2001	6.85	0.030	0.63	0.00021	0.064	7.54
2002	7.01	0.031	0.64	0.00021	0.065	7.71
2003	7.17	0.031	0.66	0.00022	0.067	7.90
2004	7.28	0.032	0.67	0.00022	0.068	8.02
2005	7.40	0.032	0.68	0.00022	0.069	8.15
2006	7.51	0.033	0.69	0.00023	0.070	8.27
2007	7.63	0.033	0.70	0.00023	0.071	8.40
2008	7.75	0.034	0.71	0.00023	0.072	8.53
2009	7.85	0.034	0.72	0.00024	0.073	8.65
2010	7.97	0.035	0.73	0.00024	0.074	8.78

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 cropland as arable land and nurseries (including tree nurseries). Intensive grasslands are not included in this category and are reported under Grassland. For part of the agricultural land, rotation between cropland and grassland is frequent, but data on where exactly this occurs are as yet lacking. Currently, the situation as registred 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 allow 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). Figures for the years 1990, 2004 and 2009 are based on observations of land use; the values for the periods 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 of land use and the land use change matrix in chapter 7.2. More detailed descriptions of the methods used and EFs can be found in the protocols 13-032 and 13-033 on the website www.nlagency.nl/nie.

Living biomass

For Land converted to cropland, biomass gain in the year of conversion is calculated using Tier 1 default values.

Soil

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 increasing slightly (Hanegraaf et al., 2009; Reijneveld et al., 2009). Based on a large database of soil samples from farmers, 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 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 LULUCF sector. The uncertainties in the Dutch analysis of carbon levels depend on the collective factors with which feed into the calculations (calculation of the organic substances in the soil profile and 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 per cent; see Olivier et al. (2009) for details (rounded to 50 per cent in the Tier 1 calculation spreadsheet, since it is the order of magnitude that is important).

Uncertainty in activity data

The activity data used relate to area change, calculated by comparing three topographical maps. The uncertainty of one topographical map is estimated to be 5 per cent (expert judgement).

Time series consistency

The yearly emission of CO_2 due to the conversion of land converted to cropland shows an increase from 122 Gg CO_2 in 1990 to 155 Gg CO_2 in 2011.

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

Not applicable for this submission.

7.6.9 Category-specific planned improvements

For this land use category no improvements are planned in the immediate 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 to grassland). The source category 5C1 is by far the more important source of CO_2 within the LULUCF sector.

7.7.2 Activity data and (implied) emission factors

The activity data are derived from land use maps and the land use change matrix. The activity data for organic soils are 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 cropland. It also includes vegetation that falls below is not expected to exceed, without human intervention, the threshold for 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:

- Grassland – all areas predominantly covered by grassy vegetation (whether natural, recreational or cultivated);
- Nature – all natural areas excluding grassland (natural grassland and grassland used for recreation purposes). These mainly consist of heath land, peat moors and other natural areas. Many have the occasional tree as part of the typical vegetation structure. This category was a sub-category within Forest land in previous submissions.

The Netherlands currently reports under Grassland any type of terrain that is predominantly covered by grass vegetation. No distinction is made between intensively and extensively managed agricultural grassland and natural grassland. However, the potential and the need for this distinction are currently under discussion. In addition to pure grassland, 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 Cropland, 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. In orchards, as in grassland, no change in above-ground biomass is reported; therefore, the carbon stored in orchard trees is not reported.

7.7.5 Methodological issues

Living biomass
For Land converted to grassland, biomass gain in the year of conversion is calculated using Tier 1 default values.

Soil
For information on the methodology for assessing 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. CO_2 emissions from 5C1 (Grassland remaining grassland) are calculated on the basis of observations of 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). For the 2003 area of organic soils, with the relevant water management conditions and measures and calculated loss of organic matter, an IEF of on average 19.04 tons CO_2/ha is calculated (Kuikman et al., 2005). For the period 1990–2011 the emissions from organic soils under grassland are based on the fixed area and IEF value. Both are the result of analysis of the developments in a range of peat lands (including water and soil management). The area used so far conflicts to some extent with the results for grassland on organic soils of the land use change matrix.

The matrix shows a 4 per cent 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 data 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 EFs can be found in protocols 13-032 and 13-033 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 by 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 per cent; 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 per cent (50 per cent 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 Land converted to cropland and is, therefore, identical. The uncertainty is estimated to be 56 per cent (50 per cent used in the Tier 1 calculation spreadsheet).

Uncertainty in activity data of categories 5C1 and 5C2
The activity data used are area change, calculated by comparing three topographic maps. The uncertainty of one topographic map is estimated to be 5 per cent (expert judgement).

Time series consistency
The yearly emission 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 268 Gg CO_2 in 2011.

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 with more than one sub-category). This will be improved in the next submission.

7.7.8 Source-specific recalculations

During the previous submission an error was made in the EFs applied to carbon stock change (gain) in living biomass for conversion from settlements to grassland (5C.2.4) and from other land to grassland. Instead of applying the default EF for grassland (i.e. 6.8 Mg C ha-1), the EF for cropland was applied (5 Mg C ha-1). This is corrected in this submission and has resulted in minor recalculations for all inventory years.

7.7.9 Category-specific planned improvements

Currently, for organic soils, emissions are calculated on the basis of the total agricultural area on organic soils, and these emissions are reported under the category Grassland remaining grassland. For the submission of the NIR 2014 it is intended to disaggregate this value into the different categories.

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 are derived from 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 by nature a country with many wet areas, many of these are covered by grassy vegetation and those are included under Grassland. Some wetlands are covered by a rougher vegetation of wild grasses or shrubby vegetation, which is reported in the sub-category of Grassland, Nature. Forested wetlands like willow coppice are reported in the sub-categories of Forest land, FAD or TOF, 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 that 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. the water in harbours and docks as well as waterways.

7.8.5 Methodological issues

For information on the methodology for assessing land use and land use change see chapter 7.2. Emissions of CH_4 from wetland are not estimated due to a lack of data. More detailed descriptions of the methods used and the EFs can be found in protocols 13-032 and 13-033 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 slow increase from 80 Gg CO_2 in 1990 to 135 Gg CO_2 in 2011.

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 with more than one sub-category). This will be improved in the next submission.

7.8.8 Source-specific recalculations

Not applicable for this submission.

7.8.9 Category-specific planned improvements

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

7.9 Settlements [5E]

7.9.1 Source category description

This source category 5E (Settlements) 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 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 1) built-up areas and 2) urban areas and transportation infrastructure. Built-up areas include any constructed item, independent of the type of construction material, which is (expected to be) permanent, is fixed to the soil surface and serves as a place of residence or location for 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, with the exception of forest roads, which are included in the official forest definition. They also include train tracks, (paved) open spaces in urban areas, car parks and graveyards. Though some of the last classes are covered by grass, the distinction cannot be made from a study of maps. As even grass graveyards are not managed as grassland, their 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 for assessing land use and land use change see chapter 7.2. More detailed descriptions of the methods used and the EFs can be found in the protocols 13-032 and 13-033 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 817 Gg CO_2 in 2011.

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 with more than one sub-category). This will be improved in the next submission.

7.9.8 Source-specific recalculations

Not applicable for this submission.

7.9.9 Category-specific planned improvements

For this land use category no improvements are planned in the immediate 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 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. 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 surfaces of bare soil that are not included in any other category. In The Netherlands, this means mostly almost bare sands and the earliest stages of succession on sand in 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 Wetland).

7.10.5 Methodological issues

For information on the methodology for assessing 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 an other 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 substantial amount of carbon). More detailed descriptions of the methods used and the EFs can be found in protocols 13-032 and 13-033 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 slow increase from 20 Gg CO_2 in 1990 to
27 Gg CO_2 in 2011.

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 with more than one sub-category). This will be improved in the next submission.

7.10.8 Source-specific recalculations

Not applicable for this submission.

7.10.9 Category-specific planned improvements

For this land use category no improvements are planned in the immediate 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 Agriculture 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 are derived from agricultural statistics for total lime fertilisers (period 1990–2011). Data available on the application of limestone and dolomite do 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 amounts of limestone and dolomite used are converted into carbon dioxide emissions in line with the calculations in the IPCC guidelines.

7.11.3 Methodological issues

The reporting is considered to be at the Tier 2 level (see protocol 13-033). Limestone ('lime marl') and dolomite ('carbonic magnesium lime') amounts, reported in CaO equivalents, are multiplied by the EFs 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 EFs can be found in protocols 13-032 and 13-033 on the website www.nlagency.nl/nie, as indicated in section 7.4.

Table 7.7 CO_2 emissions from using limestone and dolomite in agriculture (Units: Gg CO_2).

	1990	1995	2000	2005	2010	2011
5G Other (liming of agricultural soils)	183	98	98	75	73	73

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 by IPCC source category. The uncertainty in the CO_2 emissions from 5G (Liming of soils) is calculated to be 25 per cent. The uncertainty in the activity data is estimated to be 25 per cent, and the uncertainty in EFs is 1 per cent. 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 application for the period 1990–2011 is consistent over time. The use of fertiliser containing chalk in The Netherlands decreased from 265 million kg in 1990 to 134 million kg in 2010. Over that period the proportion of limestone doubled, from about 12 per cent in 1990 to about 24 per cent in 2010, and the proportion of dolomite decreased from about 38 per cent in 1990 to levels between 25 per cent and 30 per cent in following years and reached 23 per cent in 2010 (the remaining is earth foam). The CO_2 emissions related to these fertilisers are shown in table 7.7. Due to lack of fertiliser statistics, 2011 emissions are 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

2010 emissions have been recalculated because fertiliser data for 2010 has become available. In the previous NIR, 2010 emissions had been set equal to 2009 emissions.

7.11.7 Category-specific planned improvements

A recalculation over 2011 will be carried out when fertiliser data become available.

8 Waste [CRF Sector 6]

Major changes in the Waste sector compared with the National Inventory Report 2012

Emissions:	In 2012, 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 emission factor for the GHG from solid waste disposal was 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 these are considered to be part of the carbon cycle and are not a net source. The Netherlands does not report emissions from waste incineration facilities in the Waste sector because these facilities also produce electricity and/or heat used for energy purposes; thus, 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 from the Waste sector in The Netherlands (see also Annex 6):
- Protocol 13-034: CH_4 from Waste disposal (6A1);
- Protocol 13-035: CH_4, N_2O from Wastewater treatment (6B);
- Protocol 13-036: CH_4, N_2O from Industrial composting (6D);
- Protocol 13-038: CO_2 CH_4 N_2O from Biomass (1A).

The Waste sector accounted for 2 per cent of total national emissions (without LULUCF) in 2011 compared with 6 per cent in 1990, emissions of CH_4 and N_2O accounting for 87 per cent and 13 per cent of CO_2-equivalent emissions from the sector, respectively. Emissions of CH_4 from waste – almost all (87 per cent) from Landfills (6A) – accounted for 22 per cent of total national CH_4 emissions in 2011. N_2O emissions from the Waste sector stem from domestic and commercial wastewater. 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 70 per cent between 1990 and 2011 (see figure 8.1), mainly due to a 74 per cent reduction in CH_4 from Landfills (6A1 Managed waste disposal on land). Between 2010 and 2011, CH_4 emissions from landfills decreased by about 6 per cent. 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 per cent in 1990 to 21 per cent in 2011).

Table 8.1 shows the contribution of the emissions from the Waste sector to 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 3.8 Tg CO_2 eq in 2011. This decrease was mainly due to:
- 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 greenhouse gas emissions of this sector. Category 6A1 (Solid waste disposal sites (SWDS)) is a key source specified by both level and trend, while category 6B (N_2O emissions from wastewater 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 2011 there were 22 operating landfill sites as well as a few thousand old 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 50 per cent (vol.) CH_4 and 50 per cent (vol.) CO_2. Due to a light overpressure, 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 lower CH_4 emissions.

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 unique characteristics: concentration and type of organic matter, moisture and

Figure 8.1 Sector 6 'Waste': trend and emission levels of source categories, 1990-2011.

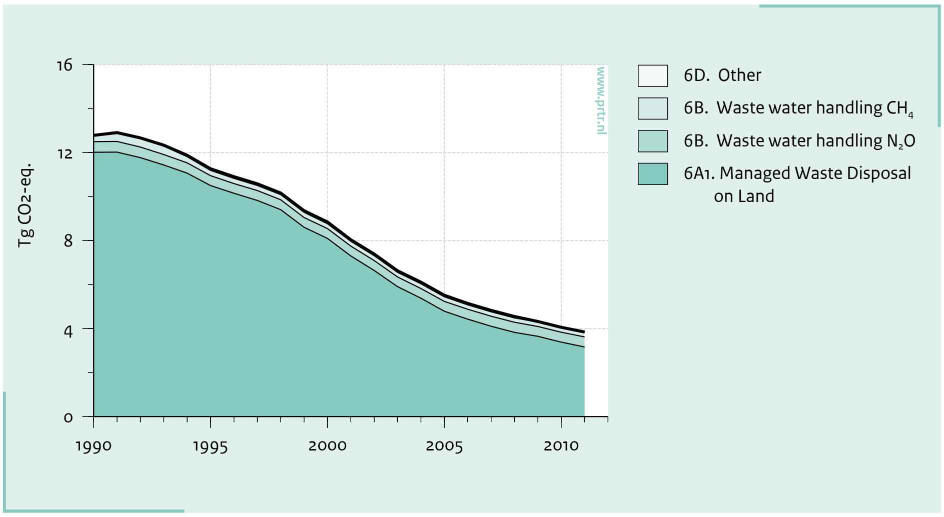


Table 8.1 Contribution of main categories and key sources in Sector 6 Waste.

Sector/category	Gas	Key	Emissions base-year Gg	Emissions base-year Tg CO_2 eq	Emissions 2010 Gg	Emissions 2010 Tg CO_2 eq	Emissions 2011 Gg	Emissions 2011 Tg CO_2 eq	Change 2011–2010 Gg	Contribution to total in 2011 (%) by sector	of total gas	of total CO_2 eq
6 Waste	CH_4		585.8	12.3	171.8	3.6	161.3	3.4	-0.2	87%	22%	2%
	N_2O		1.6	0.5	1.6	0.5	1.6	0.5	0.01	13%	5%	0.3%
	All			12.8		4.4		3.9	-0.5	100%		2%
6A Solid Waste Disposal on Land	CH_4		572.0	12.0	161.1	3.4	150.8	3.2	-0.2	82%	21%	2%
6A1 Managed Waste Disposal on Land	CH_4	L,T	572.0	12.0	161.1	3.4	150.8	3.2	-0.2	82%	21%	2%
6B Waste water handling	N_2O	L2	1.6	0.5	1.5	0.5	1.5	0.5	0.01	12%	5%	0.2%
	CH_4		13.8	0.3	9.7	0.2	9.5	0.2	0.00	5%	1.3%	0.1%
	All			0.8		0.7		0.7	0.00	17%		0.3%
6D Other	CH_4		0.06	0.00	1.0	0.02	1.0	0.02	0.00	0.6%	0.1%	0.01%
	N_2O		0.00	0.00	0.11	0.00	0.11	0.00	0.00	0.1%	0.0%	0.00%
	All			0.00		0.06		0.06	0.00	1.5%		0.03%
National Emissions	CH_4		1,224.4	25.7	758.9	15.9	726.8	15.3	-0.7			
	N_2O		64.5	20.0	29.7	9.2	29.4	9.1	-0.1			
National Total GHG emissions (excl. CO_2 LULUCF)	All			213.2		209.2		194.4	-14.8			

temperature, among others. The major factors determining the decreased net CH_4 emissions are lower quantities of organic carbon deposited into landfills (organic carbon content × total amount of land-filled waste) and higher methane recovery rates from landfills (see sections 8.2.2 and 8.2.3).

The share of CH_4 emissions from landfills in the total national inventory of greenhouse gas emissions was 6 per cent in 1990 and 2 per cent in 2011 – a decrease of 74 per cent. This decrease is due partly to the increase in recovered CH_4 – from about 5 per cent in 1990 to 21 per cent in 2011 – but also to the decrease in methane produced in solid waste disposal sites and the decrease of the relative amount of methane in landfill gas from 60 per cent to 50 per cent.

In 2011, solid waste disposal on land accounted for

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	2010	2011
Waste generation rate (kg/cap/day)	1.52	1.50	1.69	1.75	1.66	1.67
Fraction MSW disposed to SWDS	0.38	0.29	0.09	0.01	0.00	0.01
Fraction DOC in MSW	0.13	0.13	0.11	0.06	0.03	0.03
CH_4 generation rate constant (k)	0.09	0.07	0.07	0.05	0.05	0.05
Number of SWDS recovering CH_4	45	50	55	50	53	53
Fraction CH_4 in landfill gas	0.6	0.6	0.6	0.53	0.51	0.50

82 per cent of total emissions from the Waste sector and 2 per cent of 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 sent to landfill 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 sent to landfills has decreased from more than 14 million tons in 1990 to 2 million tons in 2011, thereby reducing emissions from this source category.

Methodological issues

A more detailed description of the method used and EFs can be found in the protocol 13-034 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. These data can be found on the website www.nlagency.nl/nie and are documented in Agentschap NL (2012a). This document also contains the amount of CH_4 recovered from landfill sites yearly. The IEFs correspond with the IPCC default values.

In order to calculate CH_4 emissions from all the landfill sites in The Netherlands, it was assumed that all waste was 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' were 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; decreasing from 2000 till 2004 to 0.05 (IPCC parameter) and constant thereafter; this corresponds to a half-life of 14.0 years (see table 8.2 for a detailed time series);
- CH_4 oxidation factor: 10 per cent;
- fraction of DOC actually dissimilated (DOCF): 0.58 till 2000 (see also Oonk et al., 1994); from 2000 till 2004 decreasing to 0.5 (IPCC parameter) and constant thereafter;
- CH_4 conversion factor (IPCC parameter): 1.0;
- The fraction of methane in landfill gas recovered 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 per cent.

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 the land-filling of combustible waste, 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. Moreover, since 2008 there has been a decrease in the amount of combustible waste land-filled, due to overcapacity at incineration plants. The integration time for the emissions 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 by

IPCC source category and gas. The uncertainty in CH_4 emissions from solid waste disposal sites is estimated to be approximately 35 per cent in annual emissions. The uncertainty in the activity data and the EF are estimated to be 30 per cent and 15 per cent, 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 has been determined yearly based on the composition of the landfill gas (at CH_4 recovering sites). 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 emissions 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 2012 review, a validation of the landfill model was performed because the latest validation was from almost two decades ago (Oonk et al., 1994). Based on a recent re-validation study (TAUW, 2011) a few parameters were adapted:

- CH_4 generation (decomposition) rate constant (k);
- Fraction of DOC actually dissimilated (DOCF).

See for these parameters paragraph 8.2.1 under methodological issues.

Other adaptations were:

- The amount of methane in landfill gas was 60 per cent until 1999. This amount decreased from 2000 till 2004 to 50 per cent (IPCC default) and remained constant thereafter. As a result of this recalculation, the CH_4 emission from Solid waste disposal decreased by 1.2 Tg CO_2 eq in 2005 in comparison with the last submission.
- The amount of waste land-filled is now calculated via a new method. During the review of the NIR 2006 by the ERT it was recommended to include waste streams like soils and bottom ashes from incineration plants in the calculation. This recommendation was followed in the course of this adaptation. This new method has also resulted in modified fractions of degradable organic carbon. As a result of this new method, the total amount of degradable organic carbon increased, resulting in an increase in CH_4 emissions from Solid waste disposal.

The total recalculation led to a decrease of 0.9 Tg CO_2 eq in 2010 in comparison with the last submission.

8.2.5 Source-specific planned improvements

For this category, in coherence with the categories Waste incineration and Other waste handling, an assessment of the uncertainties will be conducted.

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 CH_4 emissions from anaerobic industrial wastewater treatment plants (IWWTP) and CH_4 and N_2O emissions from septic tanks, but these are small compared with those from public WWTP.

N_2O emissions from wastewater treatment (see Table 8.1) contributed about 5 per cent of total N_2O emissions in 2011 and 0.3 per cent in total CO_2-equivalent N_2O emissions from wastewater handling and effluents decreased by 4 per cent during the period 1990–2011. This small decrease is the result of two counteracting trends. Improved biological breakdown of nitrogen compounds at public WWTPs (see table 8.4) has led to a gradual increase in N_2O emissions. However, improved nitrogen removal has resulted in lower effluent loads (see table 8.4) and a subsequent decrease in (indirect) N_2O emissions from human sewage.

The contribution of wastewater handling to the national total of CH_4 emissions in 2011 was 1.3 per cent. Since 1994,

Table 8.3 Wastewater handling emissions of CH_4 and N_2O (Units: Gg/year).

	1990	1995	2000	2005	2010	2011
CH_4 industrial wastewater	0.25	0.33	0.34	0.36	0.34	0.33
CH_4 domestic & commercial wastewater	9.07	7.90	7.96	8.20	8.60	8.37
CH_4 septic tanks	4.47	3.25	2.20	1.47	0.77	0.78
Net CH_4 emissions	13.79	11.48	10.50	10.03	9.70	9.48
CH_4 recovered and/or flared	33.0	39.2	40.4	41.9	45.0	45.7
Recovery/flared (% gross emission)	70.5	77.4	79.4	80.7	82.3	82.8
N_2O domestic & commercial wastewater	0.66	0.75	0.88	0.99	1.12	1.16
N_2O from human sewage	0.85	0.65	0.53	0.43	0.32	0.30
N_2O septic tanks	0.052	0.043	0.029	0.019	0.010	0.010
Total N_2O emissions	1.50	1.40	1.41	1.43	1.44	1.46

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	2010	2011
Wastewater DOC [1] WWTP	Gg/year	933	921	921	943	953	965
Sludge DOC [1] WWTP	Gg/year	254	269	281	298	320	325
Nitrogen removed in urban WWTP	Gg/year	42.0	47.7	55.8	63.1	71.3	74.0
Treated volume WWTP	Mm^3/y	1,711	1,908	2,034	1,841	1,934	1,917
Wastewater DOC [2] IWWTP	Gg/year	181	233	244	261	239.7	238.3
Nitrogen in effluents [3]	Gg/year	53.8	41.5	33.8	27.8	22.1	20.9
% Inhabitants with septic tanks	%	4.0	2.8	1.9	1.2	0.62	
Annual per capita protein uptake	kg	34.86	39.97	38.69	38.03	38.62	38.62

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.

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 wastewater handling decreased by 31 per cent during the period 1990–2011. 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 emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 13-035 on the website www.nlagency.nl/nie.

Most of the activity data on wastewater treatment are collected by Statistics Netherlands (CBS, 2012) in yearly questionnaires that cover all public WWTPs as well as all anaerobic IWWTPs; 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 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
13-035 (see the website www.nlagency.nl/nie) and in the background document (Oonk et al., 2004). In general, emissions are calculated according to the IPCC Guidelines, with country-specific parameters and EFs 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 wastewater treatment

For anaerobic IWWTPs, 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 per cent.
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 per cent (Oonk et al., 2004). The design capacity is available in terms of Pollution Equivalents (p.e. also named Inhabitant Equivalents, see protocol 13-135), with 1 p.e equal to 40 kg COD per year.
Assuming a methane recovery of 99 per cent (Oonk et al., 2004) and taking into account all aforementioned factors and parameters, the overall EF can be calculated as 0.056 t/t DOC design capacity expressed in Population Equivalents.

Table 8.4 provides the time series of total DOC design capacity for industrial wastewater treatment plants, based on the design capacity (source: CBS, 2012). In 2011, 66 per cent of the anaerobic capacity was installed within the food and beverage industry. Other branches with anaerobic wastewater treatment are the waste processing facilities (14 per cent), chemical industry (10 per cent) and paper and cardboard industry (4 per cent).

Data from the questionnaire among IWWTPs, performed by Statistics Netherlands (CBS), show that only 2 out of a total of 160 IWWTPs 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 from wastewater treatment and sludge handling are thus included elsewhere, namely within the category Domestic and commercial wastewater handling.

CH_4 emissions from domestic and commercial wastewater treatment

For public WWTPs and related anaerobic sludge handling, the combined EF is defined as 0.0085 tons CH_4 per ton $DOC_{influent}$. DOC is measured and calculated as the chemical oxygen demand (COD). The following parameters underlie the calculation of this EF (for further details, see the 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 per cent (Doorn et al., 1997, as referred to in IPCC-GPG, 2001);
- 37 per cent of the $DOC_{influent}$ remains in the sludge (country-specific long-term annual average);
- MCF of anaerobic sludge treatment = 54 per cent (country-specific long-term annual average);
- In anaerobic sludge treatment, 42 per cent of the incoming DOC is digested (country-specific long-term annual average).
- CH_4 recovery (MR) from anaerobic sludge treatment = 94 per cent (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 2011, the amount of CH_4 emitted by the venting of biogas was 0.17 Gg CH_4, equalling 2 per cent of total CH_4 emissions from the category Domestic and commercial wastewater. During the last decade, this value varied between 2 per cent and 10 per cent.

CH_4 emissions from septic tanks

For septic tanks, the overall EF 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 (2010), it is estimated that in 2011 only 0.62 per cent of the population was connected to a septic tank (see also section 8.3.5).

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 EF 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).

N_2O emissions from domestic and commercial wastewater handling are determined on the basis of country-specific activity data on the total nitrogen loads removed from public WWTPs (see also table 8.4). Influent and effluent loads of public WWTPs are monitored systematically by all the Dutch Regional Water Authorities in accordance with the rules of the EU Urban Wastewater Treatment Directive. Wastewater treated at public WWTPs is a mixture of household wastewater, run-off rainwater and wastewater 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 with N_2O from public wastewater treatment, no N_2O emissions were estimated for separate industrial wastewater treatment.

N_2O emissions from septic tanks are calculated according to the default method provided in the IPCC 1996 revised Guidelines (IPCC, 1997). For the calculation of annual per capita protein uptake (see table 8.4), FAO statistics were used. Recently, the FAO statistics were updated with new figures for the period 2008–2009. As a result, the emissions data for 2008–2010 were recalculated (see also section 8.3.5). For data on the percentage 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 shown in Tables A7.1 and A7.2 in Annex 7 provides estimates of uncertainties by IPCC source category and gas. The uncertainty in annual CH_4 and N_2O emissions from wastewater handling is estimated to be 32 per cent and 54 per cent, respectively. The uncertainty in activity data is based on the judgements of experts and is estimated to be 20 per cent. The uncertainty in EFs for CH_4 and N_2O is estimated to be 25 per cent and 50 per cent, respectively.

Time series consistency

The same methodology has been used to estimate emissions for all years, thereby providing 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 (CBS).

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

For the calculation of CH_4 and N_2O emissions from septic tanks, more recent and corrected data were used on the percentage of population connected to septic tanks for 2008–2010. These data were published by Rioned (2010). For 2010, a new value of 0.62 per cent was published, which is quite similar to the latest published value of 0.6 for 2007. The values for 2008 and 2009 were adjusted from 0.4 per cent to 0.62 per cent. Also for 2011, a value of 0.62 per cent was used in the calculations. The new data caused an increase in CH_4 emissions for 2008–2010 from 0.49 to 0.77 Gg CH_4.

FAO statistics on annual pro capita protein uptake were adjusted recently. The new values for 2008 to 2011 (see Table 8.4) were used in the calculation of N_2O emissions from septic tanks, according to the update strategy described in the protocol 13-035 (see the website www.nlagency.nl/nie). Together with the changes due to the new time series of percentage of population connected to septic tanks (see above), the changes in activity data resulted for 2008–2010 in an increase in N_2O emissions from septic tanks from approximately 0.006 Gg to 0.010 Gg N_2O.

8.3.6 Source-specific planned improvements

There are no source-specific planned improvements.

8.4 Waste incineration [6C]

8.4.1 Source category description

Emissions from the source category Waste incineration are 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 activities should be included in category 1A1a (Public electricity and heat production: other fuels; see section 3.2.6).

Table 8.5 Composition of incinerated waste.

	1990	1995	2000	2005	2010	2011
Total waste incinerated (Gg)	2,780	2,913	4,896	5,503	6,459	7,207
- of which household waste (Gg)	2,310	2,083	3,115	4,413	3,727	2,613
- of which						
paper/cardboard (weight %)	26%	33%	32%	25%	21%	20%
wood (weight %)	1%	2%	2%	3%	4%	3%
other organic matter (weight %)	51%	37%	35%	35%	33%	35%
plastics (weight %)	8%	11%	13%	19%	18%	16%
other combustible (weight %)	3%	5%	5%	6%	10%	10%
non-combustible (weight %)	11%	13%	13%	13%	14%	15%
Total waste incinerated (TJ)	22,746	27,903	51,904	55,058	63,818	68,995
Energy content (MJ/kg)	8.2	9.6	10.6	10.0	9.9	9.6
Fraction organic (energy %)	58.2%	55.2%	50.4%	47.8%	53.1%	53.7%
Amount of fossil carbon (Gg)	164	221	433	561	675	701
Amount of organic carbon (Gg)	544	561	938	909	1,172	1,298

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.nlagency.nl/nie and in a background document (Agentschap NL, 2012a).

A more detailed description of the method used and the EFs can be found in the protocol 13-038 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 annual environmental reports and included in the ER-I dataset. 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 (e.g. household waste). 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 EF 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 per cent in 1990 to 37 per cent in 2011.

In 2009, the biomass 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 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 gases from waste incinerators is below the background CH_4 concentration in ambient air. Therefore, The Netherlands uses an EF of 0 g/GJ and reports no methane is unable problems to handle such a value, the code '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 by IPCC source category and gas. The uncertainty in annual CO_2 emissions from waste incineration is estimated at 11%. The main factors influencing these emissions are the total amount being incinerated and 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 EF 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, which 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 for this category.

8.4.6 Source-specific planned improvements

For this category, in coherence with the categories Solid waste disposal on land and Other waste handling, an assessment of the uncertainties will be conducted.

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 to 1.3 million tons in 2011. In 2011, there were 22 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 emission factors
Detailed information on activity data and emission factors can be found in the monitoring protocol 13-036 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.nlagency.nl/nie and in a background document (Agentschap NL, 2012a). This document also contains the amount of compost produced on a yearly basis.
A more detailed description of the method used and the EFs can be found in protocol 13-036 on the website www.nlagency.nl/nie, as indicated in section 8.1.
A country-specific methodology was 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 from this source category are calculated using an average EF that has been obtained from the literature. Given the large scatter in reported EFs, 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, which 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 with the previous submission, no recalculations took place for this submission.

8.5.6 Source-specific planned improvements

For this category, in coherence with the categories Solid waste disposal on land and Waste incineration, an assessment of the uncertainties will be conducted.

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 2012

For the NIR 2013, the data for the most recent year (2011) 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 1990-2010.

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 2013), The Netherlands uses the CRFreporter software 3.6.2. The present CRF tables are based on updated methodologies and data as part of the national improvement programmes and remarks made in the UNFCCC review in 2012. These improved methodologies are also described in the (updated) monitoring protocols 2013 (see Annex 6).

This chapter summarises the relevant changes in emission figures compared with the NIR 2012.
A distinction is made between:
- methodological changes: New emission data are reported, resulting from revised or new estimation methods; improved EFs 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, national emissions in 1990 decreased by 0.16 Tg CO_2 eq compared with the submission of April 2012. For 1995, the corrections led to a decrease in emissions of 0.18 Tg CO_2 eq. For 2010, a decrease in emissions amounting to 0.85 Tg CO_2 eq was 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.

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 on likely changes with involved experts and users of information) improves the peer review and timely documentation of the background to and justification for changes.

Recalculations in this submission (compared with the previous NIR) are:
- changed GHG emissions from transport for the years 1990 to 2010 due to implementation of improved calculation of N_2O from fuel use in road transport;
- improved fuel consumption data for domestic civil aviation, military aviation and inland navigation;
- improved fuel consumption data for railways;
- improved estimates of emissions from natural gas in road transport;
- improved fuel consumption and resulting CH_4 emissions from road transport;

The above-mentioned improvements resulted in small changes in emissions totals (-0.2 Tg CO_2 eq in 1990 and -0.01 Tg CO_2 eq in 2010).

- changed HFC emissions for the years 2000 to 2010 due to improved activity data and historical error corrections (-0.0002 Tg CO_2 eq in 2000 and -0.022 Tg CO_2 eq in 2010);
- changed PFC and SF_6 emissions for some historical years due to new more accurate activity data and historical error corrections (-0.001 Tg CO_2 eq in 2000);
- changed CH_4 emissions from Manure management for the years 1990 to 2010 due to the use of the IPCC methane density figure rather than the country-specific figure;
- improvment of the NH_3 emission model, which affects the total N balance in the Agriculture sector and, indirectly, N_2O emissions;
  - The above-mentioned improvements resulted in small changes in emissions totals from the Agriculture sector (0.03 Tg CO_2 eq in 1990 and 0.01 Tg CO_2 eq in 2010).
- inclusion of wildfire emissions in the LULUCF sector (0.006 Tg CO_2 eq in 1990 and 0.009 Tg CO_2 eq in 2010);
- correction of emission factors for carbon stock change (gain) in living biomass for conversion from Settlements to Grassland (5C.2.4) and from Other land to Grassland, resulting in minor recalculations for all inventory years;
- changes in the CH_4 emissions from Solid waste disposal as a result of recommendations from the 2011 and 2012 review (-0.9 Tg CO_2 eq in 2010);
- changed N_2O and CH_4 emissions from Wastewater handling due to new statistics from 2008 onwards (0.07 Tg CO_2 eq in 2010).

As a result of some of the above-mentioned methological changes (and others) figures for emissions from precursor gases changed over the whole time series. The explanation of the recalculations can be found in the IRR report (2013).

Source allocation
No changes in source allocation for GHG emissions has taken place since the 2012 submission.

For the precursor gases the allocation of sources was further streamlined with the allocation as used in the IIR reports. This resulted in a shift of emissions in nearly all sectors.

Table 10.1 Increased emissions of CO_2, CH_4 and N_2O as a result of forest fires, resultin in an equal reduction of the CO2 sink of re/afforested land

Year	CO_2 (Gg)	CH_4 (Gg)	CH_4 (Gg CO_2 eq)	N_2O (Gg)	N_2O (Gg CO_2 eq)	Total (Gg CO_2 eq)
2008	0.86	0.0038	0.079	0.000026	0.008029	0.95
2009	0.91	0.0040	0.083	0.000027	0.008432	1.00
2010	0.95	0.0042	0.087	0.000029	0.008855	1.05

Error correction

In general, the 2010 figures were updated whenever improved statistical data had become available since the 2012 submission. Furthermore, as a result of internal QA/QC procedures, minor errors (in activity data and emission figures) were detected and corrected. These error corrections amount to max ±0.1 Gg CO_2 eq per source category and are not all explained in detail.

10.1.2 KP-LULUCF inventory

To increase completeness, CO_2, CH_4 and N_2O emissions from wildfires in forests (forest fires) were this year included for all years for the first time. This resulted in a decreased sink of CO_2 and increased emissions of CH_4 and N_2O in re/afforested land (see Table 10.1 for emissions from forest fires).

An update of the liming statistics increased the estimated CO_2 emissions from the liming of deforested land now used as cropland in 2010 by 0.038 Gg C (or 0.14 Gg CO_2).

10.2 Implications for emissions levels

10.2.1 GHG inventory

This chapter outlines and summarises the implications of the changes described in section 10.1 for emissions levels over time. Table 10.2 elaborates the differences between last year's submission and the current NIR with respect to the level of the different greenhouse gases. More detailed explanations are given in the relevant chapters 3–8.

10.2.1.1 *Effect of recalculations on base year and 2010 emissions levels*

Table 10.2 gives the changes due to the recalculations for the 1990, 1995, 2000 and 2005 and 2010 (compared with the NIR 2012). From the table it emerges that the recalculations changed national emissions only to a small extent. The year 2005 holds the largest recalculation (1.5 Tg CO_2 eq), due to the recommendations from the review of Solid waste disposal on land.

10.2.2 KP-LULUCF inventory

As discussed in 10.1.1. the CO2, CH4 and N2O emissions from wildfires in forests (forest fires) are now included for all years. The emissions increased in the order of magnitude of 1 Gg CO2 eq compared with the previous submissions.

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.

103.2 KP-LULUCF inventory

The inclusion of forest fires in the inventory increased the KP emissions by about 1 Gg CO_2 eq for all years, thus keeping the trend as reported in earlier submissions.

10.4 Recalculations, response to the review process and planned improvements

10.4.1 GHG inventory

10.4.1.1 *Recalculations*

No major recalculations are anticipated in the next submission of the NIR. Improvements are planned for the calcuation (bottom-up) of fuel use in road transport to improve CH_4 and N_2O emission estimates and of fuel use in domestic and military aviation. Furthermore, improvements in the Agriculture sector are anticipated in the 2014 submission in terms of the regional subdivision of the methane EF in 4A and the inclusion of specific estimates for anaerobic manure digestion.

Table 10.2 Differences between NIR 2012 and NIR 2013 for the period 1990–2010 due to recalculations (Units: Tg CO_2 eq; for F-gases: Gg CO_2 eq)

Gas	Source	1990	1995	2000	2005	2010
CO_2 [Tg]	NIR 2013	**162.2**	173.6	172.9	179.0	184.4
Incl. LULUCF	NIR 2012	**162.2**	173.6	172.9	179.0	184.2
	Difference	0.0%	0.0%	0.0%	0.0%	0.1%
CO_2 [Tg]	NIR 2013	**159.2**	170.7	169.9	175.9	181.4
Excl. LULUCF	NIR 2012	**159.2**	170.7	169.9	175.9	181.2
	Difference	0.0%	0.0%	0.0%	0.0%	0.1%
CH_4 [Tg]	NIR 2013	**25.7**	24.3	19.9	16.1	15.9
	NIR 2012	**25.7**	24.3	19.9	17.4	16.8
	Difference	0.1%	0.1%	0.0%	-7.3%	-5.1%
N_2O [Tg]	NIR 2013	**20.0**	19.9	17.4	15.4	9.2
	NIR 2012	**20.2**	20.1	17.6	15.6	9.4
	Difference	-0.9%	-1.1%	-1.1%	-1.2%	-2.0%
PFCs [Gg]	NIR 2013	2,264	**1,938**	1,581	265	209
	NIR 2012	2,264	**1,938**	1,582	266	209
	Difference	0.0%	0.0%	-0.1%	-0.3%	0.0%
HFCs [Gg]	NIR 2013	4,432	**6,019**	3,892	1,512	2,260
	NIR 2012	4,432	**6,019**	3,892	1,523	2,282
	Difference	0.0%	0.0%	0.0%	-0.7%	-1.0%
SF_6 [Gg]	NIR 2013	218	**287**	295	240	184
	NIR 2012	218	**287**	297	240	184
	Difference	0.0%	0.0%	-0.5%	0.0%	0.0%
Total	NIR 2013	214.9	226.1	215.9	212.5	212.2
[Tg CO_2 eq]	NIR 2012	215.0	226.2	216.1	214.0	213.1
Incl. LULUCF	*Difference*	-0.1%	-0.1%	-0.1%	-0.7%	-0.4%
Total	NIR 2013	211.8	223.2	213.0	209.5	209.2
[Tg CO_2 eq]	NIR 2012	212.0	223.4	213.2	211.0	210.1
Excl. LULUCF	*Difference*	-0.1%	-0.1%	-0.1%	-0.7%	-0.4%

Note: Base year values are indicated in bold.

Table 10.3 Differences between NIR 2012 and NIR 2013 with respect to emission trends during the period 1990–2010 (Units: Gg CO_2 eq, rounded)

Gas	Trend (absolute)			Trend (percentage)		
CO_2 eq (Gg) [1]	NIR 2012	NIR 2013	Difference	NIR 2012	NIR 2013	Difference
CO_2	21,942	22,145	202	13.8%	13.9%	0.1%
CH_4	-8,900	-9,776	-877	-34.6%	-38.0%	-3.4%
N_2O	-10,770	-10,779	-9	-53.4%	-53.9%	-0.5%
HFCs	-2,150	-2,172	-23	-48.5%	-49.0%	-0.5%
PFCs	-2,056	-2,056	0	-90.8%	-90.8%	0.0%
SF_6	-34	-34	0	-15.7%	-15.7%	0.0%
Total	-1,967	-2,672	-706	-0.9%	-1.3%	-0.3%

[1] Excluding LULUCF.

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 2013.

The peer review includes a general check on all chapters. In addition, special attention is given to a specific sector or topic each year. This year, a separate study (Royal HaskoningDHV, 2013) focussed on industrial process emissions. In the report the conclusion is drawn that the (draft) report for The Netherlands is in general complete,

accurate and transparent and meets the reporting requirements as defined by the UNFCCC and the IPCC. The quality of the report is in general high. One of the key recommendations is to make better use of data that are available from the allocation and monitoring of process emissions under EU ETS, taking into account the differences between monitoring under EU ETS and monitoring under UNFCCC. Another recommendation is to address in more detail how recommendations from UNFCCC and EU reviews should be implemented. Finally, some suggestions were made as to improvement of the transparency and readability of the chapter on industrial process emissions.
Peer reviews in past years focussed on the following sectors and categories: LULUCF (Somogyi, 2012), 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 2012, a centralised review of the NIR 2012 took place. An intensive process of questions and answers was part of this process. The review did not result in a Saturday paper. The draft report by the ERT was not received until December 2012. Therefore, The Netherlands could not use the recommendations in the latest ERT report for further improvements to this NIR.
Improvements were based on the final ARR of the 2011 in-country review of 16 April 2012.
Table 10.4 shows the improvements made in response to the 2011 UNFCCC review.

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 EFs;
- N_2O from industrial wastewater (6B1), due to negligible amounts;
- part of CH_4 from industrial wastewater (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 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. The detailed data to estimate potential emissions 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 of 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 had 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 met the requirements for implementation of the general functions of a 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, 2012).

Table 10.4 I mprovements made in response to UNFCCC review 2011.

ARR 2011 paragraph	Category	ERT comment	Netherlands' response	Reference section of NIR
28, 29	Key sources	KSA and uncertainty	KSA 1990 included in CRF NIR text adapted	Annex 1
34, 35	General	QA/QC plan	In the QA/QC plan a text is included on the QA/QC of small changes. It should be underlined that this concerns interannual changes, e.g. between the emission in 2010 (reported in 2013) and the emission in 2011 (reported in 2013), and not recalculations of emissions in 2010 (reported in 2012 and reported in 2013).	1.6.1.
37	Technical assessment	Provide additional information in NIR	NIR text adapted for LULUCF	7, 10
39, 79, 82, 99	Inventory management	Confidential data availability	NIR text adapted to clarify how to obtain confidential data	1.6.3., 3.2.6., 3.3.1., 4.1., 4.3.4., 4.6.4., 4.7.6
42	Improvements	Follow up on announced improvements	Included in different sectoral sections	3, 4
77	General	Update protocols	Updated protocols are available	Annex 6
78, 81, 86, 88, 99	General/IP	Confidential data	NIR text adapted	4.1, 4.3.3, 4.3.4, 4.4., 4..6.4, 4.7.4.
46, 48, 66, 58, 103, 110–115	General	Improve use of codes and consistency between NIR and CRF	Major improvements were made	CRF database
49	Energy	Provide detailed information on how plant-specific emission factors are used	Text improved; details are in protocol 13-002	3.2.6., 3.2.7., 4.4.4.; details are in protocol 13-002, Annex 1
50, 59	Energy	Accounting of oxidation losses for chemical waste gas during production of ethylene, methanol and carbon black	This recommendation has not yet been followed up as no resources are available for the necessary study	n.a.
52	Energy	Describe the process of derivation of uncertainties by expert judgement	Text improved	1.7.1. and 3.2.8
53	Energy	Quantify apparent consumption	Implemented	CRF table 1.AC
57	Energy	Specify emissions from coal mines	Text included	3.3.1.
59–60	Energy/IP	Allocate 1990 emissions from coke production according to 1996 IPCC GL	Not possible due to aggregated energy balance of 1990	n.a.
63, 64	Transport	CS EFs and Tier description	Text updated	3.2.8.
71,72,72	Transport	Clarification on aviation and railway fuel data and emissions	Text updated	3.2.8.
76, 94	IP	Report emissions from road paving and asphalt roofing	Not possible due to lack of data and no resources to resolve this minor issue	4.2.9
89	IP	Include potential emissions	Included in CRF	CRF tables 2.F.1 and 2.F.9

Table 10.4 I mprovements made in response to UNFCCC review 2011.

ARR 2011 paragraph	Category	ERT comment	Netherlands' response	Reference section of NIR
90	IP	Allocation of SF_6 to 2.F.7	Included in 2.F.9 due to CBI	CRF table 2.F.9
93	IP	Documentation on lime production	Included in NIR	4.2.1.
104, 105	Agriculture	Documentation of used data	Included in NIR	a.o. 6.2.3. and Annex 8
110	Agriculture	Improve CRF filling	Included in CRF	CRF
117	Agriculture	Improve/limit description of planned improvements	Adapted in NIR	6
107, 118	Agriculture	Create new sub-category for rabbits and fur-bearing animals	Included NIR and CRF	CRF 4A and NIR section 6.1.
118	Agriculture	Develop category-specific Tier 2 QC procedures	Research is ongoing	n.a.
35, 121–130, 146–155	LULUCF	Include missing estimates for different removals and emissions, improve NIR documentation and include QA/QC information	Emissions from forest fires and carbon stock changes from grassland and cropland now included in the NIR. For organic soils emissions are calculated on the basis of the total agricultural area on organic soils, and these emissions are reported under the category Grassland remaining grassland. For the submission of the NIR 2014 it is intended to disaggregate this value into the different categories.	7.3., 7.5.4.2., 7.5.9., 7.6.5., 7.7.5., 11.3.1.1., 11.3.1.2.
134, 141-143	Waste	Include additional information on uncertainties and planned improvements	For this category, in coherence with the categories Waste incineration and Other waste handling, an assessment of the uncertainties will be conducted	8.2.5.
138	Waste	Improve transparency on interpolation approach for landfill emissions	Renewed validation of the landfill model which results in improved parameters for the calculation from 2000 onwards	8.2.4.
139	Waste	Missing emission estimates for N_2O from septic tanks	Estimates included in the NIR	8.3.1.

One of the improvement actions relates to the 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 country specific EF was established in this way for 2004 and the base year 1990, during the compilation of the NIR 2006. For both years, the EF 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 were 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, 2009), the value in 2009 and 2010 was 56.6 (Zijlema, 2010a, 2010b) and the value in 2011 was 56.5 (see Annex 2; Zijlema, 2011).

In 2012, The Netherlands plan to improve its bottom-up approach for calculating the fuel consumption by road transport in The Netherlands, probably resulting in a recalculation of the N_2O and CH_4 emissions from road transport.

Monitoring protocol and QA/QC programme

The Netherlands uses monitoring protocols that describe the methodology and data sources used (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 (e.g. the additional information that is now included in background documents). For 2009, The Netherlands included this recommendation in its QA/QC 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, 2012) continues the assessment of improvement options in the longer term, partly based on the consequences of the 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 2013. Another issue for the ERT was the recommendation of further centralisation of the archiving of intermediate calculations by Task Forces. Since 2011, the RIVM database has held storage space where Task Forces can store the crucial data for their emissions calculations. Finally, the improvement of uncertainties will be continued in 2013.

10.4.2 KP-LULUCF inventory

The Netherlands received comments on the completeness of reporting for Grassland and Cropland (biomass). These carbon stock changes have been included in the NIR 2013.

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;
- roads, cleared tracts, firebreaks and other small open areas, all narrower than 6 m, within the forest;
- forests 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 30 m;
- 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 FAO reporting since 1984 and was chosen within the ranges set by the Kyoto Protocol. The definition matches the sub-category of Forest land, Forests according to the Kyoto definition (abbreviated as FAD) in the inventory under the Convention on Climate Change.

11.1.2 Elected activities under article 3, para graph 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 (AR land) 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 on or after 1 January 1990 but ceased to comply with this definition at any moment in time (that can be measured) after 1 January 1990. Once land is classified as deforested (D land), 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 sub-categories 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 deter mining 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). Afforestation, reforestation and deforestation (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 to 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, 1 January 2004 (Kramer et al., 2009) and 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 a second matrix between January 2004 and January 2009. Mean annual rates of change for all land use transitions between those years were 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 has been created for 1 January 2013, ensuring that we are able to capture all land use changes before 2012 (IPCC, 2003). A land use map with map date of 1 January 2008 would have allowed exact land use changes during the CP, but this was practically not feasible. As emissions from all land use changes between 1990 and 2012 are part of the Kyoto Protocol, 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 to 2011 (bottom 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 2011 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 2011, based on an extrapolation of the mean annual rate of land use

Table 11.1 Results of the calculations of the area change (in kha) of re/afforestation (AR) and deforestation (D) in the period 1990-2011.

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
2011	46.52	2.53	0.88	45.48	1.64	4,054.45	97.05

change between 2004 and 2009 (these values will be subject to recalculation when updates of the land use maps become available).

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 should 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 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 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, a small number of inconsistencies were discovered, which could not be resolved for this submission but will be for the next (2014), in which a new land use change matrix will also be implemented. 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 in which 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 BN 1990 consists of the paper topographical map 1:25,000 (Top25) and the digital topographical map 1:10,000 (Top10Vector). Map sheets with exploration years in the period 1986–1994 were used.

Table 11.2 Characteristics of BN 1990, BN 2004 and BN 2009.

Characteristics	BN 1990	BN 2004	BN 2009
Name	Historical Land Use Netherlands 1990	Base Map Nature 2004	Base Map Nature 2009
Aim	Historical land use map for 1990	Base map for monitoring nature development	Base map for monitoring nature development
Resolution	25 m	25 m	25 m
Coverage	Netherlands	Netherlands	Netherlands
Base year source data	1986–1994	1999–2003	2004–2008
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	Digital topographical maps at 1:10,000 and additional sources to distinguish specific nature types
Number of classes	10	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	Grassland, Arable land, Heath land, Forest, Built-up area and infrastructure, Water, Reed marsh, Drifting sands, Dunes and beaches

The source material for BN 2004 consists of the digital topographical map 1:10,000 (Top10Vector). All topographical maps have been explored in the period 1999–2003. For BN 2004 as well as BN 2009, information from the Top 10 vector is combined with four other sources, i.e. two subsidy regulations (information from 2004 respectively 2009), a map of the geophysical regions of The Netherlands (Fysisch Geografische Regio's) and a map of 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 to 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 Top10Vector files and digitised Top25 maps were (re)classified to match the requirements of UNFCCC reporting. In this process, additional datasets were used and the Forest definition was applied to distinguish forests that comply with the minimum area and width specified by 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 of re/afforested area or deforested area is confirmed for each of the individual locations on the map that were subject to ARD between 1990 and 2009. However, it is unknown for each individual location when exactly ARD occurred. A mean annual rate for The Netherlands as a whole is derived from the before mentioned analysis 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 1 January 2013 will be available. All ARD will then be recalculated for the years that were based on extrapolated data.

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
2011	103.89	37.00	NE	NE	7.56	-23.06

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
2011	-120.35	-22.45	-58.90	-2.70	-9.34	-14.62

CSC : carbon stock change
AR : afforestation and reforestation
AG : above ground
DW : Dead wood, deforestation
BG : below ground

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 and 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;
- 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 forests) to Forests according to the Kyoto definition, included in 5.1.1.
- 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 sections 7.2 and 7.5. 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 (Arets et al., 2013). Carbon stock change due to changes in above- and below-ground biomass in land use conversions from Cropland and Grassland were calculated on the basis of Tier 1 default carbon stocks.

  Carbon stock changes in dead wood and litter are not reported (see section 11.3.1.2). Methods for carbon stock changes in mineral and organic soils are presented below. 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 Settlements;
- 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 forests, included in 5.1.1.

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 7.5. 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 (Arets et al., 2013). Carbon stock change due to changes in above- and below-ground biomass in land use conversions to Cropland and Grassland were calculated on the basis of Tier 1 default carbon stocks. 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 of estimating 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., 2012) The LSK database contains quantified soil properties, including soil organic matter, for about 1,400 locations at five depths. The soil types for each of the sample points were reclassified to 11 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 dataset contains only 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 settlements that is 0.9 times the carbon stock of the previous land use is calculated on the basis of the following assumptions:

(i) 50% of the area classified as Settlements 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 (25 m x 25 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 forests (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 is 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 20 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 thus:

$$C_{\Delta yi_t} = C_{xi} + t \cdot \frac{C_{yi} - C_{xi}}{T}$$

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 20.7 (2008), 25.1 (2009), 29.7 (2010) and 34.35 (2011) kton CO_2 per year for deforestation and a net sink of 27.9 (2008), 28.8 (2009), 28.2 and 27.7 (2010) kton CO_2 per year for re/afforestation.

Method of estimating carbon stock change in ARD land in organic soils

The area of organic soils under forests is very small: 11,539 ha (4% of the 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 change is a conversion between Kyoto Forest and agricultural land (Cropland or Grassland).

Table 11.5 Estimates area and GHG emissions from wildfires on AR land

Year	AR as fraction of total forest area	AR area burned (ha)	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
2008	0.111	4.21	0.863	0.004	0.00003
2009	0.115	4.36	0.907	0.004	0.00003
2010	0.119	4.51	0.952	0.004	0.00003
2011	0.123	4.66	0.997	0.004	0.00003

Drainage of organic soils to sustain forestry is not part of the land management nor actively done. However, organic soils under forest are indirectly also 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 (Kramer et al., 2009) and overlaid with the subsidence map of peat areas. The emissions from organic soils were then calculated using the subsidence 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 are available on emissions from peat soils under forest or on 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 subsidence map of peat soils with the locations of re/afforestation and deforestation (land use changes from 1990 to 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 of estimating nitrous oxide emissions associated with disturbance of soils when deforested areas are converted to Cropland

Nitrous oxide emissions associated with the disturbance of soils when deforested areas are converted to Cropland are calculated using equations 3.3.14 and 3.3.15 of the 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 of estimating carbon stock change in ARD land due to liming

Liming of forests 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 either of these categories. The total amount of liming is reported in sector 5G of the Convention and described in section 7.11. There is no information on how much of the total amount of lime is applied to Cropland and Grassland that are reported under deforestation (as opposed to other Cropland and Grassland). A mean per ha lime application was calculated on the basis of the total amount of lime applied and the total area under Grassland and Cropland. This was multiplied by the total area of Grassland and Cropland reported under article 3.3 deforestation to calculate the amount of CO_2 emission due to liming.

Statistics on lime application lag behind one year. Therefore, the 2010 data were updated from 0.61 to 0.75 Gg CO_2. The 2011 emissions from lime application were estimated using the 2010 quantities of lime applied, resulting in an emission of 0.79 Gg CO_2.

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 controlled biomass burning in areas that are afforested or reforested (AR) does not occur, as no slash burning etc. is allowed, and are therefore reported as not occurring (NO). No recent statistics on wildfires are available (only 1980–1992). Therefore, from this submission onwards greenhouse gas emissions (CO_2, CH_4 and N_2O) from forest fires on AR land are estimated using the Tier 1 method with average annual area AR land burned estimated from the historical series of total forest area burned between 1980 and 1992 (on average 37.8 ha, about 0.1% of the total area of forest land; Wijdeven et al., 2006) scaled to the proportion of AR to total forest area (approximately 11%–12%; see Table 11.5) and average annual carbon stock in living biomass, litter and dead wood. These estimates are reported in table 5(KP-II)5.
The estimated GHG emissions for wildfires have a high

Figure 11.1 Volume of dead wood (standing and lying) in Dutch NFI plots in relation to tree age.

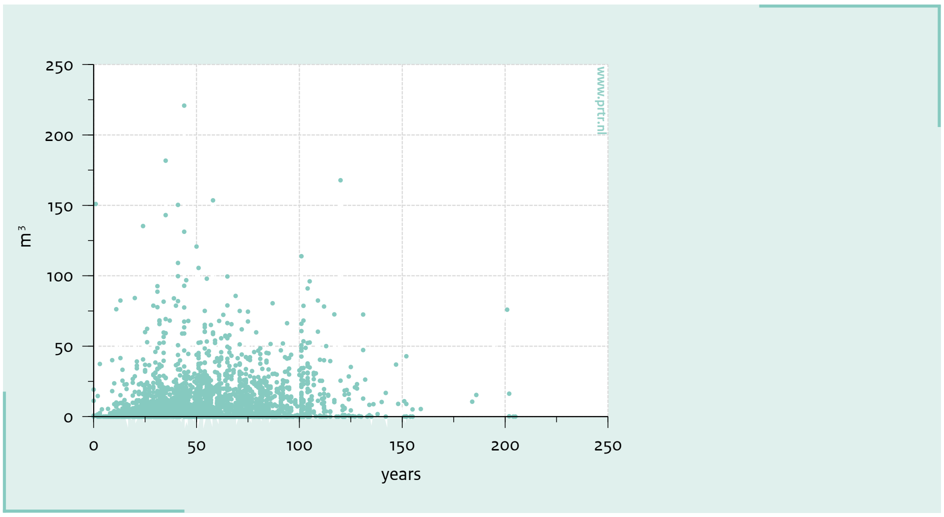
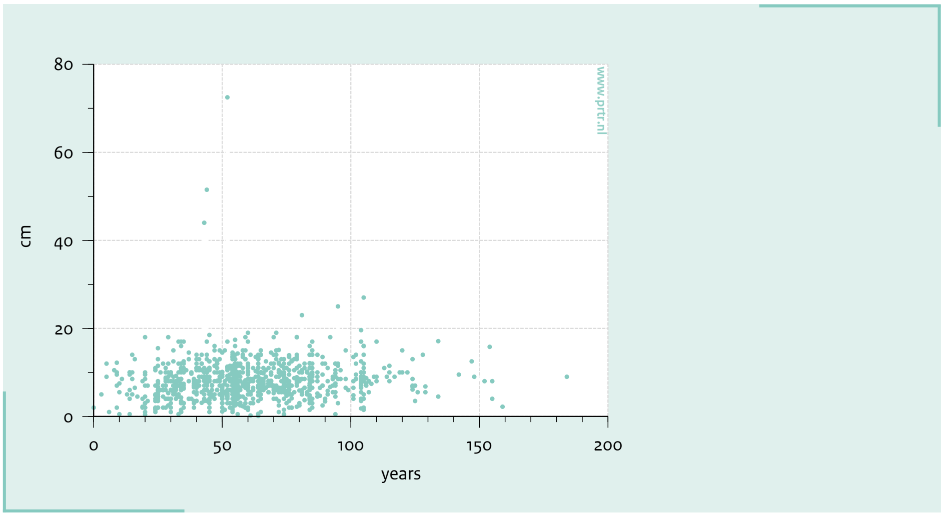


Figure 11.2 Thickness of litter layer (LFH) in Dutch NFI plots in relation to tree age. LFH measurements were conducted only in plots on sandy soils.



level of uncertainty due to the uncertain areas of wildfires and the large year-to-year variation in area burned over the period 1980–1992 used to estimate an average area.

Forest fires are estimated only for AR land because after deforestation all biomass is assumed to be removed already.

11.3.1.2 *Justification for 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 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 Forest, no land use has a similar carbon stock in litter (in Dutch Grassland, management prevents the 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), the 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 emissions 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 as NO.

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 the 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 the 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 higher carbon emissions 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)

1. To increase completeness this year, CO_2, CH_4 and N_2O emissions from wildfires in forests (forest fires) were included for the years 2008–2011 for the first time. This resulted in a decreased sink of CO_2 and increased emissions of CH_4 and N_2O from AR land.
2. Emissions from liming for 2010 were updated. In the previous NIR fertiliser data were not available for 2010 and therefore 2010 emissions were set equal to 2009 emissions. These fertiliser data have become available and have been used to calculate 2010 emissions.

These correspond with part of the recalculations described in par. 7.4 for the submission under the Convention (recalculations 1 and 2).

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 LULUCF sector. 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.

Table 11.6 Net emissions from AR and D for accounting years 2008–2011 (Gg CO_2 eq).

Activities	Net emissions/removals 2008	2009	2010	2011	Total	Accounting quantity
A. Article 3.3 activities						
A.1. Afforestation and Reforestation						**-1,753.42**
A.1.1. Units of land not harvested since the beginning of the commitment period	-403.74	-441.19	-449.84	-458.66	-1,753.42	-1,753.42
A.2. Deforestation	763.01	787.56	813.38	838.67	3,202.62	**3,202.62**

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 by 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 any country in 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 Forest 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 the size and geographical location of forest areas that have lost forest cover but 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 Forest was classified as clearcut area, that is, without tree cover.

11.4.4 Information on accounting for activities under article 3.3 activities A1 (afforesta tion and reforestation) and A2 (deforestation)

The Netherlands has opted for end of period accounting. The current net emissions for accounting are presented in table 11.6.

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 637 Gg CO_2 (1B1b CO_2 from coke production; see Annex 1). With 458.76 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 2011 causes an emission of 838.09 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 2012 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_2013_1_21-21-47 9-4-2013.xls).

12.2 Summary of information reported in the SEF tables

There were 1,102,807,330 AAUs in The Netherlands' National Emission Trading Registry at the end of the year 2012, of which 542,673,011 AAUs were in the Party holding account, 3.979 AAUs in the other cancellation accounts and 560,130,340 AAUs in the retirement account.

There were 45,654,972 CERs in the registry at the end of 2012: 23,945,399 CERs were held in the Party holding account, 14,201,386 CERs were held in the entity holding accounts, 120,692 CERs in the other cancellation accounts and 7,387,495 CERs were held in the retirement account.

There were 51,471,631 ERUs in the registry at the end of 2012: 9,670,179 ERUs were held in the Party holding account, 40,906,339 ERUs were held in the entity holding accounts, no ERUs were held in the other cancellation accounts and 895,113 ERUs were held in 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 1,199,933,933 tons CO_2 eq.

The Netherlands' assigned amount is 1,001,262,141 tons 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 2012 has been submitted to the UNFCCC Secretariat electronically (SEF_NL_2013_1_21-21-47 9-4-2013.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	No discrepant transactions occurred in 2012.
List of discrepant transactions	No CDM notifications occurred in 2012.
15/CMP.1 annex I.E paragraph 13 & 14	No non-replacements occurred in 2012.
List of CDM notifications	No invalid units existed as at 31 December 2012.
15/CMP.1 annex I.E paragraph 15	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 above-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, which 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 (see 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 or RMUs have been cancelled on the basis of activities under article 3, paragraphs 3 and 4 to date.
	paragraph 47h No ERUs, CERs, AAUs or 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 from which to carry ERUs, CERs, and AAUs over.

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 tons CO_2 equivalent. The CPR was calculated at that point in time at 901,135,927 tons 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 the 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 had been established in accordance with the guidelines.

There have been no functional changes in the National System since the last submission and since the Initial Report, with the exception of the following administrative 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) changed as of 1 January 2010 to NL Agency.
- The name of the Ministry of Housing, Spatial Planning and the Environment (VROM) 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.
- As a result of a merger with the Minstry of Economic Affairs, the current name of the Ministry of Agriculture, Nature and Food Quality (LNV) is the Ministry of Economic Affairs (EZ). From 2010 until 2012 the ministry was called the Ministry of Economic Affairs, Agriculture and Innovation (EL&I).

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

Directive 2009/29/EC, adopted in 2009, provides for the centralisation of EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector in the ETS. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of party registries – in particular decision 13/CMP.1 and decision 24/CP.8.
With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating parties, the registry of EU has undergone a major re-development. The platform that implements the national registries in a consolidated manner (including the registry of EU) is called the Consolidated System of EU Registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

1. Each party retains its organisation, designated as its registry administrator, to maintain the national registry of that party and remains responsible for all the obligations of parties that are to be fulfilled through registries.
2. Each Kyoto unit issued by the parties in such a consolidated system is issued by one of the constituent parties and continues to carry the party of origin identifier in its unique serial number.
3. Each party retains its own set of national accounts as required by paragraph 21 of the annex to decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the party and a unique number within the party where the account is maintained.
4. Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions.
5. The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL.
6. The requirements of paragraphs 44 to 48 of the annex to decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each party individually.

7. All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
   a. With regard to data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel).
   b. The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated.
   c. With regard to data storage, the consolidated platform continues to guarantee that data are kept confidential and protected against unauthorised manipulation.
   d. The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries.
   e. In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each party.

The following changes to the national registry of The Netherlands occurred in 2012 as a consequence of the transition to the CSEUR platform:

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	The EU Member States who are also parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went into operation on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire** • **Application loggi** • **Change management procedure** • **Disaster recovery** • **Manual intervention** • **Operational plan** • **Roles and responsibilities** • **Security plan** • **Time validation plan** • **Version change management** The documents above are provided as an annex to this document. These documents cannot be made publicly available. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as a second level of support to the local support provided by the parties. It also plays a key communication role with the ITL Service Desk, notably with regard to connectivity and reconciliation issues.

Reporting item	Submission
15/CMP.1 annex II.E paragraph 32.(c) Change to database or the capacity of national registry	In 2012, the EU registry underwent a major redevelopment in order to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU Registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and led to **successful certification on 1 June 2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change of conformity to technical standards	The overall change to a Consolidated System of EU Registries triggered changes to the registry software and required new conformity testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and led to successful certification on 1 June 2012.
15/CMP.1 annex II.E paragraph 32.(e) Change of discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and the **operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(f) Change of security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g) Change of list of publicly available information	No change to the list of publicly available information occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(h) Change of internet address	The new internet address of the Dutch registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/NL/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i) Change of data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change of test results	On 2 October 2012 a new software program (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into operation. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	There were no recommendations in the previous Annual Review

15 Information on minimisation of adverse impacts in accordance with Article 3, paragraph 14

The Netherlands has reported information on the minimisation of adverse impacts in its 5th National Communication, submitted to the UNFCCC in December 2009, and in the NIR 2010, 2011 and 2012.
Since the submission of the NIR 2012, there have been limited changes in the activities on minimising adverse impacts. Policies are still in place and being executed.

The Netherlands is pleased that the Kyoto Protocol has been amended with a second commitment period 2013-2020, agreed upon at COP 18 in Doha. The Netherlands and the European Union have made every effort to achieve this result. Although fewer countries are now participating, the reduction of this second commitment period is now 18 per cent compared with 1990, as compared with the 5.2 per cent of the first commitment period. Moreover the amendment ensures that the KP regulatory system, on emission trading and reporting for instance, is still in place. The Netherlands will also actively participate in the working programme that has been established to work towards a new, legally binding instrument for the period after 2020, which should be applicable to all parties. Now new steps are urgently needed to develop a new climate arrangement that is able to meet the ever greater climate challenges in the areas of mitigation, adaptation, technology and finance during the 21st century.

Recent changes concerning Dutch efforts on the minimisation of adverse impacts include improvements to the Green Climate Fund and New Market Mechanisms. These are seen as important steps to assist 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 establishing the Green Climate Fund by agreeing on its Governing Instrument, COP 17 in Durban has taken an important step towards the full operationalisation of the GCF. In the Transitional Committee, The Netherlands has been actively involved in formulating an effective governing instrument that will enable wise spending and maximum climate benefits in terms of enhanced resilience and robust mitigation efforts. The consolidation of these rules in the Durban Agreements in the Governing Instrument is welcomed by The Netherlands.

The Netherlands are pleased that, the important role of the private sector in realising the necessary investments has been formally acknowledged by COP 17 through endorsement of the Governing Instrument.

As part of the GCF the 'private sector facility' will have to facilitate public–private partnerships as part of the Fund. This will have to be a crucial part of operationalising the business model of the Green Climate Fund in 2013 similar to ensuring wise spending, performance-based allocation and ensuring transformational impact.

2013 will be crucial to turn vision into impact. The selection of the host country and the establishment of the Interim Secretariat were crucial to that end. A fully operationalised business model will be crucial as a basis for capitalisation of the Fund.

Collaboration between authorities, business and knowledge institutions

In the years ahead, The Netherlands will be working more closely with companies and knowledge institutions to contribute to combating climate change and its consequences. The innovations and financial strength of these parties are essential to meet the challenges of climate change together. The Netherlands has, for example, a great deal of expertise in the fields of water, food security and energy and we are already collaborating with various countries in these fields: on water, for instance, with Vietnam, Colombia and Indonesia. In the future, the private sector and knowledge institutions will be more closely involved and this is a key factor in the Dutch strategy. It is also in line with our ambitions for the new climate instrument: to offer customisation and to let everyone make an appropriate contribution.

Fast start finance

Meanwhile, The Netherlands has fulfilled the Copenhagen agreement on 'Fast Start Finance'. This involved financially supporting immediate action on climate change and kick starting mitigation and adaptation efforts in developing countries from 2010 to 2012. Although this agreement terminated at the end of 2012, The Netherlands will continue to finance climate initiatives in developing countries: in 2013 to the amount of 200 million euros. It was agreed in Doha that in 2013 further discussion will take place on what the structure of climate funding should be between now and 2020.

The Netherlands is pleased that its website, www.faststartfinance.org, could be of value to the promotion of transparency on fast start finance. This module on the UNFCCC website safeguards the UNFCCC responsibility for transparency. It is confident that with the established fast start finance module on the UNFCCC website, this transparency will be safeguarded.

Market Mechanisms

In the view of The Netherlands, COP 17 in Durban showed important progress on the future and the use of (flexible) market mechanisms. COP 17 '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 2013, 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. However, The Netherlands also intends to actively participate in the further discussions on the development and implementation of the Framework for Various Approaches in order to, on the one hand allow flexibility in the use of market instruments and, on the other, ensure that environmental integrity is safeguarded. By this approach, fragmentation of the carbon market can beminimised.

An important outcome of COP 18 is the decision to continue the Kyoto Protocol, which in practice implies that CDM and JI can continue to operate beyond 2013. For CDM and JI, decisions were taken to further enhance their efficiency and credibility.

Carbon Capture and Storage

Carbon capture and storage (CCS) will reduce emissions of CO_2 into the air, noting that the use of 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 with the aim of capturing CO_2 from an industrial source, transport it by ship and inject it into an oil field under the North Sea for EOR and consequently storage.

16 Other information

No other information.

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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 national emissions 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 equivalent). Other mobile sources are not assessed separately by gas. Fugitive emissions from oil and gas operations (1B) are important sources 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 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 per cent of the national total (excluding LULUCF): 33 sources for annual level assessment (emissions in 2011) and 32 sources for the trend assessment out of a total of 72 sources. The two lists can be combined to obtain an overview of sources that meet one or two of these criteria.

The IPCC Tier 2 method for the 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 of the Tier 1 uncertainty analysis see Olivier et al., 2009). Here, a total contribution of up to 90 per cent 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 44 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, four sources are added to the list of 44 Tier 1 level and trend key sources (excluding LULUCF):

- 1A3 Mobile combustion: road vehicles N_2O (Tier 2 trend);
  4A8 CH_4 emissions from enteric fermentation in domestic livestock: swine (Tier 2 level);
- 4B9 Emissions from manure management: poultry CH_4 (Tier 2 trend);
- 6B Emissions from wastewater handling: N_2O (Tier 2 level).

The share of these sources in the national annual total becomes more important when taking their uncertainty (50 per cent–100 per cent) into account (table A1.4). When we 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, this results in four additional key sources, giving an overall total of 48 key sources; see also table A1.2. In this report, the key source assessment is based on emission figures from Common Reporting Format (CRF) 2013 version 1.2, submitted to the European Union (EU) in March 2013.

Please note that the key source analysis for the base year (1990 for the direct GHG and 1995 for the F-gases) 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. Level assessment for 2011 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,T1)	Yes	Yes	No	No
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	Key(L)	Yes	No	Yes	No
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	Non key	No	No	No	No
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	Key(L)	Yes	No	Yes	No
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A3	Mobile combustion: water-borne navigation	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A3	Mobile combustion: aircraft	CO_2	Non key	No	No	No	No
1A3	Mobile combustion: other (railways)	CO_2	Non key	No	No	No	No
1A3	Mobile combustion: other (non-road)	CH_4	Non key	No	No	No	No
1A3	Mobile combustion: other (non-road)	N_2O	Non key	No	No	No	No
1A3	Mobile combustion: road vehicles	CH_4	Non key	No	No	No	No
1A3	Mobile combustion: road vehicles	N_2O	Key(,T2)	No	No	No	Yes
1A4	Stationary combustion: Other Sectors, solids	CO_2	Non key	No	No	No	No
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	Key(,T)	No	Yes	No	Yes
1A5	Military use of fuels (1A5 Other)	CO_2	Non key	No	No	No	No
1A	Emissions from stationary combustion: non-CO_2	CH_4	Key(L,T)	Yes	Yes	Yes	Yes

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	No	No	No	No
1B1	Coal mining	CH_4					
1B1b	Coke production	CO_2	Key(L2,T2)	No	No	Yes	Yes
1B2	Fugitive emissions from venting/flaring: CO_2	CO_2	Key(,T)	No	Yes	No	Yes
1B2	Fugitive emissions venting/flaring	CH_4	Key(,T)	No	Yes	No	Yes
1B2	Fugitive emissions from oil and gas: gas distribution	CH_4	Non key	No	No	No	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	Non key	No	No	No	No
	INDUSTRIAL PROCESSES						
2A1	Cement production	CO_2	Non key	No	No	No	No
2A3	Limestone and dolomite use	CO_2	Non key	No	No	No	No
2A7	Other minerals	CO_2	Non key	No	No	No	No
2B1	Ammonia production	CO_2	Key(L1,)	Yes	No	No	No
2B2	Nitric acid production	N_2O	Key(,T)	No	Yes	No	Yes
2B5	Caprolactam production	N_2O	Key(L,)	Yes	No	Yes	No
2B5	Other chemical product manufacture	CO_2	Key(L,T2)	Yes	No	Yes	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	Key(L1,T1)	Yes	Yes	No	No
2C3	CO_2 from aluminium production	CO_2	Non key	No	No	No	No
2C3	PFC from aluminium production	PFC	Key(,T)	No	Yes	No	Yes
2F	SF_6 emissions from SF_6 use	SF_6	Non key	No	No	No	No
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	Key(L,T)	Yes	Yes	Yes	Yes
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	Key(,T)	No	Yes	No	Yes
2E	HFC by-product emissions from HFC manufacture	HFC	Non key	No	No	No	No
2F	PFC emissions from PFC use	PFC	Non key	No	No	No	No
2G	Other industrial: CO_2	CO_2	Non key	No	No	No	No
2G	Other industrial: CH_4	CH_4	Non key	No	No	No	No
2G	Other industrial: N_2O	N_2O	Non key	No	No	No	No
	SOLVENTS AND OTHER PRODUCT USE						
3	Indirect CO_2 from solvents/product use	CO_2	Non key	No	No	No	No
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,)	Yes	No	Yes	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	Non key	No	No	No	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	Key(L,T1)	Yes	Yes	Yes	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	Key(L2,)	No	No	Yes	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	Non key	No	No	No	No
4B	Emissions from manure management	N_2O	Key(L,)	Yes	No	Yes	No
4B1	Emissions from manure management: cattle	CH_4	Key(L,T)	Yes	Yes	Yes	Yes
4B8	Emissions from manure management: swine	CH_4	Key(L,T)	Yes	Yes	Yes	Yes
4B9	Emissions from manure management: poultry	CH_4	Key(,T2)	No	No	No	Yes

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	No	No	No	No
4C	Rice cultivation	CH_4					
4D1	Direct N_2O emissions from agricultural soils	N_2O	Key(L,T)	Yes	Yes	Yes	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	Key(L,T)	Yes	Yes	Yes	Yes
4D2	Animal production on agricultural soils	N_2O	Key(L,T)	Yes	Yes	Yes	Yes
	WASTE SECTOR						
6A1	CH_4 emissions from solid waste disposal sites	CH_4	Key(L,T)	Yes	Yes	Yes	Yes
6B	Emissions from wastewater handling	CH_4	Non key	No	No	No	No
6B	Emissions from wastewater handling	N_2O	Key(L2,)	No	No	Yes	No
6C	Emissions from waste incineration	all					
	OTHER						
6D	OTHER CH_4	CH_4	Non key	No	No	No	No
3, 6D	OTHER N_2O	N_2O	Non key	No	No	No	No
	[1)] = 6D Other waste						
	[2)] = 4D animal production - waste dropped on soils + 3D Solvents		SUM	33	32	29	24

Table A1.2 Key source list identified by the Tier 1 level and trend assessments. Level assessment for 2011 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,T1)	Yes	Yes	No	No
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	Key(L,)	Yes	Yes	Yes	No
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	Non key	No	No	No	No
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	Key(L,)	Yes	No	Yes	No
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A3	Mobile combustion: water-borne navigation	CO_2	Key(L1,T1)	Yes	Yes	No	No
1A3	Mobile combustion: aircraft	CO_2	Non key	No	No	No	No
1A3	Mobile combustion: other (railways)	CO_2	Non key	No	No	No	No
1A3	Mobile combustion: other (non-road)	CH_4	Non key	No	No	No	No
1A3	Mobile combustion: other (non-road)	N_2O	Non key	No	No	No	No
1A3	Mobile combustion: road vehicles	CH_4	Non key	No	No	No	No
1A3	Mobile combustion: road vehicles	N_2O	Key(,T2)	No	No	No	Yes
1A4	Stationary combustion: Other Sectors, solids	CO_2	Non key	No	No	No	No
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	Key(L,T1)	Yes	Yes	Yes	No
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	Key(,T)	No	Yes	No	Yes
1A5	Military use of fuels (1A5 Other)	CO_2	Non key	No	No	No	No

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)	Yes	Yes	Yes	Yes
1A	Emissions from stationary combustion: non-CO_2	N_2O	Non key	No	No	No	No
1B1	Coal mining	CH_4					
1B1b	Coke production	CO_2	Key(L2,T2)	Yes	No	Yes	Yes
1B2	Fugitive emissions from venting/flaring: CO_2	CO_2	Key(,T)	No	Yes	No	Yes
1B2	Fugitive emissions venting/flaring	CH_4	Key(,T)	No	Yes	No	Yes
1B2	Fugitive emissions from oil and gas: gas distribution	CH_4	Non key	No	No	No	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	Non key	No	No	No	No
	INDUSTRIAL PROCESSES						
2A1	Cement production	CO_2	Non key	No	No	No	No
2A3	Limestone and dolomite use	CO_2	Non key	No	No	No	No
2A7	Other minerals	CO_2	Non key	No	No	No	No
2B1	Ammonia production	CO_2	Key(L1,)	Yes	No	No	No
2B2	Nitric acid production	N_2O	Key(,T)	No	Yes	No	Yes
2B5	Caprolactam production	N_2O	Key(L,)	Yes	No	Yes	No
2B5	Other chemical product manufacture	CO_2	Key(L,T2)	Yes	No	Yes	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	Key(L1,T1)	Yes	Yes	No	No
2C3	CO_2 from aluminium production	CO_2	Non key	No	No	No	No
2C3	PFC from aluminium production	PFC	Key(,T)	No	Yes	No	Yes
2F	SF_6 emissions from SF_6 use	SF_6	Non key	No	No	No	No
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	Key(L,T)	Yes	Yes	Yes	Yes
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	Key(,T)	No	Yes	No	Yes
2E	HFC by-product emissions from HFC manufacture	HFC	Non key	No	No	No	No
2F	PFC emissions from PFC use	PFC	Non key	No	No	No	No
2G	Other industrial: CO_2	CO_2	Non key	No	No	No	No
2G	Other industrial: CH_4	CH_4	Non key	No	No	No	No
2G	Other industrial: N_2O	N_2O	Non key	No	No	No	No
	SOLVENTS AND OTHER PRODUCT USE						
3	Indirect CO_2 from solvents/product use	CO_2	Non key	No	No	No	No
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,)	Yes	No	Yes	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	Non key	No	No	No	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	Key(L,T1)	Yes	Yes	Yes	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	Key(L2,)	No	No	Yes	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	Non key	No	No	No	No
4B	Emissions from manure management	N_2O	Key(L,)	Yes	No	Yes	No
4B1	Emissions from manure management: cattle	CH_4	Key(L,T)	Yes	Yes	Yes	Yes
4B8	Emissions from manure management: swine	CH_4	Key(L,T)	Yes	Yes	Yes	Yes

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)	No	No	No	Yes
4B	Emissions from manure management: other	CH_4	Non key	No	No	No	No
4C	Rice cultivation	CH_4					
4D1	Direct N_2O emissions from agricultural soils	N_2O	Key(L,T)	Yes	Yes	Yes	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	Key(L,T)	Yes	Yes	Yes	Yes
4D2	Animal production on agricultural soils	N_2O	Key(L,T)	Yes	Yes	Yes	Yes
	LULUCF						
5A1	Forest Land remaining Forest Land	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
5A2	Land converted to Forest Land	CO_2	Key(L2,T)	No	Yes	Yes	Yes
5B2	Land converted to Cropland	CO_2	Non key	No	No	No	No
5C1	Grassland remaining Grassland	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
5C2	Land converted to Grassland	CO_2	Non key	No	No	No	No
5D2	Land converted to Wetlands	CO_2	Non key	No	No	No	No
5E2	Land converted to Settlements	CO_2	Key(L,T)	Yes	Yes	Yes	Yes
5F2	Land converted to Other Land	CO_2	Non key	No	No	No	No
5G	Other (liming of soils)	CO_2	Non key	No	No	No	No
	WASTE SECTOR						
6A1	CH_4 emissions from solid waste disposal sites	CH_4	Key(L,T)	Yes	Yes	Yes	Yes
6B	Emissions from wastewater handling	CH_4	Non key	No	No	No	No
6B	Emissions from wastewater handling	N_2O	Key(L2,)	No	No	Yes	No
6C	Emissions from waste incineration	all					
	OTHER						
6D	OTHER CH_4	CH_4	Non key	No	No	No	No
3, 6D	OTHER N_2O	N_2O	Non key	No	No	No	No
	[1] = 6D Other waste						
	[2] = 4D animal production - waste dropped on soils + 3D Solvents		SUM	37	37	33	28

A1.2 Changes in key sources compared with previous submission

Due to the use of emissions data for 2011 and new uncertainty data concerning traffic emissions, the following changes have taken place compared with the previous NIR:

- 1A3 Mobile combustion water-borne navigation CO_2, now key (L1,T) (non-key in NIR 2012);
- 4A8 CH4 emissions from enteric fermentation in domestic livestock: swine now key (L2) (non-key in NIR 2012)

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 2011 annual emissions total and to the base year to 2011 trend, respectively. This resulted in 33 level key sources and 32 trend key sources (excluding LULUCF). Inclusion of LULUCF sources in the analysis adds four Tier 1 level and trend key sources (see Table A1.2).

Table A1.3a Source ranking using IPCC Tier 1 level assessment 2011, 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	23,701	12%	12%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23,333	12%	24%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20,170	10%	35%	Yes
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	16,630	9%	43%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13,159	7%	50%	Yes
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13,062	7%	57%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/ Institutional, gases	CO_2	9,352	5%	61%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,563	4%	66%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	8,043	4%	70%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7,166	4%	74%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4,022	2%	76%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3,963	2%	78%	Yes
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3,600	2%	80%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	3,236	2%	81%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	3,166	2%	83%	Yes
2B1	Ammonia production	CO_2	2,681	1%	84%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2,570	1%	86%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1,928	1%	87%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,795	1%	88%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	1,723	1%	88%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1,641	1%	89%	Yes
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,627	1%	90%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	1,594	1%	91%	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1,450	1%	92%	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	1,110	1%	92%	Yes
4D2	Animal production on agricultural soils	N_2O	1,108	1%	93%	Yes
4B	Emissions from manure management	N_2O	1,052	1%	93%	Yes
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	909	0%	94%	Yes
2B5	Caprolactam production	N_2O	870	0%	94%	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	843	0%	95%	Yes
4B8	Emissions from manure management : swine	CH_4	770	0%	95%	Yes
2B5	Other chemical product manufacture	CO_2	728	0%	95%	Yes
1A3	Mobile combustion: water-borne navigation	CO_2	669	0%	96%	Yes
1B1b	CO_2 from coke production	CO_2	637	0%	96%	No
2A3	Limestone and dolomite use	CO_2	600	0%	96%	No

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	463	0%	97%	No
6B	Emissions from wastewater handling	N_2O	457	0%	97%	No
2C3	CO_2 from aluminium production	CO_2	438	0%	97%	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	392	0%	97%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	388	0%	98%	No
1A5	Military use of fuels (1A5 Other)	CO_2	355	0%	98%	No
2A1	Cement production	CO_2	351	0%	98%	No
2A7	Other minerals	CO_2	344	0%	98%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	334	0%	98%	No
2G	Other industrial: CO_2	CO_2	325	0%	98%	No
1B2	Fugitive emissions venting/flaring	CH_4	323	0%	99%	No
2G	Other industrial: CH_4	CH_4	281	0%	99%	No
1A3	Mobile combustion: road vehicles	N_2O	270	0%	99%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	268	0%	99%	No
2B2	Nitric acid production	N_2O	243	0%	99%	No
6B	Emissions from wastewater handling	CH_4	199	0%	99%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	184	0%	99%	No
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	166	0%	99%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	161	0%	100%	No
2F	SF_6 emissions from SF_6 use	SF_6	147	0%	100%	No
3	Indirect CO_2 from solvents/product use	CO_2	123	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	102	0%	100%	No
2F	PFC emissions from PFC use	PFC	101	0%	100%	No
2C3	PFC from aluminium production	PFC	82	0%	100%	No
3, 6D	OTHER N_2O	N_2O	71	0%	100%	No
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	54	0%	100%	No
1A3	Mobile combustion: road vehicles	CH_4	45	0%	100%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	42	0%	100%	No
4B9	Emissions from manure management : poultry	CH_4	41	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	38	0%	100%	No
4B	Emissions from manure management : other	CH_4	24	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	22	0%	100%	No
6D	OTHER CH_4	CH_4	22	0%	100%	No
2G	Other industrial: N_2O	N_2O	11	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%	No
	TOTAL	GHG	194,344			33

Table A1.3b Source ranking using IPCC Tier 1 level assessment 2011, 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	23,701	12%	12%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23,333	12%	23%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20,170	10%	33%	Yes
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	16,630	8%	41%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13,159	6%	48%	Yes
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13,062	6%	54%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/ Institutional, gases	CO_2	9,352	5%	59%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,564	4%	63%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	8,043	4%	67%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7,166	4%	71%	Yes
5C1	Grassland remaining Grassland	CO_2	4,246	2%	73%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4,022	2%	75%	Yes
4A1	CH4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3,963	2%	77%	Yes
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3,600	2%	79%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	3,236	2%	80%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	3,166	2%	82%	Yes
2B1	Ammonia production	CO_2	2,681	1%	83%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2,570	1%	84%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1,928	1%	85%	Yes
5A1	5A1. Forest Land remaining Forest Land	CO_2	1,893	1%	86%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,795	1%	87%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	1,723	1%	88%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1,641	1%	89%	Yes
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,627	1%	90%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	1,594	1%	90%	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1,450	1%	91%	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	1,110	1%	92%	Yes
4D2	Animal production on agricultural soils	N_2O	1,108	1%	92%	Yes
4B	Emissions from manure management	N_2O	1,052	1%	93%	Yes
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	909	0%	93%	Yes
2B5	Caprolactam production	N_2O	870	0%	94%	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	843	0%	94%	Yes
5E2	Land converted to Settlements	CO_2	817	0%	94%	Yes
4B8	Emissions from manure management : swine	CH_4	770	0%	95%	Yes
2B5	Other chemical product manufacture	CO_2	728	0%	95%	Yes
1A3	Mobile combustion: water-borne navigation	CO_2	669	0%	95%	Yes

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
1B1b	CO_2 from coke production	CO_2	637	0%	96%	Yes
2A3	Limestone and dolomite use	CO_2	600	0%	96%	No
5A2	Land converted to Forest Land	CO_2	541	0%	96%	No
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	463	0%	97%	No
6B	Emissions from wastewater handling	N_2O	457	0%	97%	No
2C3	CO_2 from aluminium production	CO_2	438	0%	97%	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	392	0%	97%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	388	0%	97%	No
1A5	Military use of fuels (1A5 Other)	CO_2	355	0%	98%	No
2A1	Cement production	CO_2	351	0%	98%	No
2A7	Other minerals	CO_2	344	0%	98%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	334	0%	98%	No
2G	Other industrial: CO_2	CO_2	325	0%	98%	No
1B2	Fugitive emissions venting/flaring	CH_4	323	0%	98%	No
2G	Other industrial: CH_4	CH_4	281	0%	98%	No
1A3	Mobile combustion: road vehicles	N_2O	270	0%	99%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	268	0%	99%	No
2B2	Nitric acid production	N_2O	243	0%	99%	No
5C2	Land converted to Grassland	CO_2	236	0%	99%	No
6B	Emissions from wastewater handling	CH_4	199	0%	99%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	184	0%	99%	No
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	166	0%	99%	No
5B2	5B2. Land converted to Cropland	CO_2	165	0%	99%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	161	0%	99%	No
2F	SF_6 emissions from SF_6 use	SF_6	147	0%	99%	No
5D2	5D2. Land converted to Wetlands	CO_2	135	0%	100%	No
3	Indirect CO_2 from solvents/product use	CO_2	123	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	102	0%	100%	No
2F	PFC emissions from PFC use	PFC	101	0%	100%	No
2C3	PFC from aluminium production	PFC	82	0%	100%	No
5G	Other (liming of soils)	CO_2	73	0%	100%	No
3, 6D	OTHER N_2O	N_2O	71	0%	100%	No
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	54	0%	100%	No
1A3	Mobile combustion: road vehicles	CH_4	45	0%	100%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	42	0%	100%	No
4B9	Emissions from manure management : poultry	CH_4	41	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	38	0%	100%	No
5F2	5F2. Land converted to Other Land	CO_2	27	0%	100%	No
4B	Emissions from manure management : other	CH_4	24	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	22	0%	100%	No
6D	OTHER CH_4	CH_4	22	0%	100%	No
2G	Other industrial: N_2O	N_2O	11	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%	No
	TOTAL	GHG	202,477			37

Table A1.4a Source ranking using IPCC Tier 1 trend assessment 2011, 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	13,348	23,701	12%	7%	15%	15%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11,821	20,170	10%	5%	12%	27%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12,011	3,166	2%	4%	10%	37%	Yes
2B2	Nitric acid production	N_2O	6,330	243	0%	3%	7%	44%	Yes
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	166	0%	3%	7%	51%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19,020	13,159	7%	2%	5%	56%	Yes
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10,908	13,062	7%	2%	4%	60%	Yes
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1,042	3,600	2%	1%	3%	64%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7,632	9,352	5%	1%	3%	67%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2,570	1%	1%	3%	69%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9,999	7,166	4%	1%	3%	72%	Yes
4D2	Animal production on agricultural soils	N_2O	3,150	1,108	1%	1%	2%	74%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1,928	1%	1%	2%	76%	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2,740	843	0%	1%	2%	78%	Yes
2C3	PFC from aluminium production	PFC	1,901	82	0%	1%	2%	81%	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3,358	1,450	1%	1%	2%	83%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7,330	8,043	4%	1%	2%	84%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1,594	1%	1%	1%	86%	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	2,267	1,110	1%	1%	1%	87%	Yes
1B2	Fugitive emissions venting/flaring	CH_4	1,252	323	0%	0%	1%	88%	Yes
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1,356	463	0%	0%	1%	89%	Yes
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	909	0%	0%	1%	90%	Yes
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	54	0%	0%	1%	91%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2,587	1,723	1%	0%	1%	92%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5,033	4,022	2%	0%	1%	92%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	4,137	3,236	2%	0%	1%	93%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2,264	1,641	1%	0%	1%	94%	Yes

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 ?
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18,696	16,630	9%	0%	1%	94%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,956	8,563	4%	0%	1%	95%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,593	1,795	1%	0%	0%	95%	Yes
1A3	Mobile combustion: water-borne navigation	CO_2	405	669	0%	0%	0%	95%	Yes
4B8	Emissions from manure management : swine	CH_4	1,154	770	0%	0%	0%	96%	Yes
1B1b	CO_2 from coke production	CO_2	403	637	0%	0%	0%	96%	No
1A1c	Stationary combustion : Manuf, of Solid Fuels and Other En, Ind,: gases	CO_2	1,526	1,627	1%	0%	0%	96%	No
4B9	Emissions from manure management : poultry	CH_4	275	41	0%	0%	0%	97%	No
1A3	Mobile combustion: road vehicles	N_2O	101	270	0%	0%	0%	97%	No
2B5	Caprolactam production	N_2O	766	870	0%	0%	0%	97%	No
3	Indirect CO_2 from solvents/product use	CO_2	316	123	0%	0%	0%	97%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25,776	23,333	12%	0%	0%	98%	No
2A3	Limestone and dolomite use	CO_2	481	600	0%	0%	0%	98%	No
1A5	Military use of fuels (1A5 Other)	CO_2	566	355	0%	0%	0%	98%	No
3, 6D	OTHER N_2O	N_2O	250	71	0%	0%	0%	98%	No
2B1	Ammonia production	CO_2	3,096	2,681	1%	0%	0%	98%	No
2B5	Other chemical product manufacture	CO_2	649	728	0%	0%	0%	99%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	42	0%	0%	0%	99%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	334	0%	0%	0%	99%	No
2F	SF_6 emissions from SF_6 use	SF_6	287	147	0%	0%	0%	99%	No
1A3	Mobile combustion: road vehicles	CH_4	158	45	0%	0%	0%	99%	No
2A7	Other minerals	CO_2	275	344	0%	0%	0%	99%	No
2C3	CO_2 from aluminium production	CO_2	395	438	0%	0%	0%	99%	No
2F	PFC emissions from PFC use	PFC	37	101	0%	0%	0%	100%	No
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	0%	100%	No
2G	Other industrial: CO_2	CO_2	304	325	0%	0%	0%	100%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	268	0%	0%	0%	100%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	184	0%	0%	0%	100%	No
2A1	Cement production	CO_2	416	351	0%	0%	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	12	38	0%	0%	0%	100%	No
4B	Emissions from manure management	N_2O	1,183	1,052	1%	0%	0%	100%	No
6D	OTHER CH_4	CH_4	2	22	0%	0%	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	91	102	0%	0%	0%	100%	No
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	161	0%	0%	0%	100%	No
2G	Other industrial: CH_4	CH_4	297	281	0%	0%	0%	100%	No
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	0%	100%	No

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 ?
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4,356	3,963	2%	0%	0%	100%	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	392	0%	0%	0%	100%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	388	0%	0%	0%	100%	No
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	28	22	0%	0%	0%	100%	No
1A1c	Stationary combustion : Manuf, of Solid Fuels and Other En, Ind,: liquids	CO_2	2	1	0%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	0%	100%	No
	TOTAL	GHG	213,178	194,344		43.7%			32

Table A1.4b Source ranking using IPCC Tier 1 trend assessment 2011, 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	13,348	23,701	12%	6%	14%	14%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11,821	20,170	10%	5%	12%	26%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12,011	3,166	2%	4%	10%	36%	Yes
2B2	Nitric acid production	N_2O	6,330	243	0%	3%	7%	43%	Yes
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	166	0%	3%	6%	49%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19,020	13,159	6%	2%	5%	55%	Yes
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10,908	13,062	6%	2%	4%	59%	Yes
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1,042	3,600	2%	1%	3%	62%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7,632	9,352	5%	1%	3%	65%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2,570	1%	1%	3%	67%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9,999	7,166	4%	1%	3%	70%	Yes
4D2	Animal production on agricultural soils	N_2O	3,150	1,108	1%	1%	2%	72%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1,928	1%	1%	2%	74%	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2,740	843	0%	1%	2%	76%	Yes
2C3	PFC from aluminium production	PFC	1,901	82	0%	1%	2%	78%	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3,358	1,450	1%	1%	2%	81%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7,330	8,043	4%	1%	2%	82%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1,594	1%	1%	1%	84%	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	2,267	1,110	1%	1%	1%	85%	Yes
1B2	Fugitive emissions venting/flaring	CH_4	1,252	323	0%	0%	1%	86%	Yes
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1,356	463	0%	0%	1%	87%	Yes
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	909	0%	0%	1%	88%	Yes
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	54	0%	0%	1%	88%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2,587	1,723	1%	0%	1%	89%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5,033	4,022	2%	0%	1%	90%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	4,137	3,236	2%	0%	1%	91%	Yes
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18,696	16,630	8%	0%	1%	91%	Yes
5A2	5A2. Land converted to Forest Land	CO_2	56	541	0%	0%	1%	92%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2,264	1,641	1%	0%	1%	93%	Yes

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 ?
5E2	Land converted to Settlements	CO_2	459	817	0%	0%	0%	93%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,956	8,564	4%	0%	0%	93%	Yes
5C1	Grassland remaining Grassland	CO_2	4,246	4,246	2%	0%	0%	94%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,593	1,795	1%	0%	0%	94%	Yes
5A1	Forest Land remaining Forest Land	CO_2	2,407	1,893	1%	0%	0%	95%	Yes
1A3	Mobile combustion: water-borne navigation	CO_2	405	669	0%	0%	0%	95%	Yes
4B8	Emissions from manure management : swine	CH_4	1,154	770	0%	0%	0%	95%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25,776	23,333	12%	0%	0%	96%	Yes
1B1b	CO_2 from coke production	CO_2	403	637	0%	0%	0%	96%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,526	1,627	1%	0%	0%	96%	No
4B9	Emissions from manure management : poultry	CH_4	275	41	0%	0%	0%	97%	No
1A3	Mobile combustion: road vehicles	N_2O	101	270	0%	0%	0%	97%	No
2B5	Caprolactam production	N_2O	766	870	0%	0%	0%	97%	No
3	Indirect CO_2 from solvents/product use	CO_2	316	123	0%	0%	0%	97%	No
1A5	Military use of fuels (1A5 Other)	CO_2	566	355	0%	0%	0%	98%	No
2A3	Limestone and dolomite use	CO_2	481	600	0%	0%	0%	98%	No
3, 6D	OTHER N_2O	N_2O	250	71	0%	0%	0%	98%	No
2B1	Ammonia production	CO_2	3,096	2,681	1%	0%	0%	98%	No
2B5	Other chemical product manufacture	CO_2	649	728	0%	0%	0%	98%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	42	0%	0%	0%	98%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	334	0%	0%	0%	99%	No
2F	SF_6 emissions from SF_6 use	SF_6	287	147	0%	0%	0%	99%	No
1A3	Mobile combustion: road vehicles	CH_4	158	45	0%	0%	0%	99%	No
5G	5G. Other (liming of soils)	CO_2	183	73	0%	0%	0%	99%	No
2A7	Other minerals	CO_2	275	344	0%	0%	0%	99%	No
2C3	CO_2 from aluminium production	CO_2	395	438	0%	0%	0%	99%	No
2F	PFC emissions from PFC use	PFC	37	101	0%	0%	0%	99%	No
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	0%	99%	No
5D2	Land converted to Wetlands	CO_2	80	135	0%	0%	0%	99%	No
5B2	Land converted to Cropland	CO_2	122	165	0%	0%	0%	100%	No
2G	Other industrial: CO_2	CO_2	304	325	0%	0%	0%	100%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	268	0%	0%	0%	100%	No
4B	Emissions from manure management	N_2O	1,183	1,052	1%	0%	0%	100%	No
2A1	Cement production	CO_2	416	351	0%	0%	0%	100%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	184	0%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4,356	3,963	2%	0%	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	12	38	0%	0%	0%	100%	No
6D	OTHER CH_4	CH_4	2	22	0%	0%	0%	100%	No

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 ?
1A3	Mobile combustion: other (railways)	CO_2	91	102	0%	0%	0%	100%	No
5C2	Land converted to Grassland	CO_2	239	236	0%	0%	0%	100%	No
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	161	0%	0%	0%	100%	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	392	0%	0%	0%	100%	No
2G	Other industrial: CH_4	CH_4	297	281	0%	0%	0%	100%	No
5F2	Land converted to Other Land	CO_2	20	27	0%	0%	0%	100%	No
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	0%	100%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	388	0%	0%	0%	100%	No
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	28	22	0%	0%	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	0%	100%	No
	TOTAL	GHG	220,991	202,477		42.9%			37

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 2011 annual emissions total and to the trend, respectively. Comparison with the Tier 1 assessment presented in Tables A1.3 and A1.4 show fewer level and trend key sources (29 and 24, respectively, instead of 33 and 32). The inclusion of LULUCF sources in the analysis adds no extra sources for Tier 2 solely level or trend (see table A1.2).

Table A1.5a Source ranking using IPCC Tier 2 level assessment 2011, excluding LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year	Share	Uncertainty estimate	Level * Uncertainty	Share L*U	Cum. Share L*U	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1,450	1%	206%	2%	12%	14%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	3,236	2%	61%	1%	8%	26%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	9,352	5%	20%	1%	7%	36%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,795	1%	100%	1%	7%	43%	Yes
4D2	Animal production on agricultural soils	N_2O	1,108	1%	100%	1%	4%	49%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	3,166	2%	34%	1%	4%	55%	Yes
4B	Emissions from manure management	N_2O	1,052	1%	100%	1%	4%	59%	Key
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7,166	4%	14%	1%	4%	62%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1,928	1%	51%	1%	4%	65%	Yes
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	16,630	9%	5%	0%	3%	67%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/ Fisheries, gases	CO_2	8,043	4%	10%	0%	3%	70%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	1,594	1%	50%	0%	3%	72%	Yes
4B8	Emissions from manure management : swine	CH_4	770	0%	100%	0%	3%	74%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23,333	12%	3%	0%	3%	76%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3,963	2%	16%	0%	2%	78%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20,170	10%	3%	0%	2%	80%	Yes
2B5	Other chemical product manufacture	CO_2	728	0%	71%	0%	2%	82%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4,022	2%	10%	0%	2%	83%	Yes
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13,062	7%	3%	0%	1%	85%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,563	4%	4%	0%	1%	86%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1,641	1%	21%	0%	1%	87%	Yes
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,627	1%	21%	0%	1%	88%	Yes
1B1b	CO_2 from coke production	CO_2	637	0%	50%	0%	1%	88%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2.570	1%	11%	0%	1%	89%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13.159	7%	2%	0%	1%	90%	Yes
2B5	Caprolactam production	N_2O	870	0%	30%	0%	1%	91%	Yes

IPCC	Category	Gas	CO_2-eq last year	Share	Uncertainty estimate	Level * Uncertainty	Share L*U	Cum. Share L*U	Key ?
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	1,723	1%	15%	0%	1%	91%	Yes
6B	Emissions from wastewater handling	N_2O	457	0%	54%	0%	1%	92%	Yes
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	392	0%	50%	0%	1%	92%	Yes
1A3	Mobile combustion: road vehicles	N_2O	270	0%	70%	0%	1%	93%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	334	0%	50%	0%	1%	93%	No
2A3	Limestone and dolomite use	CO_2	600	0%	25%	0%	1%	94%	No
2G	Other industrial: CH_4	CH_4	281	0%	51%	0%	1%	94%	No
1A3	Mobile combustion: water-borne navigation	CO_2	669	0%	20%	0%	1%	95%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	23,701	12%	1%	0%	1%	95%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	388	0%	30%	0%	0%	95%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	184	0%	54%	0%	0%	96%	No
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	463	0%	20%	0%	0%	96%	No
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	909	0%	10%	0%	0%	96%	No
2A7	Other minerals	CO_2	344	0%	25%	0%	0%	97%	No
1B2	Fugitive emissions venting/flaring	CH_4	323	0%	25%	0%	0%	97%	No
1A5	Military use of fuels (1A5 Other)	CO_2	355	0%	20%	0%	0%	97%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	268	0%	25%	0%	0%	97%	No
2G	Other industrial: CO_2	CO_2	325	0%	21%	0%	0%	98%	No
2C1	Iron and steel production (carbon inputs)	CO_2	1,110	1%	6%	0%	0%	98%	No
6B	Emissions from wastewater handling	CH_4	199	0%	32%	0%	0%	98%	No
2B1	Ammonia production	CO_2	2,681	1%	2%	0%	0%	98%	No
2F	SF_6 emissions from SF_6 use	SF_6	147	0%	34%	0%	0%	98%	No
1A3b	Mobile combustion: road vehicles: LPG	CO_2	843	0%	5%	0%	0%	98%	No
4B9	Emissions from manure management : poultry	CH_4	41	0%	100%	0%	0%	99%	No
2A1	Cement production	CO_2	351	0%	11%	0%	0%	99%	No
3, 6D	OTHER N_2O	N_2O	71	0%	54%	0%	0%	99%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	161	0%	21%	0%	0%	99%	No
3	Indirect CO_2 from solvents/product use	CO_2	123	0%	27%	0%	0%	99%	No
1A3	Mobile combustion: road vehicles	CH_4	45	0%	70%	0%	0%	99%	No
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	54	0%	50%	0%	0%	99%	No
2F	PFC emissions from PFC use	PFC	101	0%	25%	0%	0%	99%	No
4B	Emissions from manure management : other	CH_4	24	0%	100%	0%	0%	99%	No
2C3	CO_2 from aluminium production	CO_2	438	0%	5%	0%	0%	100%	No

IPCC	Category	Gas	CO_2-eq last year	Share	Uncertainty estimate	Level * Uncertainty	Share L*U	Cum. Share L*U	Key ?
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	166	0%	14%	0%	0%	100%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	42	0%	50%	0%	0%	100%	No
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3,600	2%	1%	0%	0%	100%	No
2B2	Nitric acid production	N_2O	243	0%	8%	0%	0%	100%	No
2C3	PFC from aluminium production	PFC	82	0%	20%	0%	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	38	0%	22%	0%	0%	100%	No
2G	Other industrial: N_2O	N_2O	11	0%	71%	0%	0%	100%	No
6D	OTHER CH_4	CH_4	22	0%	32%	0%	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	22	0%	30%	0%	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	102	0%	5%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	50%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	50%	0%	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0%	0%	100%	No
	TOTAL	GHG	194,344			13.2%			29

Table A1.5b Source ranking using IPCC Tier 2 level assessment 2011, including LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year abs	Share	Uncertainty estimate	Level * Uncertainty	Share L*U	Cum. Share L*U	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1,450	1%	206%	1%	10%	10%	Yes
5C1	Grassland remaining Grassland	CO_2	4,246	2%	56%	1%	8%	18%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	3,236	2%	61%	1%	6%	24%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	9,352	5%	20%	1%	6%	30%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,795	1%	100%	1%	6%	36%	Yes
5A1	Forest Land remaining Forest Land	CO_2	1,893	1%	67%	1%	4%	40%	Yes
4D2	Animal production on agricultural soils	N_2O	1,108	1%	100%	1%	4%	44%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	3,166	2%	34%	1%	3%	48%	Yes
4B	Emissions from manure management	N_2O	1,052	1%	100%	1%	3%	51%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7,166	4%	14%	1%	3%	54%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1,928	1%	51%	0%	3%	58%	Yes
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	16,630	8%	5%	0%	3%	60%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	8,043	4%	10%	0%	3%	63%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	1,594	1%	50%	0%	3%	66%	Yes
4B8	Emissions from manure management : swine	CH_4	770	0%	100%	0%	3%	68%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	23,333	12%	3%	0%	2%	71%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3,963	2%	16%	0%	2%	73%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	20,170	10%	3%	0%	2%	75%	Yes
2B5	Other chemical product manufacture	CO_2	728	0%	71%	0%	2%	76%	Yes
5E2	Land converted to Settlements	CO_2	817	0%	56%	0%	2%	78%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4,022	2%	10%	0%	1%	79%	Yes
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	13,062	6%	3%	0%	1%	80%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,564	4%	4%	0%	1%	81%	Yes
5A2	Land converted to Forest Land	CO_2	541	0%	63%	0%	1%	83%	Yes
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1,641	1%	21%	0%	1%	84%	Yes
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,627	1%	21%	0%	1%	85%	Yes
1B1b	CO_2 from coke production	CO_2	637	0%	50%	0%	1%	86%	Yes

IPCC	Category	Gas	CO_2-eq last year abs	Share	Uncertainty estimate	Level * Uncertainty	Share L*U	Cum. Share L*U	Key ?
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2,570	1%	11%	0%	1%	87%	Yes
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13,159	6%	2%	0%	1%	88%	Yes
2B5	Caprolactam production	N_2O	870	0%	30%	0%	1%	89%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	1,723	1%	15%	0%	1%	89%	Yes
6B	Emissions from wastewater handling	N_2O	457	0%	54%	0%	1%	90%	Yes
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	392	0%	50%	0%	1%	91%	Yes
1A3	Mobile combustion: road vehicles	N_2O	270	0%	70%	0%	1%	92%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	334	0%	50%	0%	1%	92%	No
2A3	Limestone and dolomite use	CO_2	600	0%	25%	0%	1%	93%	No
2G	Other industrial: CH_4	CH_4	281	0%	51%	0%	0%	93%	No
1A3	Mobile combustion: water-borne navigation	CO_2	669	0%	20%	0%	0%	93%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	23,701	12%	1%	0%	0%	94%	No
5C2	Land converted to Grassland	CO_2	236	0%	56%	0%	0%	94%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	388	0%	30%	0%	0%	95%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	184	0%	54%	0%	0%	95%	No
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	463	0%	20%	0%	0%	95%	No
5B2	Land converted to Cropland	CO_2	165	0%	56%	0%	0%	96%	No
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	909	0%	10%	0%	0%	96%	No
2A7	Other minerals	CO_2	344	0%	25%	0%	0%	96%	No
1B2	Fugitive emissions venting/flaring	CH_4	323	0%	25%	0%	0%	97%	No
5D2	Land converted to Wetlands	CO_2	135	0%	56%	0%	0%	97%	No
1A5	Military use of fuels (1A5 Other)	CO_2	355	0%	20%	0%	0%	97%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	268	0%	25%	0%	0%	97%	No
2G	Other industrial: CO_2	CO_2	325	0%	21%	0%	0%	97%	No
2C1	Iron and steel production (carbon inputs)	CO_2	1,110	1%	6%	0%	0%	98%	No
6B	Emissions from wastewater handling	CH_4	199	0%	32%	0%	0%	98%	No
2B1	Ammonia production	CO_2	2,681	1%	2%	0%	0%	98%	No
2F	SF_6 emissions from SF_6 use	SF_6	147	0%	34%	0%	0%	98%	No
1A3b	Mobile combustion: road vehicles: LPG	CO_2	843	0%	5%	0%	0%	98%	No
4B9	Emissions from manure management : poultry	CH_4	41	0%	100%	0%	0%	99%	No
2A1	Cement production	CO_2	351	0%	11%	0%	0%	99%	No
3, 6D	OTHER N_2O	N_2O	71	0%	54%	0%	0%	99%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	161	0%	21%	0%	0%	99%	No

IPCC	Category	Gas	CO_2-eq last year abs	Share	Uncertainty estimate	Level * Uncertainty	Share L*U	Cum. Share L*U	Key ?
3	Indirect CO_2 from solvents/product use	CO_2	123	0%	27%	0%	0%	99%	No
1A3	Mobile combustion: road vehicles	CH_4	45	0%	70%	0%	0%	99%	No
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	54	0%	50%	0%	0%	99%	No
2F	PFC emissions from PFC use	PFC	101	0%	25%	0%	0%	99%	No
4B	Emissions from manure management : other	CH_4	24	0%	100%	0%	0%	99%	No
2C3	CO_2 from aluminium production	CO_2	438	0%	5%	0%	0%	99%	No
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	166	0%	14%	0%	0%	100%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	42	0%	50%	0%	0%	100%	No
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3,600	2%	1%	0%	0%	100%	No
2B2	Nitric acid production	N_2O	243	0%	8%	0%	0%	100%	No
5G	Other (liming of soils)	CO_2	73	0%	25%	0%	0%	100%	No
2C3	PFC from aluminium production	PFC	82	0%	20%	0%	0%	100%	No
5F2	Land converted to Other Land	CO_2	27	0%	56%	0%	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	38	0%	22%	0%	0%	100%	No
2G	Other industrial: N_2O	N_2O	11	0%	71%	0%	0%	100%	No
6D	OTHER CH_4	CH_4	22	0%	32%	0%	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	22	0%	30%	0%	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	102	0%	5%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	50%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	50%	0%	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0%	0%	100%	No
	TOTAL	GHG	202,477			15.0%			33

With respect to Tier 2 level key sources, and perhaps surprisingly, the Energy industries, with the highest share (30 per cent) 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:

- 4D3 indirect N_2O emissions from nitrogen used in agriculture;
- 4D1 direct N_2O emissions from agricultural soils.

The uncertainty in these emissions is estimated at 50 per cent to 200 per cent, indirect N_2O emissions having an uncertainty factor of 2; one or two orders of magnitude higher than the 4 per cent 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	3,358	1,450	1%	1%	206%	2%	21%	21%	Yes
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12,011	3,166	2%	4%	34%	1%	17%	38%	Yes
4D2	Animal production on agricultural soils	N_2O	3,150	1,108	1%	1%	100%	1%	11%	49%	Yes
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1,928	1%	1%	51%	0%	6%	55%	Yes
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	166	0%	3%	14%	0%	5%	59%	Yes
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1,594	1%	1%	50%	0%	3%	63%	Yes
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7,632	9,352	5%	1%	20%	0%	3%	66%	Yes
2B2	Nitric acid production	N_2O	6,330	243	0%	3%	8%	0%	3%	68%	Yes
4B1	Emissions from manure management : cattle	CH_4	1,593	1,795	1%	0%	100%	0%	2%	71%	Yes
2C3	PFC from aluminium production	PFC	1,901	82	0%	1%	20%	0%	2%	73%	Yes
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	54	0%	0%	50%	0%	2%	75%	Yes
4D1	Direct N_2O emissions from agricultural soils	N_2O	4,137	3,236	2%	0%	61%	0%	2%	77%	Yes
4B8	Emissions from manure management : swine	CH_4	1,154	770	0%	0%	100%	0%	2%	79%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9,999	7,166	4%	1%	14%	0%	2%	80%	Yes
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11,821	20,170	10%	5%	3%	0%	2%	82%	Yes
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2,570	1%	1%	11%	0%	1%	83%	Yes
4B9	Emissions from manure management : poultry	CH_4	275	41	0%	0%	100%	0%	1%	85%	Yes
1B2	Fugitive emissions venting/flaring	CH_4	1,252	323	0%	0%	25%	0%	1%	86%	Yes
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1,356	463	0%	0%	20%	0%	1%	87%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7,330	8,043	4%	1%	10%	0%	1%	88%	Yes
1B1b	CO_2 from coke production	CO_2	403	637	0%	0%	50%	0%	1%	89%	Yes

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: road vehicles	N_2O	101	270	0%	0%	70%	0%	1%	90%	Yes
2B5	Other chemical product manufacture	CO_2	649	728	0%	0%	71%	0%	1%	90%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2,587	1,723	1%	0%	15%	0%	1%	91%	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2,740	843	0%	1%	5%	0%	1%	91%	No
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10,908	13,062	7%	2%	3%	0%	1%	92%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2,264	1,641	1%	0%	21%	0%	1%	93%	No
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19,020	13,159	7%	2%	2%	0%	1%	93%	No
3, 6D	OTHER N_2O	N_2O	250	71	0%	0%	54%	0%	1%	94%	No
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	909	0%	0%	10%	0%	0%	94%	No
1A3	Mobile combustion: road vehicles	CH_4	158	45	0%	0%	70%	0%	0%	94%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	42	0%	0%	50%	0%	0%	95%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13,348	23,701	12%	7%	1%	0%	0%	95%	No
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	334	0%	0%	50%	0%	0%	96%	No
1A3	Mobile combustion: water-borne navigation	CO_2	405	669	0%	0%	20%	0%	0%	96%	No
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5,033	4,022	2%	0%	10%	0%	0%	96%	No
2C1	Iron and steel production (carbon inputs)	CO_2	2,267	1,110	1%	1%	6%	0%	0%	97%	No
2B5	Caprolactam production	N_2O	766	870	0%	0%	30%	0%	0%	97%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,526	1,627	1%	0%	21%	0%	0%	97%	No
3	Indirect CO_2 from solvents/ product use	CO_2	316	123	0%	0%	27%	0%	0%	98%	No
2A3	Limestone and dolomite use	CO_2	481	600	0%	0%	25%	0%	0%	98%	No
2F	SF_6 emissions from SF_6 use	SF_6	287	147	0%	0%	34%	0%	0%	98%	No
1A5	Military use of fuels (1A5 Other)	CO_2	566	355	0%	0%	20%	0%	0%	98%	No
4B	Emissions from manure management	N_2O	1,183	1,052	1%	0%	100%	0%	0%	99%	No
2A7	Other minerals	CO_2	275	344	0%	0%	25%	0%	0%	99%	No

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 ?
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	32%	0%	0%	99%	No
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18,696	16,630	9%	0%	5%	0%	0%	99%	No
2F	PFC emissions from PFC use	PFC	37	101	0%	0%	25%	0%	0%	99%	No
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,956	8,563	4%	0%	4%	0%	0%	99%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	184	0%	0%	54%	0%	0%	99%	No
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1,042	3,600	2%	1%	1%	0%	0%	99%	No
2G	Other industrial: CO_2	CO_2	304	325	0%	0%	21%	0%	0%	100%	No
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	54%	0%	0%	100%	No
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	268	0%	0%	25%	0%	0%	100%	No
6D	OTHER CH_4	CH_4	2	22	0%	0%	32%	0%	0%	100%	No
2E	HFC by-product emissions from HFC manufacture	HFC	12	38	0%	0%	22%	0%	0%	100%	No
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	71%	0%	0%	100%	No
2G	Other industrial: CH_4	CH_4	297	281	0%	0%	51%	0%	0%	100%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25,776	23,333	12%	0%	3%	0%	0%	100%	No
2C3	CO_2 from aluminium production	CO_2	395	438	0%	0%	5%	0%	0%	100%	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	392	0%	0%	50%	0%	0%	100%	No
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	100%	0%	0%	100%	No
2B1	Ammonia production	CO_2	3,096	2,681	1%	0%	2%	0%	0%	100%	No
2A1	Cement production	CO_2	416	351	0%	0%	11%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	161	0%	0%	21%	0%	0%	100%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	388	0%	0%	30%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4,356	3,963	2%	0%	16%	0%	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	91	102	0%	0%	5%	0%	0%	100%	No
1A3	Mobile combustion: aircraft	CO_2	28	22	0%	0%	30%	0%	0%	100%	No

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: other (non-road)	N_2O	1	2	0%	0%	50%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	50%	0%	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	20%	0%	0%	100%	No
	TOTAL	GHG	213,178	194,344				8.9%			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 ?
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	909	0%	0%	10%	0%	0%	94%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25,776	23,333	12%	0%	3%	0%	0%	100%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13,348	23,701	12%	6%	1%	0%	0%	95%	No
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2,570	1%	1%	11%	0%	1%	80%	Yes
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9,999	7,166	4%	1%	14%	0%	2%	77%	Yes
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1,042	3,600	2%	1%	1%	0%	0%	99%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	20%	0%	0%	100%	No
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1,526	1,627	1%	0%	21%	0%	0%	97%	No
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8,956	8,564	4%	0%	4%	0%	0%	99%	No
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5,033	4,022	2%	0%	10%	0%	0%	96%	No
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19,020	13,159	6%	2%	2%	0%	1%	93%	No
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	42	0%	0%	50%	0%	0%	95%	No
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7,632	9,352	5%	1%	20%	0%	3%	62%	Yes
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18,696	16,630	8%	0%	5%	0%	0%	99%	No
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7,330	8,043	4%	1%	10%	0%	1%	89%	Yes
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2,587	1,723	1%	0%	15%	0%	1%	90%	Yes
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1,356	463	0%	0%	20%	0%	1%	87%	Yes

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	355	0%	0%	20%	0%	0%	98%	No
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1,594	1%	1%	50%	0%	3%	59%	Yes
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	334	0%	0%	50%	0%	0%	95%	No
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10,908	13,062	6%	2%	3%	0%	1%	92%	No
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11,821	20,170	10%	5%	3%	0%	2%	79%	Yes
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2,740	843	0%	1%	5%	0%	1%	91%	No
1A3	Mobile combustion: water-borne navigation	CO_2	405	669	0%	0%	20%	0%	0%	96%	No
1A3	Mobile combustion: aircraft	CO_2	28	22	0%	0%	30%	0%	0%	100%	No
1A3	Mobile combustion: other (railways)	CO_2	91	102	0%	0%	5%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	50%	0%	0%	100%	No
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	50%	0%	0%	100%	No
1A3	Mobile combustion: road vehicles	CH_4	158	45	0%	0%	70%	0%	0%	94%	No
1A3	Mobile combustion: road vehicles	N_2O	101	270	0%	0%	70%	0%	1%	90%	Yes
1B2	Fugitive emissions venting/flaring	CH_4	1,252	323	0%	0%	25%	0%	1%	85%	Yes
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	268	0%	0%	25%	0%	0%	100%	No
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	184	0%	0%	54%	0%	0%	99%	No
1B1b	CO_2 from coke production	CO_2	403	637	0%	0%	50%	0%	1%	88%	Yes
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	54	0%	0%	50%	0%	2%	72%	Yes
2A1	Cement production	CO_2	416	351	0%	0%	11%	0%	0%	100%	No
2A3	Limestone and dolomite use	CO_2	481	600	0%	0%	25%	0%	0%	97%	No
2A7	Other minerals	CO_2	275	344	0%	0%	25%	0%	0%	99%	No
2B1	Ammonia production	CO_2	3,096	2,681	1%	0%	2%	0%	0%	100%	No
2B2	Nitric acid production	N_2O	6,330	243	0%	3%	8%	0%	3%	64%	Yes
2B5	Caprolactam production	N_2O	766	870	0%	0%	30%	0%	0%	97%	No
2B5	Other chemical product manufacture	CO_2	649	728	0%	0%	71%	0%	1%	91%	Yes
2C1	Iron and steel production (carbon inputs)	CO_2	2,267	1,110	1%	1%	6%	0%	0%	96%	No
2C3	CO_2 from aluminium production	CO_2	395	438	0%	0%	5%	0%	0%	100%	No
2C3	PFC from aluminium production	CO_2	1,901	82	0%	1%	20%	0%	2%	70%	Yes

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 ?
2F	SF_6 emissions from SF_6 use	SF_6	287	147	0%	0%	34%	0%	0%	98%	No
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1,928	1%	1%	51%	0%	5%	51%	Yes
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	166	0%	3%	14%	0%	4%	56%	Yes
2E	HFC by-product emissions from HFC manufacture	HFC	12	38	0%	0%	22%	0%	0%	100%	No
2F	PFC emissions from PFC use	PFC	37	101	0%	0%	25%	0%	0%	99%	No
2G	Other industrial: CO_2	CO_2	304	325	0%	0%	21%	0%	0%	99%	No
2G	Other industrial: CH_4	CH_4	297	281	0%	0%	51%	0%	0%	100%	No
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	71%	0%	0%	100%	No
3	Indirect CO_2 from solvents/ product use	CO_2	316	123	0%	0%	27%	0%	0%	97%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4,356	3,963	2%	0%	16%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	161	0%	0%	21%	0%	0%	100%	No
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2,264	1,641	1%	0%	21%	0%	1%	92%	No
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	392	0%	0%	50%	0%	0%	100%	No
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	388	0%	0%	30%	0%	0%	100%	No
4B	Emissions from manure management	N_2O	1,183	1,052	1%	0%	100%	0%	0%	98%	No
4B1	Emissions from manure management : cattle	CH_4	1,593	1,795	1%	0%	100%	0%	2%	68%	Yes
4B8	Emissions from manure management : swine	CH_4	1,154	770	0%	0%	100%	0%	2%	76%	Yes
4B9	Emissions from manure management : poultry	CH_4	275	41	0%	0%	100%	0%	1%	83%	Yes
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	100%	0%	0%	100%	No
4D1	Direct N_2O emissions from agricultural soils	N_2O	4,137	3,236	2%	0%	61%	0%	2%	66%	Yes
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3,358	1,450	1%	1%	206%	2%	20%	20%	Yes
4D2	Animal production on agricultural soils	N_2O	3,150	1,108	1%	1%	100%	1%	11%	46%	Yes
6A1	CH4 emissions from solid waste disposal sites	CH_4	12,011	3,166	2%	4%	34%	1%	16%	35%	Yes

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 ?
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	32%	0%	0%	99%	No
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	54%	0%	0%	100%	No
6D	OTHER CH_4	CH_4	2	22	0%	0%	32%	0%	0%	100%	No
3, 6D	OTHER N_2O	N_2O	250	71	0%	0%	54%	0%	1%	93%	No
5A1	Forest Land remaining Forest Land	CO_2	2,407	1,893	1%	0%	67%	0%	1%	84%	Yes
5A2	Land converted to Forest Land	CO_2	56	541	0%	0%	63%	0%	2%	74%	Yes
5B2	Land converted to Cropland	CO_2	122	165	0%	0%	56%	0%	0%	98%	No
5C1	Grassland remaining Grassland	CO_2	4,246	4,246	2%	0%	56%	0%	1%	86%	Yes
5C2	Land converted to Grassland	CO_2	239	236	0%	0%	56%	0%	0%	99%	No
5D2	Land converted to Wetlands	CO_2	80	135	0%	0%	56%	0%	0%	98%	No
5E2	Land converted to Settlements	CO_2	459	817	0%	0%	56%	0%	1%	81%	Yes
5F2	Land converted to Other Land	CO_2	20	27	0%	0%	56%	0%	0%	100%	No
5G	Other (liming of soils)	CO_2	183	73	0%	0%	25%	0%	0%	99%	No
	TOTAL	GHG	220,991	202,477		43%		9%			28

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 was 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, the Steering Committee Emission Registration delegated the authority to decide on revisions of the list to the Working Group Emission Monitoring (WEM). On 28 February 2013 the present document (version February 2013; Vreuls and Zijlema, 2013) 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 13-002 for stationary sources and protocols 13-004 to 13-011 for mobile sources (see Annex 6).

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 trading, 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 reports are also used for the national monitoring.
The Netherlands' list of energy carriers and standard CO_2 emission factors (henceforth 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 emission factor;
- a fact sheet per energy carrier, substantiating the values given, presenting synonyms for fuel 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 acquired 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 2011 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 included in the IPCC Guidelines (Revised 1996 Intergovernmental Panel on Climate Change (IPCC) for national greenhouse gas inventories, henceforth 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 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 Statistics Netherlands (CBS) 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 decimal place.
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 carbon content 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 emission factor has been determined for the following fuels:
1. petrol/gasoline;

2. gas and diesel oil;
3. LPG;
4. coke coals (coke ovens and blast furnaces);
5. other bituminous coal;
6. coke ovens/gas cokes;
7. coke oven gas;
8. blast furnace gas;
9. oxygen furnace gas;
10. phosphorus furnace gas;
11. natural gas.

For industrial gases, chemical waste gas is also differentiated from refinery gas. For the IPCC main group 'other fuels', only non-biogenic waste is differentiated.

Coking coal
For coking coal the standard CO_2 emission 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 of determining the CO_2 emission factor for natural gas (TNO, 2006). This resulted in an advice to use 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 suggestion 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 EF of natural gas. In this document (version February 2013) the EF of natural gas for 2012 and 2013 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 EF of waste 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 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 February 2013) the heating value and the EF of Waste are determined for 2011. Incinerated waste is a mixture of biogenic and non-biogenic waste. Therefore, the percentage of biogenic waste is given for both the heating value and the EF.

Biomass
The list also includes biomass as a fuel, with accompanying specific Netherlands CO2 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 CO2 emissions trading, the emissions are not included because an emission factor of zero is used for biomass.
The CO2 emission factor for wood is used for solid biomass and that of palm oil is used for liquid biomass. A weighted average of three specified biogases is used as the standard factor for gaseous biomass:
1. wastewater 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 during the compilation of the 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 emission factor
   d. Density (if relevant), converting from weight to volume or converting from gases to m3 standard natural gas equivalent;
   e. Substantiating the choices, plus accurate referral to references and/or specific text sections within the reference;
   f. Year and/or period for which the specific values apply.

If a standard Dutch value for 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).

[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)

Table A2.1 The Netherlands fuels and standard CO_2 emission factors, version February 2013.

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

Table A2.1 The Netherlands fuels and standard CO_2 emission factors, version February 2013.

Main group (Dutch language)	Main group (English) IPCC (supplemented)	Unit	Heating value (MJ/unit)	CO_2 EF (kg/GJ)
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	9.6	106.3

[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 years 2011, 2012 and 2013 (Zijlema, 2011, 2012). 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 the reporting on emissions trading and for the Kyoto Protocol.

[3)] The values are applicable for the emission year 2011. 54% of the heating value and 65% of the emissionfactor is attributed to biogenic waste. In the emission year 2010 the heating value was 9.9 MJ/kg (53% biogenic) and the emission factor was 106.1 kg/GJ (63% biogenic). 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).

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. 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 EFs may differ markedly between countries, sometimes by as much as 10 per cent for nominally similar fuels, national inventories should be prepared using local EFs 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 EFs 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 emissions allowances. With respect to 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 operator reports, the Directive 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 EFs, which is consistent with the latest national inventory such as submitted to the UNFCCC secretariat, these categories and the accompanying EFs 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 EU CO_2 emissions trading is further explained in EC Directive 2007/589/EG and The Netherlands system for monitoring the trade in emissions 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 the EU 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 and predicting CO_2 emissions). Selections can be made 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 in laws, regulations and or guidelines on behalf of 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 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 EFs. 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, exports and 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 being included in the bunker total, as they were in the original national energy statistics.

Table A4.1 presents the results of the Reference Approach calculation for 1990–2011 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 per cent and 4 per cent.

The Reference Approach (RA) and National Approach (NA) data show an 19 per cent RA vs. 7 per cent NA increase in emissions from liquid fuels (1990–2011) and a 10 per cent RA vs. 11 per cent NA increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period by 14 per cent in the RA vs. a decrease of 12 per cent in the NA. The emissions from others (fossil carbon in waste) increased from 0.6 Tg in 1990 to 2.6 Tg CO_2 in 2011. 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 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 category 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 difference is generally below ±2 per cent. The remaining difference is 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 EFs in some cases, as discussed in section A4.4 (for more details, see Annex 2).

A4.3 Feedstock component in the CO_2 Reference Approach

Feedstock/non-energy uses of fuels in the energy statistics are also part of the IPCC Reference Approach for CO_2 from fossil fuel use. The fraction of carbon not oxidised during the use of these fuels in product manufacture or for other purposes is subtracted from the total carbon contained in total apparent fuel consumption by fuel type. The fractions stored/oxidised have been calculated as three average values: for gas and for 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 is presented and the average values derived from them.) The table shows indeed that the factors are subject to significant interannual variation, in particular the factor for solid fuels.

The use of one average oxidation factor per fuel type for all years, despite the fact that in the derivation of the annual oxidation figures differences of up to a few per cent can be observed, is one reason for the differences between the RA and the corrected NA.

Table A4.1 Comparison of CO_2 emissions: Reference Approach (RA) versus National Approach (NA) (in Tg).

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
RA										
Liquid fuels	45.5	46.6	53.8	55.2	54.6	58.2	55.9	53.1	54.5	54.2
Solid fuels	34.0	34.7	30.5	32.2	30.2	33.2	31.4	29.4	29.7	29.3
Gaseous fuels	71.9	79.9	81.0	81.8	79.6	77.1	80.6	81.3	91.1	79.3
Others	0.6	0.8	1.6	2.1	2.1	2.2	2.2	2.5	2.5	2.6
Total RA	**152.0**	**162.0**	**166.9**	**171.3**	**166.6**	**170.7**	**170.2**	**166.3**	**177.8**	**165.4**
NA										
Liquid fuels	49.7	52.4	54.6	56.3	56.0	56.1	56.1	53.0	53.8	53.2
Solid fuels	31.0	32.4	28.8	30.2	28.7	30.7	30.1	27.6	28.3	27.4
Gaseous fuels	68.6	76.0	76.7	78.5	77.0	74.5	78.4	78.9	88.2	76.1
Others	0.6	0.8	1.6	2.1	2.1	2.2	2.2	2.5	2.5	2.6
Total NA	**149.9**	**161.6**	**161.7**	**167.1**	**163.8**	**163.5**	**166.9**	**162.0**	**172.8**	**159.3**
Difference (%)										
Liquid fuels	-8.4%	-11.1%	-1.4%	-2.0%	-2.5%	3.7%	-0.3%	0.2%	1.3%	1.9%
Solid fuels	9.8%	7.2%	6.1%	6.6%	5.3%	8.2%	4.2%	6.6%	5.0%	6.9%
Gaseous fuels	4.8%	5.2%	5.5%	4.2%	3.4%	3.4%	2.8%	3.0%	3.3%	4.1%
Other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	**1.5%**	**0.3%**	**3.2%**	**2.5%**	**1.7%**	**4.4%**	**2.0%**	**2.7%**	**2.9%**	**3.8%**

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	2011
Reference Approach	152.0	162.0	166.9	171.3	170.2	166.3	177.8	165.4
National Approach	149.9	161.6	161.7	167.1	166.9	162.0	172.8	159.3
Difference RA-NA	**2.2**	**0.4**	**5.2**	**4.2**	**3.3**	**4.3**	**5.0**	**6.1**
CO_2 fossil in cat. 1B								
1B1b Solid fuel transf.	0.4	0.5	0.4	0.6	0.7	0.5	1.0	0.6
1B2c Flaring	0.4	0.3	0.2	0.1	0.0	0.0	0.1	0.0
1B2a–iv Oil refining	0.0	0.0	0.0	0.9	0.8	1.0	1.0	0.8
CO_2 fossil in sector 2	6.0	5.9	5.1	4.7	4.2	4.2	4.4	4.4
A. Mineral products								
Soda ash production	0.1	0.3	0.1	0.1	0.1	0.0	0.0	0.0
B. Chemical industry								
1. Ammonia production	3.1	3.6	3.6	3.1	2.9	2.9	3.2	2.7
5. Other, excl. act. carbon	0.4	0.2	0.2	0.4	0.4	0.3	0.4	0.4
C. Metal industry								
1. Inputs in blast furnace	2.2	1.5	1.0	0.9	0.7	0.8	0.7	1.1
D. Other Production								
2. Food and drink	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. Other economic sectors	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Not in NA-1A	0.8	0.8	0.6	1.6	1.6	1.6	2.0	1.5
NA+1B+Ind. proc.	**156.8**	**168.2**	**167.5**	**173.4**	**172.7**	**167.8**	**179.2**	**165.2**
RA	152.0	162.0	166.9	171.3	170.2	166.3	177.8	165.4
New difference (abs)	**4.7**	**6.2**	**0.5**	**2.2**	**2.5**	**1.5**	**1.4**	**-0.1**
New difference (%)	**3.1%**	**3.9%**	**0.3%**	**1.3%**	**1.5%**	**1.0%**	**0.8%**	**-0.1%**

In The Netherlands, about 10 per cent to 25 per cent of all carbon in the apparent consumption of fossil fuels is stored in manufactured products.

A4.4 Other country-specific data used in the Reference Approach

Apart from different storage fractions of non-energy use of fuels as presented in A4.4, 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 and 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.

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 so small as to be negligible. For those sources that were not negligible, methods for estimating the emissions were developed during the improvement programme. As a result of this process, it was decided to keep only very few sources as 'NE', where 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 was reassessed and 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 with asphalt (2A6), both due to missing activity data; information on the use of bitumen is split between just 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 the 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 behind the decision to not estimate these emissions. As a follow-up on the 2008 review, information was collected from the branch organisation for roofing, indicating that the number of producers of asphalt roofing declined from about 15 in 1990 to fewer than 5 in 2008 and that the import of asphalt roofing increased. Also, information has been researched on asphalt production (for road paving), as reported under the voluntary agreements for energy efficiency. A first estimate indicates that annual CO_2 emissions could be around 0.5 kton.
- CH_4 from Enteric fermentation poultry (4A9), due to missing EFs; for this source category no IPCC default EF is available.
- N_2O from Industrial wastewater (6B1), due to negligible amounts. As presented in the NIR 2008, page 194, the source for activity data is yearly questionnaires that cover all urban WWTPs and all anaerobic industrial WWTPs. From anaerobic pre-treatment, there are no N_2O emissions.

In 2000, The Netherlands investigated not previously estimated sources for non-CO_2 emissions. One of these sources was wastewater handling (DHV, 2000). As a result of this study, emissions were estimated (Oonk, 2004) and the methods are presented in the protocol "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. During the allocation of available budgets for improvements in emission estimates, it was decided that a new data collection process or new statistics for this source was not a priority. Arguments for this decision include:

- The majority of the small and medium-size enterprises are linked to the municipal wastewater treatment plants (for which we made emission estimates) and do not have their own wastewater treatment.
- 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 urban 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 has low N content. In addition, there are indications that the number of industrial WWTPs will reduce in the immediate future and this will also further minimise the effect of not estimating this source.
- Part of CH_4 from industrial wastewater (6B1b 'sludge'), due to negligible amounts. For industrial wastewater treatment the situation is follows:
  - The major part of Dutch industry discharge their wastewater to the sewage system, which is subject to municipal wastewater treatment. These emissions are included in the category Domestic and commercial wastewater.
  - In the case of anaerobic wastewater treatment, emissions from sludge handling are included in emissions from industrial anaerobic wastewater handling.
  - Among the aerobic wastewater 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 IWWTP, the sludge undergoes simultaneous stabilisation in the aerobic wastewater reactors. The industrial sludge produced is therefore already very stable in terms of digestible matter. CH_4 emissions are

therefore 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 2013, from 15 April 2013, available at the website; www.nlagency.nl/nie).

Protocol	IPCC code	Description	Gases
13-001	All	Reference Approach	CO_2
13-002	1A1 1A2 1A4	Stationary combustion (fossil)	CO_2 N_2O CH_4
13-003	1A1b 1B1b 1B2aiv 2A4i 2B1 2B4i 2B5i 2B5vii 2B5viii 2C1vi 2D2 2Giv	Process emissions (fossil)	CO_2 N_2O CH_4
13-004	1A2f 1A4c	Mobile equipment	CO_2 N_2O CH_4
13-005	1A3a	Inland aviation	CO_2 N_2O CH_4
13-006	1A3b	Road transport	CO_2
13-007	1A3b	Road transport	N_2O CH_4
13-008	1A3c	Rail transport	CO_2 N_2O CH_4
13-009	1A3d	Inland navigation	CO_2 N_2O CH_4
13-010	1A4c	Fisheries	CO_2 N_2O CH_4
13-011	1A5	Defence	CO_2 N_2O CH_4
13-012	1B2	Oil & gas production	CO_2 CH_4
13-013	1B2	Oil & gas distribution/transport	CO_2 CH_4
13-014	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
13-015	2B2	Nitric acid	N_2O
13-016	2B5	Caprolactam	N_2O
13-017	2C3	Aluminium production	PFC
13-018	2E1	HCFC-22 production	HFC
13-019	2E3	HFC by-product emissions	HFC
13-020	2F1	Stationary refrigeration	HFC
13-021	2F1	Mobile refrigeration	HFC
13-022	2F2, 2F4	Hard foams, Aerosols	HFC
13-024	2F8	Soundproof windows, Electron microscopes	SF_6
13-025	2F8	Semi-conductors	SF_6 PFC
13-026	2F8	Electrical equipment	SF_6
13-027	4A	Enteric fermentation,	CH_4
13-028	4B	Manure management	N_2O
13-029	4B	Manure management	CH_4
13-030	4D	Agricultural soils, indirect	N_2O
13-031	4D	Agricultural soils, direct	N_2O
13-032	5A	Forest	CO_2
13-033	5D-5G	Soil	CO_2
13-034	6A1	Waste disposal	CH_4
13-035	6B	Wastewater treatment	CH_4 N_2O
13-036	6D	Large-scale composting	CH_4 N_2O
13-037	Memo item	International bunker emissions	CO_2 N_2O CH_4
13-038	1A, (CO_2 memo item)	Biomass	CO_2 CH_4 N_2O
13-039	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 and 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. IVM report no. R03-06. Institute for Environmental Studies (IVM), Free University, Amsterdam.
- 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.

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 773201 003. Bilthoven.
- Kuikman, P.J., J.J.H van den Akker and F. de Vries, 2005: Lachgasemissie uit organische landbouwbodems. Alterra report 1035-II. Alterra, Wageningen.
- 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 and 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 68012.003/2007, MNP report 500080003/2007. Bilthoven.
- Nabuurs, G.J., I.J. van den Wyngaert, W.D. Daamen, A.T.F. Helmink, W. de Groot, W.C. Knol, H. Kramer and 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 rapport 1035-I. Alterra, Wageningen.
- Van den Wyngaert, I.J.J., Kramer, H., Kuikman, P. and G.J. Nabuurs, 2009: Greenhouse gas reporting of the LULUCF sector, revisions and updates related to the Dutch NIR 2009. Alterra report 1035.7. 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 ML-BB-20010367. DHV, Amersfoort.
- RIVM, 2011: Werkplan EmissieRegistratie ronde 2011–2012. RIVM, Bilthoven.
- NL Agency, 2012: The Netherlands National System: QA/QC programme 2012/2013 Version 8.0.

A6.5 Documentation of changes to the National Registry

- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Application Logging Plan, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Change Management Procedure, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Disaster Recovery Plan, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, ITL Manual Interventions, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Operational Plan, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Roles and Responsibilities, Version 0.1, 27/7/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Security Plan, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Time Validation Plan, Version 1.1, 15/11/2011.
- European Commission (DIRECTORATE-GENERAL CLIMATE ACTION), EU Registry, Version Change Management, Version 1.1, 15/11/2011.

A6.6 Registry Information

Report R1

Party Netherlands
Submission year 2013
Reported year 2012
Commitment period 1

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	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 2013
Reported year 2012
Commitment period 1

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							NO	NO	NO	59518	NO	NO
Sub-total		NO	NO				NO	NO	NO	59518	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	187736942	895113	NO	7387495	NO	NO

Party	Netherlands
Submission year	2013
Reported year	2012
Commitment period	1

Add registry | Delete registry | No external transactions

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												
EE	82931	99469	NO	NO	NO	NO	NO	52323	NO	12996	NO	NO
DK	207569	NO	NO	NO	NO	NO	NO	NO	NO	111286	NO	NO
CZ	303528	181535	NO	7811	NO	NO	7811	21247	NO	367400	NO	NO
IT	12750400	NO	NO	317996	NO	NO	5606352	2148576	NO	3557966	NO	NO
LV	431503	NO	NO	NO	NO	NO	NO	7954	NO	35187	NO	NO
PL	5088183	434602	NO	NO	NO	NO	420000	396717	NO	423235	NO	NO
SK	375300	NO	NO	NO	NO	NO	135000	NO	NO	7500	NO	NO
CH	58570	7318058	NO	10193225	NO	NO	2986	19833755	NO	5177377	NO	NO
BG	785004	944485	NO	NO	NO	NO	NO	NO	NO	113925	NO	NO
DE	12464378	1915511	NO	6107872	NO	NO	10729366	2027704	NO	5418618	NO	NO
FI	62638	NO	NO	NO	NO	NO	NO	150231	NO	32638	NO	NO
JP	NO	NO	NO	1748739	NO	NO	NO	NO	NO	362718	NO	NO
SI	71000	13404	NO	55568	NO	NO	25000	120120	NO	NO	NO	NO
EU	59881	2018355	NO	6164713	NO	NO	NO	4932818	NO	23695975	NO	NO
HU	1728612	NO	NO	NO	NO	NO	6000	NO	NO	NO	NO	NO
GR	213342	NO	NO	NO	NO	NO	30000	NO	NO	58342	NO	NO
PT	74480	NO	NO	NO	NO	NO	265	NO	NO	117760	NO	NO
SE	105915	194013	NO	1165843	NO	NO	77808	86373	NO	111072	NO	NO
FR	7079669	465004	4000000	1779524	NO	NO	2131657	1723914	NO	1968637	NO	NO
RO	100395	1811229	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
GB	27469386	4079955	NO	21778968	NO	NO	14097123	10269859	4000000	20138493	NO	NO
BE	6892333	100000	NO	60000	NO	NO	567041	101049	NO	680162	NO	NO
NO	11000	NO	NO	1128152	NO	NO	89078	NO	NO	36879	NO	NO
LU	4203	NO	NO	NO	NO	NO	80000	177213	NO	229613	NO	NO
ES	2826672	1563926	NO	75602	NO	NO	43875	1629005	NO	272517	NO	NO
IE	NO	NO	NO	232700	NO	NO	131200	9931	NO	184742	NO	NO
AT	330649	NO	NO	35366	NO	NO	78702	NO	NO	10649	NO	NO
NZ	NO	45514	NO	1148430	NO	NO	NO	NO	NO	NO	NO	NO
CDM	NO	NO	NO	15171333	NO	NO	NO	NO	NO	NO	NO	NO
UA	NO	64303687	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LT	NO	282765	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RU	NO	2476715	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	79577541	88248227	4000000	67171842	NO	NO	34259264	43688789	4000000	63125687	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	79577541	88248227	4000000	67171842	NO	NO	34259264	43688789	4000000	63185205	NO	NO

Party	Netherlands
Submission year	2013
Reported year	2012
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	2013
Reported year	2012
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	542673011	9670179	NO	23945399	NO	NO
Entity holding accounts	NO	40906339	NO	14201386	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	120692	NO	NO
Retirement account	560130340	895113	NO	7387495	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	1102807330	51471631	NO	45654972	NO	NO

Party	Netherlands
Submission year	2013
Reported year	2012
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)	79577541	88248227	4000000	67171842	NO	NO	34259264	43688789	4000000	63185205	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	716520799	112295386	4000000	319387661	NO	NO	614979589	60823755	4000000	273853381	NO	NO
Total	1717782940	112295386	4000000	319387661	NO	NO	614979589	60823755	4000000	273853381	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

	Retirement				
	Unit type				
Year	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)	187736942	895113	NO	7387495	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	560130340	895113	NO	7387495	NO

Party	Netherlands
Submission year	2013
Reported year	2012
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
NO TRANSACTION												

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
NO TRANSACTION								

Table 6 (c). Memo item: Corrective transactions relating to retirement

	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
NO TRANSACTION						

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 EFs 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 EFs are derived from a mixture of empirical data and expert judgement and presented here as half the 95 per cent confidence interval. The reason for halving the 95 per cent 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; Ramírez-Ramírez et al., 2006). This conclusion holds for both annual uncertainties and the trend uncertainty (see section 1.7 for more details).

Details of 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 judgement and are therefore also rather uncertain (usually of the order of 50 per cent). However, the reason to make these estimates is to identify the most important uncertain sources. For this purpose, a reasonable order-of-magnitude estimate of the uncertainty in activity data and in EFs 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 of the sources . Another part, however, can be attributed to elements of the inventory of which the uncertainty could be reduced in the course of time as a result of dedicated research initiated by either 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 lower 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%	± 2%-points of 5% increase
CH_4	± 16%	± 7%-points of 41% decrease
N_2O	± 43%	± 8%-points of 54% decrease
F-gases	± 40%	± 12%-points of 70% decrease

Table A7.2 Tier 1 level and trend uncertainty assessment 1990–2011 (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 year abs	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	909	1%	10%	10%	0.0%	0.3%	0.4%	0.0%	0.0%	0.0%
1A1a	Stationary combustion: public electricity and heat production: solids	CO_2	25,776	23,333	1%	3%	3%	0.4%	-0.1%	10.6%	0.0%	0.1%	0.1%
1A1a	Stationary combustion: public electricity and heat production: gases	CO_2	13,348	23,701	1%	0%	1%	0.1%	5.2%	10.7%	0.0%	0.1%	0.1%
1A1a	Stationary combustion: public electricity and heat production: waste incineration	CO_2	601	2,570	10%	5%	11%	0.1%	0.9%	1.2%	0.0%	0.2%	0.2%
1A1b	Stationary combustion: petroleum refining: liquids	CO_2	9,999	7,166	10%	10%	14%	0.5%	-0.9%	3.2%	-0.1%	0.5%	0.5%
1A1b	Stationary combustion: petroleum refining: gases	CO_2	1,042	3,600	1%	0%	1%	0.0%	1.2%	1.6%	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%	0.0%
1A1c	Stationary combustion: manuf. of solid fuels and other en. ind.: gases	CO_2	1,526	1,627	20%	5%	21%	0.2%	0.1%	0.7%	0.0%	0.2%	0.2%
1A2	Stationary combustion: manufacturing industries and construction, liquids	CO_2	8,956	8,563	1%	4%	4%	0.2%	0.2%	3.9%	0.0%	0.1%	0.1%
1A2	Stationary combustion: manufacturing industries and construction, solids	CO_2	5,033	4,022	2%	10%	10%	0.2%	-0.3%	1.8%	0.0%	0.1%	0.1%
1A2	Stationary combustion: manufacturing industries and construction, gases	CO_2	19,020	13,159	2%	0%	2%	0.1%	-1.9%	6.0%	0.0%	0.2%	0.2%
1A4	Stationary combustion: other sectors, solids	CO_2	189	42	50%	5%	50%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
1A4a	Stationary combustion: other sectors: commercial/institutional, gases	CO_2	7,632	9,352	20%	0%	20%	0.9%	1.1%	4.2%	0.0%	1.2%	1.2%
1A4b	Stationary combustion: other sectors, residential, gases	CO_2	18,696	16,630	5%	0%	5%	0.4%	-0.2%	7.5%	0.0%	0.5%	0.5%
1A4c	Stationary combustion: other sectors, agriculture/forestry/fisheries, gases	CO_2	7,330	8,043	10%	0%	10%	0.4%	0.6%	3.6%	0.0%	0.5%	0.5%
1A4c	Stationary combustion: other sectors, agriculture/forestry/fisheries, liquids	CO_2	2,587	1,723	15%	2%	15%	0.1%	-0.3%	0.8%	0.0%	0.2%	0.2%
1A4	Stationary combustion: other sectors, liquids excl. from 1A4c	CO_2	1,356	463	20%	2%	20%	0.0%	-0.4%	0.2%	0.0%	0.1%	0.1%
1A5	Military use of fuels (1A5 Other)	CO_2	566	355	20%	2%	20%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1,594	3%	50%	50%	0.4%	0.5%	0.7%	0.2%	0.0%	0.2%
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	334	3%	50%	50%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10,908	13,062	2%	2%	3%	0.2%	1.4%	5.9%	0.0%	0.2%	0.2%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11,821	20,170	2%	2%	3%	0.3%	4.2%	9.1%	0.1%	0.3%	0.3%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2,740	843	5%	2%	5%	0.0%	-0.8%	0.4%	0.0%	0.0%	0.0%
1A3	Mobile combustion: water-borne navigation	CO_2	405	669	20%	0%	20%	0.1%	0.1%	0.3%	0.0%	0.1%	0.1%
1A3	Mobile combustion: aircraft	CO_2	28	22	30%	4%	30%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: other (railways)	CO_2	91	102	5%	0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: other (non-road)	CH_4	1	1	36%	36%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last year abs	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	36%	36%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: road vehicles	CH_4	158	45	50%	50%	70%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A3	Mobile combustion: road vehicles	N_2O	101	270	50%	50%	70%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%
1B2	Fugitive emissions venting/flaring	CH_4	1,252	323	2%	25%	25%	0.0%	-0.4%	0.1%	-0.1%	0.0%	0.1%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	268	2%	25%	25%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	184	20%	50%	54%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
1B1b	CO2 from coke production	CO_2	403	637	50%	2%	50%	0.2%	0.1%	0.3%	0.0%	0.2%	0.2%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	54	50%	2%	50%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%
2A1	Cement production	CO_2	416	351	5%	10%	11%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
2A3	Limestone and dolomite use	CO_2	481	600	25%	5%	25%	0.1%	0.1%	0.3%	0.0%	0.1%	0.1%
2A7	Other minerals	CO_2	275	344	25%	5%	25%	0.0%	0.0%	0.2%	0.0%	0.1%	0.1%
2B1	Ammonia production	CO_2	3,096	2,681	2%	1%	2%	0.0%	-0.1%	1.2%	0.0%	0.0%	0.0%
2B2	Nitric acid production	N_2O	6,330	243	5%	6%	8%	0.0%	-2.5%	0.1%	-0.2%	0.0%	0.2%
2B5	Caprolactam production	N_2O	766	870	20%	23%	30%	0.1%	0.1%	0.4%	0.0%	0.1%	0.1%
2B5	Other chemical product manufacture	CO_2	649	728	50%	50%	71%	0.3%	0.1%	0.3%	0.0%	0.2%	0.2%
2C1	Iron and steel production (carbon inputs)	CO_2	2,267	1,110	3%	5%	6%	0.0%	-0.4%	0.5%	0.0%	0.0%	0.0%
2C3	CO_2 from aluminium production	CO_2	395	438	2%	5%	5%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
2C3	PFC from aluminium production	PFC	1,901	82	2%	20%	20%	0.0%	-0.8%	0.0%	-0.2%	0.0%	0.2%
2F	SF_6 emissions from SF_6 use	SF_6	287	147	30%	15%	34%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
2F	Emissions from substitutes for ozone-depleting substances (ODS substitutes): HFC	HFC	248	1,928	10%	50%	51%	0.5%	0.8%	0.9%	0.4%	0.1%	0.4%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5,759	166	10%	10%	14%	0.0%	-2.3%	0.1%	-0.2%	0.0%	0.2%
2E	HFC by-product emissions from HFC manufacture	HFC	12	38	10%	20%	22%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2F	PFC emissions from PFC use	PFC	37	101	5%	25%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2G	Other industrial: CO_2	CO_2	304	325	5%	20%	21%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
2G	Other industrial: CH_4	CH_4	297	281	10%	50%	51%	0.1%	0.0%	0.1%	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%	0.0%
3	Indirect CO_2 from solvents/product use	CO_2	316	123	25%	10%	27%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4,356	3,963	5%	15%	16%	0.3%	0.0%	1.8%	0.0%	0.1%	0.1%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	161	5%	20%	21%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2,264	1,641	5%	20%	21%	0.2%	-0.2%	0.7%	0.0%	0.1%	0.1%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	392	5%	50%	50%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	388	5%	30%	30%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%
4B	Emissions from manure management	N_2O	1,183	1,052	10%	100%	100%	0.5%	0.0%	0.5%	0.0%	0.1%	0.1%
4B1	Emissions from manure management: cattle	CH_4	1,593	1,795	10%	100%	100%	0.9%	0.2%	0.8%	0.2%	0.1%	0.2%
4B8	Emissions from manure management: swine	CH_4	1,154	770	10%	100%	100%	0.4%	-0.1%	0.3%	-0.1%	0.0%	0.1%

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last year abs	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	275	41	10%	100%	100%	0.0%	-0.1%	0.0%	-0.1%	0.0%	0.1%
4B	Emissions from manure management: other	CH_4	31	24	10%	100%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4,137	3,236	10%	60%	61%	1.0%	-0.3%	1.5%	-0.2%	0.2%	0.3%
4D3	Indirect N2O emissions from nitrogen used in agriculture	N_2O	3,358	1,450	50%	200%	206%	1.5%	-0.7%	0.7%	-1.5%	0.5%	1.5%
4D2	Animal production on agricultural soils	N_2O	3,150	1,108	10%	100%	100%	0.5%	-0.8%	0.5%	-0.8%	0.1%	0.8%
6A1	CH4 emissions from solid waste disposal sites	CH_4	12,011	3,166	30%	15%	34%	0.5%	-3.5%	1.4%	-0.5%	0.6%	0.8%
6B	Emissions from wastewater handling	CH_4	290	199	20%	25%	32%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
6B	Emissions from wastewater handling	N_2O	482	457	20%	50%	54%	0.1%	0.0%	0.2%	0.0%	0.1%	0.1%
6D	Other CH_4	CH_4	2	22	20%	25%	32%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3, 6D	Other N_2O	N_2O	250	71	20%	50%	54%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
5A1	5A1 Forest land remaining forest land	CO_2	2,407	1,893	25%	62%	67%	0.6%	-0.1%	0.9%	-0.1%	0.3%	0.3%
5A2	5A2 Land converted to forest land	CO_2	56	541	25%	58%	63%	0.2%	0.2%	0.2%	0.1%	0.1%	0.2%
5B2	5B2 Land converted to cropland	CO_2	122	165	25%	50%	56%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
5C1	5C1 Grassland remaining grassland	CO_2	4,246	4,246	25%	50%	56%	1.2%	0.2%	1.9%	0.1%	0.7%	0.7%
5C2	5C2 Land converted to grassland	CO_2	239	236	25%	50%	56%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
5D2	5D2 Land converted to wetland	CO_2	80	135	25%	50%	56%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
5E2	5E2 Land converted to settlements	CO_2	459	817	25%	50%	56%	0.2%	0.2%	0.4%	0.1%	0.1%	0.2%
5F2	5F2 Land converted to other land	CO_2	20	27	25%	50%	56%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5G	5G Other (liming of soils)	CO_2	183	73	25%	1%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	TOTAL	GHG	220,991	202,477				3.0%					2.7%

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 last year abs	AD unc	EF unc	Uncertainty estimate
5A1	Forest land remaining forest land	CO_2	-2,407	-1,893	25%	62%	67%
5A2	Land converted to forest land	CO_2	56	-541	25%	58%	63%
5B2	Land converted to cropland	CO_2	122	155	25%	50%	56%
5C1	Grassland remaining grassland	CO_2	4,246	4,246	25%	50%	56%
5C2	Land converted to grassland	CO_2	239	236	25%	50%	56%
5D2	Land converted to wetland	CO_2	80	135	25%	50%	56%
5E2	Land converted to settlements	CO_2	459	817	25%	50%	56%
5F2	Land converted to other land	CO_2	20	27	25%	50%	56%
5G	Other (liming of soils)	CO_2	183	73	25%	1%	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	2009	2010	2011
Cattle for breeding							
Female young stock under 1 yr	752,658	696,063	562,563	499,937	577,084	545,419	536,887
Male young stock under 1 yr	53,229	44,163	37,440	33,778	32,976	28,856	30,662
Female young stock, 1–2 yrs	734,078	682,888	594,100	515,972	527,537	563,966	531,881
Male young stock, 1–2 yrs	34,635	33,118	26,328	18,149	14,244	13,808	11,574
Female young stock, 2 yrs and over	145,648	124,970	104,633	74,180	85,381	86,913	89,841
Cows in milk and in calf	1,877,684	1,707,875	1,504,097	1,433,202	1,489,071	1,478,635	1,469,720
Bulls for service, 2 yrs and over	8,762	8,674	10,410	12,391	8,119	7,756	7,599
Cattle for fattening							
Meat calves for rose veal production	28,876	85,803	145,828	204,227	269,306	293,901	303,553
Meat calves for white veal production	572,709	583,516	636,907	624,513	624,942	633,798	602,623
Female young stock < 1 yr	53,021	57,218	41,300	43,313	41,113	39,231	38,525
Male young stock (incl. young bullocks) < 1 yr	255,375	188,193	83,447	66,655	52,764	48,790	46,085
Female young stock, 1–2 yrs	56,934	66,653	44,807	43,452	45,130	43,080	40,151
Male young stock (incl. young bullocks) 1-2 yrs	178,257	169,546	88,669	52,788	48,183	46,391	41,690
Female young stock, 2 yrs and over	42,555	48,365	16,917	15,260	19,935	19,848	20,101
Male young stock (incl. young bullocks) ≥ 2 yrs	12,073	10,969	9,397	9,346	8,512	9,463	9,480
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	119,529	146,181	163,397	151,641	123,302	115,339	104,973
Pigs							
Piglets	5,190,749	5,596,117	5,102,434	4,562,991	5,068,497	5,123,807	5,297,469
Fattening pigs	7,025,102	7,123,923	6,504,540	5,504,295	5,872,351	5,904,172	5,905,007
Gilts not yet in pig	385,502	357,520	339,570	274,085	249,118	232,261	238,473
Sows	1,272,215	1,287,224	1,129,174	946,466	985,244	983,552	978,487
Young boars	13,893	11,382	6,917	6,486	3,550	3,946	2,864
Boars for service	27,587	21,297	35,182	17,235	7,693	7,234	6,838
Poultry							
Broilers	41,172,110	43,827,286	50,936,625	44,496,116	43,285,129	44,747,893	43,911,647
Broilers, parents under 18 weeks	2,882,250	3,065,170	3,644,120	2,191,650	2,645,986	2,895,975	3,200,749
Broilers, parents, 18 weeks and over	4,389,830	4,506,840	5,397,520	3,596,700	4,287,967	4,447,519	4,136,991
Laying hens < 18 weeks, liquid manure	7,339,708	4,889,555	2,865,850	1,035,581	578,681	663,430	42,429
Laying hens < 18 weeks, solid manure	3,781,062	4,000,545	8,597,550	9,751,719	10,768,005	12,345,009	10,564,849
Laying hens ≥ 18 weeks, liquid manure	19,919,466	12,294,122	7,166,060	2,292,654	847,049	253,035	210,372
Laying hens ≥ 18 weeks, solid manure	13,279,644	16,977,598	25,406,940	29,549,756	34,446,667	35,894,850	34,851,574
Ducks for slaughter	1,085,510	868,965	958,466	1,030,867	1,156,699	1,086,990	1,015,801
Turkeys for slaughter	1,003,350	1,175,527	1,543,830	1,245,420	1,059,693	1,036,277	990,348
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	40,760	38,512	39,353
Minks (mother animals)	543,969	456,104	584,806	691,862	869,941	962,409	976,551
Foxes (mother animals)	10,029	7,102	3,816	5,240			
Other grazing animals							
Sheep (ewes)	789,691	770,730	681,441	648,235	538,279	558,184	546,293
Sheep (other)	912,715	903,445	626,116	714,288	578,330	571,316	542,192
Goats (mothers)	37,472	43,231	98,077	172,159	231,090	221,977	220,140
Goats (other)	23,313	32,832	80,825	120,073	143,094	130,851	160,211
Horses	369,592	400,004	418,244	433,321	444,924	441,481	436,118

Table A8.2 Gross energy intake (MJ/head/day) for cattle.

	1990	1995	2000	2005	2009	2010	2011
Cattle for breeding							
Female young stock under 1 yr	73.6	75.6	75.0	75.8	74.4	74.0	74.0
Male young stock under 1 yr	86.1	86.7	85.1	89.1	85.5	85.2	85.7
Female young stock, 1–2 yrs	139.5	142.5	139.5	144.6	146.0	144.9	144.2
Male young stock, 1–2 yrs	151.1	162.2	155.9	154.1	152.3	151.0	150.6
Female young stock, 2 yrs and over	139.4	142.5	139.5	144.6	146.0	144.9	144.3
Cows in milk and in calf	279.6	292.1	306.8	321.2	329.9	333.2	333.9
Bulls for service, 2 yrs and over	151.1	162.2	155.9	154.1	152.3	151.0	150.6
Cattle for fattening							
Meat calves for rose veal production	77.9	77.9	95.5	82.8	82.8	77.1	77.1
Meat calves for white veal production	30.9	32.7	35.6	34.8	37.2	41.9	42.1
Female young stock < 1 yr	73.6	75.5	74.9	75.8	74.1	73.8	73.8
Male young stock (incl. young bullocks) < 1 yr	82.3	87.6	88.8	86.7	85.6	84.7	85.1
Female young stock, 1–2 yrs	139.5	142.4	139.3	144.4	146.0	144.9	144.2
Male young stock (incl. young bullocks) 1–2 yrs	167.3	164.1	154.1	157.5	155.8	154.7	155.3
Female young stock, 2 yrs and over	139.5	142.5	139.4	144.5	146.0	144.9	144.2
Male young stock (incl. young bullocks) ≥ 2 yrs	167.3	164.1	154.1	157.5	155.8	154.7	155.3
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	165.0	167.1	169.1	180.0	183.7	183.2	185.5

Table A8.3 Emission factors enteric fermentation for cattle (kg/animals/year).

	1990	1995	2000	2005	2009	2010	2011
Cattle for breeding							
Female young stock under 1 yr	29.0	29.8	29.5	29.8	29.3	29.1	29.1
Male young stock under 1 yr	33.9	34.1	33.5	35.0	33.7	33.5	33.7
Female young stock, 1–2 yrs	54.9	56.1	54.9	56.9	57.4	57.0	56.8
Male young stock, 1–2 yrs	59.5	63.8	61.3	60.7	59.9	59.4	59.3
Female young stock, 2 yrs and over	54.9	56.1	54.9	56.9	57.5	57.0	56.8
Cows in milk and in calf	110.5	115.8	120.0	126.3	127.0	128.7	128.4
Bulls for service, 2 yrs and over	59.5	63.8	61.3	60.7	59.9	59.4	59.3
Cattle for fattening							
Meat calves for rose veal production	30.6	30.6	37.6	32.6	32.6	30.3	30.3
Meat calves for white veal production	8.1	8.6	9.3	9.1	9.8	11.0	11.0
Female young stock < 1 yr	29.0	29.7	29.5	29.8	29.2	29.0	29.0
Male young stock (incl. young bullocks) < 1 yr	32.4	34.5	34.9	34.1	33.7	33.3	33.5
Female young stock, 1–2 yrs	54.9	56.0	54.8	56.8	57.4	57.0	56.7
Male young stock (incl. young bullocks) 1–2 yrs	65.8	64.6	60.7	62.0	61.3	60.9	61.1
Female young stock, 2 yrs and over	54.9	56.1	54.9	56.9	57.4	57.0	56.8
Male young stock (incl. young bullocks) ≥ 2 yrs	65.8	64.6	60.7	62.0	61.3	60.9	61.1
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	64.9	65.8	66.6	70.8	72.3	72.1	73.0

Table A8.4 Volatile Solids (= organic matter) per 1,000 kg manure.

		1990	1995	2000	2005	2009	2010	2011
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 rose veal production	liquid manure	22.5	22.5	22.5	22.5	22.5	22.5	17
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 rose 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
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	43
Gilts not yet in pig	liquid manure	35	35	35	35	35	35	25
Sows	liquid manure	35	35	35	35	35	35	25
Young boars	liquid manure	35	35	35	35	35	35	25
Boars for service	liquid manure	35	35	35	35	35	35	25
Poultry								
Broilers	solid manure	508	508	508	508	508	508	419
Broilers, parents under 18 weeks	solid manure	423	423	423	423	423	423	419

		1990	1995	2000	2005	2009	2010	2011
Broilers, parents 18 weeks and over	solid manure	423	423	423	423	423	423	419
Laying hens < 18 weeks, liquid manure	liquid manure	90	93	93	93	93	93	93
Laying hens < 18 weeks, solid manure	solid manure	350	350	350	350	350	350	359
Laying hens ≥ 18 weeks, liquid manure	liquid manure	90	93	93	93	93	93	93
Laying hens ≥ 18 weeks, solid manure	solid manure	350	350	350	350	350	350	359
Ducks for slaughter	solid manure	209	209	209	209	209	209	237
Turkeys for slaughter	solid manure	464	464	464	464	464	464	427
Turkeys, parents under 7 months	solid manure	464	464	464	464	464	464	427
Turkeys, parents 7 months and over	solid manure	464	464	464	464	464	464	427
Rabbits (mother animals)	solid manure	367	367	367	367	367	367	332
Minks (mother animals)	solid manure	185	185	185	185	185	185	293
Foxes (mother animals)	solid manure	185	185	185	185	185	185	293
Ruminants, not cattle								
Sheep (ewes)	solid manure	205	205	205	205	205	205	195
Goats (mothers)	solid manure	182	182	182	182	182	182	174
Horses	solid manure	250	250	250	250	250	250	160
Ponies	solid manure	250	250	250	250	250	250	160
Ruminants, not cattle								
Sheep (ewes)	pasture	60	66	64	64	64	64	64
Goats (mothers)	pasture	0	0	0	0	0	0	0
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	2009	2010	2011
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 CH_4 production (B0 in m^3 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 rose 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 rose 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, liquid manure	liquid manure		0.34

		MCF	B0
Laying hens < 18 weeks, solid manure	solid manure		0.34
Laying hens ≥ 18 weeks, liquid manure	liquid manure		0.34
Laying hens ≥ 18 weeks, solid manure	solid manure		0.34
Ducks for slaughter	solid manure		0.34
Turkeys for slaughter	solid manure		0.34
Turkeys parents under 7 months	solid manure		0.34
Turkeys parents 7 months and over	solid manure		0.34
Rabbits (mother animals)	solid manure		0.34
Minks (mother animals)	solid manure		0.34
Foxes (mother animals)	solid manure		0.34
Ruminants, not cattle			
Sheep (ewes)	solid manure	0.015	0.25
Goats (mothers)	solid manure	0.015	0.25
Horses	solid manure	0.015	0.25
Ponies	solid manure	0.015	0.25
Ruminants, not cattle			
Sheep (ewes)	pasture	0.01	0.25
Goats (mothers)			
Horses	pasture	0.01	0.25
Ponies	pasture	0.01	0.25

Table A8.7 Emission factors for methane from manure (CH_4/kg manure/year).

		1990	1995	2000	2005	2009	2010	2011
Cattle for breeding								
Female young stock under 1 yr	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Male young stock under 1 yr	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Female young stock, 1–2 yrs	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Male young stock, 1–2 yrs	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Female young stock, 2 yrs and over	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Cows in milk and in calf	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Bulls for service, 2 yrs and over	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Cattle for fattening								
Meat calves for rose veal production	liquid manure	0.00053	0.00053	0.00053	0.00053	0.00053	0.00053	0.00166
Meat calves for white veal production	liquid manure	0.00035	0.00035	0.00035	0.00035	0.00035	0.00035	0.00040
Female young stock < 1 yr	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Female young stock, 1–2 yrs	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Male young stock (incl. young bullocks) 1–2 yrs	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Female young stock, 2 yrs and over	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.00171	0.00188	0.00182	0.00182	0.00182	0.00182	0.00182
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	solid manure	0.00035	0.00038	0.00038	0.00038	0.00038	0.00038	0.00038
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	2009	2010	2011
Cattle for fattening								
Meat calves for rose 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	0.00387	0.00492	0.00533	0.00533	0.00533	0.00533	0.00382
Gilts not yet in pig	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00311	0.00222
Sows	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00311	0.00222
Young boars	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00311	0.00222
Boars for service	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00311	0.00222
Poultry								
Broilers	solid manure	0.00174	0.00174	0.00174	0.00174	0.00174	0.00174	0.00143
Broilers parents under 18 weeks	solid manure	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00143
Broilers parents 18 weeks and over	solid manure	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00143
Laying hens < 18 weeks, liquid manure	liquid manure	0.00800	0.00826	0.00826	0.00826	0.00826	0.00826	0.00826
Laying hens < 18 weeks, solid manure	solid manure	0.00120	0.00120	0.00120	0.00120	0.00120	0.00120	0.00123
Laying hens ≥ 18 weeks, liquid manure	liquid manure	0.00800	0.00826	0.00826	0.00826	0.00826	0.00826	0.00826
Laying hens ≥ 18 weeks, solid manure	solid manure	0.00120	0.00120	0.00120	0.00120	0.00120	0.00120	0.00123
Ducks for slaughter	solid manure	0.00071	0.00071	0.00071	0.00071	0.00071	0.00071	0.00081
Turkeys for slaughter	solid manure	0.00159	0.00159	0.00159	0.00159	0.00159	0.00159	0.00146
Turkeys parents under 7 months	solid manure	0.00159	0.00159	0.00159	0.00159	0.00159	0.00159	0.00146
Turkeys parents 7 months and over	solid manure	0.00159	0.00159	0.00159	0.00159	0.00159	0.00159	0.00146
Rabbits (mother animals)	solid manure	0.00125	0.00125	0.00125	0.00125	0.00125	0.00125	0.00113
Minks (mother animals)	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00063	0.00100
Foxes (mother animals)	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00063	0.00100
Ruminants, not cattle								
Sheep (ewes)	solid manure	0.00052	0.00052	0.00052	0.00052	0.00052	0.00052	0.00049
Goats (mothers)	solid manure	0.00046	0.00046	0.00046	0.00046	0.00046	0.00046	0.00044
Horses	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00063	0.00040
Ponies	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00063	0.00040
Ruminants, not cattle								
Sheep (ewes)	pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Goats (mothers)	pasture	0	0	0	0	0	0	0
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	2009	2010	2011
Cattle for breeding								
Female young stock under 1 yr	liquid manure	3,500	3,500	3,500	3,500	4,000	4,000	4,500
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	8,000	8,000	9,500
Male young stock, 1–2 yrs	liquid manure	11,500	11,500	11,500	11,500	12,000	12,000	12,500
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	8,000	8,000	9,500
Cows in milk and in calf	liquid manure	16,000	16,000	18,000	20,500	23,000	23,500	23,500
Bulls for service, 2 yrs and over	liquid manure	11,500	11,500	11,500	11,500	12,000	12,000	12,500
Cattle for fattening								
Meat calves for rose veal production	liquid manure	5,000	5,000	5,000	5,000	4,500	4,500	4,500
Meat calves for white veal production	liquid manure	3,500	3,500	3,500	3,000	2,800	2,800	2,800
Female young stock < 1 yr	liquid manure	3,500	3,500	3,500	3,500	4,000	4,000	4,500
Male young stock (incl. young bullocks) < 1 yr	liquid manure	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Female young stock, 1–2 yrs	liquid manure	6,000	6,000	6,000	6,000	8,000	8,000	9,500
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	8,000	8,000	9,500
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	500
Male young stock under 1 yr								
Female young stock, 1–2 yrs	pasture	5,500	5,500	5,500	5,500	4,000	4,000	3,000
Male young stock, 1–2 yrs								
Female young stock, 2 yrs and over	pasture	5,500	5,500	5,500	5,500	4,000	4,000	3,000
Cows in milk and in calf	pasture	7,000	7,000	7,000	5,500	3,000	2,500	2,500
Bulls for service, 2 yrs and over								
Cattle for fattening								
Meat calves for rose 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	500
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1–2 yrs	pasture	5,500	5,500	5,500	5,500	4,000	4,000	3,000
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	4,000	4,000	3,000
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	1,100	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	10.0	11.0	11.0	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, liquid manure	liquid manure	25.4	25.4	25.4	22.5	22.5	22.5	22.5

		1990	1995	2000	2005	2008	2009	2010
Laying hens < 18 weeks, solid manure	solid manure	10.0	10.0	9.0	7.6	7.6	7.6	7.6
Laying hens ≥ 18 weeks, liquid 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	155	155
Foxes (mother animals)	solid manure	272	272	272	272			
Ruminants, not cattle								
Sheep (ewes)	solid manure	325	325	325	325	140	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	2,400	2,400	2,400
Goats (mothers)	pasture	0	0	0	0	0	0	0
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	2009	2010	2011
Cattle for breeding								
Female young stock under 1 yr	liquid manure	26.5	29.8	29.0	23.0	28.8	28.6	28.9
Male young stock under 1 yr	liquid manure	39.6	40.8	37.0	37.0	33.2	33.2	32.4
Female young stock, 1–2 yrs	liquid manure	43.1	48.4	46.4	42.7	45.0	44.4	49.2
Male young stock, 1–2 yrs	liquid manure	90.6	101.9	96.8	88.5	84.4	83.4	82.7
Female young stock, 2 yrs and over	liquid manure	43.0	48.4	46.3	42.7	45.0	44.5	49.3
Cows in milk and in calf	liquid manure	95.9	104.0	97.2	103.2	104.2	107.9	108.1
Bulls for service, 2 yrs and over	liquid manure	90.6	101.9	96.8	88.5	84.4	83.4	82.7
Cattle for fattening								
Meat calves for rose veal production	liquid manure	28.9	28.9	34.1	27.2	28.0	28.2	27.3
Meat calves for white veal production	liquid manure	10.6	11.6	11.9	10.6	10.6	12.4	14.0
Female young stock < 1 yr	liquid manure	26.2	29.4	28.6	22.8	28.4	28.2	28.6
Male young stock (incl. young bullocks) < 1 yr	liquid manure	28.9	29.5	26.6	27.0	26.9	26.8	23.9
Female young stock, 1–2 yrs	liquid manure	43.0	48.2	46.0	42.4	44.1	43.6	48.6
Male young stock (incl. young bullocks) 1–2 yrs	liquid manure	72.6	64.7	56.1	56.8	54.9	53.8	51.1
Female young stock, 2 yrs and over	liquid manure	43.1	48.4	46.1	42.5	44.1	43.6	48.6
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	72.6	64.7	56.1	56.8	54.9	53.8	51.1
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	solid manure	42.3	48.0	42.4	39.1	37.9	37.6	37.6
Cattle for breeding								
Female young stock under 1 yr	Pasture	15.3	14.4	13.0	17.0	7.1	7.4	5.9
Male young stock under 1 yr								
Female young stock, 1–2 yrs	Pasture	51.2	47.5	42.9	33.1	28.2	28.8	22.0
Male young stock, 1–2 yrs								
Female young stock, 2 yrs and over	Pasture	51.2	47.5	42.9	33.1	28.2	28.7	22.0
Cows in milk and in calf	Pasture	52.6	52.5	39.3	30.8	22.8	22.3	19.5
Bulls for service, 2 yrs and over								

		1990	1995	2000	2005	2009	2010	2011
Cattle for fattening								
Meat calves for rose veal production								
Meat calves for white veal production								
Female young stock < 1 yr	Pasture	15.2	14.3	12.8	16.9	7.0	7.2	5.7
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1–2 yrs	Pasture	51.2	47.5	42.9	33.1	28.6	29.2	22.1
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	28.6	29.2	22.1
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	Pasture	68.4	63.1	52.7	45.8	44.9	45.7	43.0
Pigs								
Piglets								
Fattening pigs	liquid manure	14.3	14.5	12.3	12.3	12.7	12.2	12.5
Gilts not yet in pig	liquid manure	14.0	14.4	14.2	14.3	13.6	15.4	15.9
Sows	liquid manure	33.8	31.4	30.9	30.7	30.3	30.2	30.1
Young boars	liquid manure	14.0	14.4	14.2	14.3	13.6	15.4	15.9
Boars for service	liquid manure	25.0	24.6	22.9	23.7	23.2	23.3	23.4
Poultry								
Broilers	solid manure	0.6	0.6	0.5	0.6	0.5	0.5	0.5
Broilers parents under 18 weeks	solid manure	0.5	0.5	0.4	0.3	0.3	0.4	0.4
Broilers parents 18 weeks and over	solid manure	1.3	1.3	1.1	1.1	1.1	1.1	1.1
Laying hens < 18 weeks, liquid manure	liquid manure	0.4	0.4	0.3	0.3	0.3	0.3	0.4
Laying hens < 18 weeks, solid manure	solid manure	0.4	0.4	0.3	0.3	0.3	0.3	0.4
Laying hens ≥ 18 weeks, liquid manure	liquid manure	0.8	0.8	0.7	0.7	0.8	0.8	0.8
Laying hens ≥ 18 weeks, solid manure	solid manure	0.8	0.8	0.7	0.7	0.8	0.8	0.8
Ducks for slaughter	solid manure	1.1	1.1	1.0	0.9	0.8	0.8	0.8
Turkeys for slaughter	solid manure	2.0	2.0	1.9	1.8	2.0	1.9	1.9
Turkeys parents under 7 months	solid manure	2.4	2.8					
Turkeys parents 7 months and over	solid manure	3.2	3.0					
Rabbits (mother animals)	solid manure	8.7	8.1	7.6	8.2	7.7	7.7	7.8
Minks (mother animals)	solid manure	4.1	4.1	3.5	2.7	1.9	2.2	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	1.4	1.3	1.2
Goats (mothers)	solid manure	19.9	21.5	19.4	17.7	16.1	17.5	17.6
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	12.5	12.8	11.8
Goats (mothers)	pasture	0	0	0	0	0	0	0
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	2009	2010	2011
Cattle for breeding							
Female young stock under 1 yr	0.56	0.56	0.56	0.56	0.56	0.56	0.62
Male young stock under 1 yr	0.56	0.56	0.56	0.56	0.56	0.56	0.62
Female young stock, 1–2 yrs	0.85	0.88	0.91	0.94	0.95	0.95	0.96
Male young stock, 1–2 yrs	0.85	0.88	0.91	0.94	0.95	0.95	0.96
Female young stock, 2 yrs and over	0.85	0.88	0.91	0.94	0.95	0.95	0.96
Cows in milk and in calf, winter	0.89	0.92	0.96	0.97	0.98	0.98	0.97
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	0.82
Cattle for fattening							
Meat calves for rose 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	0.61
Male young stock (incl. young bullocks) < 1 yr	0.67	0.67	0.67	0.67	0.67	0.67	0.63
Female young stock, 1–2 yrs	0.66	0.66	0.66	0.66	0.66	0.66	0.61
Male young stock (incl. young bullocks) 1–2 yrs	0.67	0.67	0.67	0.67	0.67	0.67	0.63
Female young stock, 2 yrs and over	0.66	0.66	0.66	0.66	0.66	0.66	0.61
Male young stock (incl. young bullocks) ≥ 2 yrs	0.65	0.65	0.65	0.65	0.65	0.65	0.55
Suckling cows (incl. fattening/grazing) ≥ 2 yrs	0.69	0.69	0.69	0.69	0.69	0.69	0.66
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	0.97
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	0.88
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	0.00
Laying hens ≥ 18 weeks	0.60	0.42	0.22	0.07	0.02	0.01	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					
Turkeys parents 7 months and over	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	2009	2010	2011
Winter wheat	13,510,369	12,559,909	12,050,981	11,603,963	12,889,423	13,499,853	11,315,342
Spring wheat	549,904	981,302	1,617,586	2,067,009	2,208,756	1,902,381	3,837,102
Winter barley	994,082	309,977	363,547	296,950	487,279	471,135	407,092
Spring barley	3,044,693	3,248,038	4,353,676	4,761,972	3,959,131	2,872,749	3,003,598
Rye	860,386	817,514	596,058	253,457	231,967	234,285	164,959
Oats	340,128	291,431	240,390	169,744	158,456	169,248	149,293
Triticale		257,947	664,635	408,259	273,462	267,869	182,753
Dried and green peas	1,090,832	69,149	75,204	192,508	52,106	49,319	15,744
Peas (green to harvest)	766,724	713,143	586,657	509,139	485,535	343,390	394,904
Marrowfats	79,350	36,732	38,849	39,585	69,187	45,673	27,964
Kidney beans	373,005	222,094	112,590	109,903	138,311	200,645	133,474
Broad and field beans	316,912	53,220	67,916	44,111	59,160	56,361	49,108
Grass seed	2,631,440	2,189,274	2,196,001	2,763,858	1,772,897	1,268,029	1,054,813
Rape seed	841,501	149,268	85,416	209,640	266,705	262,764	202,615
Caraway seed	34,158	121,059	13,806	9,034	9,341	11,087	12,937
Pop seed	26,356	141,119	58,806	28,286	67,873	70,837	50,829
Flax seed	553,468	440,738	437,930	473,339	216,061	189,613	215,619
Seed potatoes on sand or peat	548,553	536,058	709,599	352,313	341,500	336,534	385,463
Seed potatoes on clay	3,010,113	3,243,815	3,470,553	3,573,898	3,472,669	3,517,178	3,405,649
Potatoes on sand or peat	1,602,484	1,845,122	2,563,153	1,926,935	2,109,757	2,200,423	2,209,662
Potatoes on clay	6,086,924	6,170,599	6,180,900	4,656,037	4,942,270	5,103,070	5,051,063
Industrial potatoes	6,283,773	6,134,453	5,095,818	5,069,191	4,656,973	4,669,789	4,916,758
Sugar beets	12,499,462	11,608,057	11,099,810	9,131,265	7,270,147	7,058,416	7,332,911
Fodder beets	302,286	157,602	89,094	53,195	32,887	34,255	26,183
Lucerne	596,017	583,627	661,606	587,842	571,237	642,243	638,848
Green maize	20,181,089	21,921,725	20,532,074	23,508,819	24,197,217	23,076,537	22,963,655
Green manure	728,159	1,224,765	261,452	3,101,990	367,930	359,431	324,606
Grain maize		900,542	2,029,838	2,074,849	1,890,381	1,709,129	1,656,957
Corn cob mix		500,473	721,918	667,841	764,480	726,487	612,792
Chicory			475,596	433,848	441,616	468,640	319,574
Hemp			79,197	10,043	89,199	114,217	89,010
Onions	1,282,770	1,608,194	1,997,942	2,252,034	2,602,629	2,886,590	2,984,210
Other horticultural crops	808,437	598,220	1,088,320	1,186,888	870,402	1,063,448	792,473
Strawberry	186,688	176,313	174,568	230,089	305,475	311,100	321,133
Endive	23,392	27,629	25,198	27,971	21,044	21,136	23,850
Asparagus	266,313	232,356	208,408	233,366	261,998	269,453	292,248
Gherkin	25,738				48,593	49,189	47,768
Cabbage for preservation	157,620	178,353	152,753	139,794			
Cauliflower	236,792	242,970	216,038	239,408	240,026	236,926	226,723
Broccoli		53,379	84,602	131,115	197,874	196,558	207,990
Cabbage (spring and autumn)	100,151	113,850	101,629	107,505	278,903	275,274	277,463
Celeriac	136,263	141,421	128,519	112,772	122,325	131,064	164,954
Beetroot		35,349	29,015	27,619	41,527	40,509	49,594
Lettuce	95,475	104,217	108,978	130,353	195,592	191,408	193,874
Leeks	287,307	385,356	318,448	272,537	292,615	284,260	274,776
Scorzonera	139,536	148,006	113,796	86,697	111,817	85,167	84,387
Spinach	115,291	96,500	120,827	91,431	138,357	136,307	152,931
Brussels sprouts	480,319	438,811	483,409	309,508	299,714	294,997	291,704
Industrial French beans	369,501	467,764	362,736	425,410	291,995	275,278	228,021
Runner beans	22,493				5,935	4,440	5,184
Broad beans green	117,770	87,716	69,416	78,984	159,738	114,368	139,263
Carrot	302,983	327,442	298,512	255,140	268,781	240,223	284,484
Winter carrot (Danvers)	295,050	467,490	472,875	470,043	574,224	556,760	610,096
Chicory	591,896	388,881	419,858	342,321	301,247	301,631	327,208
Other outside horticultural crops	277,358	286,665	317,125	431,248	315,016	300,675	332,332

Table A8.12 N content per crop, crop residue and N fixation for crops.

	N content kg N/ha	Crop residue Fraction	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 (GWP) for selected greenhouse gases (kg CO_2 eq/kg)

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	1,0100
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

AAU	Assigned Amount Unit
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 (CRF code)
CO	Coke Oven (gas)
CS	Country-Specific (CRF code)
Cap	capita (person)
CBS	Statistics Netherlands
CDM	Clean Development Mechanism (one of three mechanisms of the Kyoto Protocol)
CER	Certified Emission Reductions
CHP	Combined Heat and Power
CLRTAP	Convention on Long-Range Transboundary Air Pollution (UN-ECE)
CORINAIR	CORe INventory AIR emissions
CPR	Commitment Period Reserve
CRF	Common Reporting Format (of emission data files, annexed to an 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)
EMEP	European programme for Monitoring and Evaluation of long-range transmission of air Pollutants
EMS	Emission Monitor Shipping
ENINA	Task Group Energy, Industry and Waste Handling
EPA	US Environmental Protection Agency
ER-I	Emission Registration, Individual firms
ERT	Expert Review Team
ERU	Emission Reduction Unit
ET	Emissions Trading
ETC/ACC	European Topic Centre on Air and Climate Change
ETS	Emission Trading System
EU	European Union
EZ	Ministry of Economic Affairs (formerly EL&I and LNV)
FAD	Forest According to Definition
FADN	Farm Accountancy Data Network
FAO	Food and Agricultural Organisation (UN)
F-gases	Group of fluorinated compounds comprising HFCs, PFCs and SF_6

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 (CRF code)
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
IWWTP	Industrial Wastewater Treatment Plant
KNMI	Royal Netherlands Meteorological Institute
l-CER	Long-term Certified Emission Reductions
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 (CRF code); also: National Approach
NACE	statistical classification of economic activities in 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 (CRF code)
NEa	Dutch emissions authority
NEAT	Non-Energy CO_2 emissions Accounting Tables (model of NEU-CO_2 Group)
NEC	National Emission Ceilings
NGE	Nederlandse grootte-eenheid
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	Organization 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
RMU	Removal Unit
ROB	Reduction Programme on Other Greenhouse Gases
SA	Sectoral Approach; also called 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
t-CER	Temporary Certified Emission Reductions
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 Nations 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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Report 680355013/2013

The total greenhouse gas emissions from the Netherlands in 2011 decreased by approximately 7% compared to the emissions in 2010. This decrease is mainly the result of decreased fuel combustion in the energy sector (less electricity production) and in the petrochemical industry. Emissions from space heating decreased due to the mild winter compared to the very cold 2010 winter.

In 2011, total direct greenhouse gas emissions (excluding emissions from LULUCF – land use, land use change and forestry) in the Netherlands amount to 194.4 Tg CO_2 eq. This is approximately 9% below the emissions in the base year (213.2 Tg CO_2 eq).

This report documents the 2013 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 the 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.

This is a publication of:

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April 2013

005126