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

Greenhouse gas emission in The Netherlands 1990-2012

Greenhouse Gas Emissions in the Netherlands 1990-2012

National Inventory Report 2014

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Colophon

Greenhouse gas emissions in The Netherlands 1990-2012
National Inventory Report 2014

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Greenhouse gas emissions in the Netherlands 1990–2012
National Inventory Report 2014

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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 2012].

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Many colleagues from a number of organizations (CBS, EC-LNV, LEI, Alterra, Netherlands Enterprise Agency (formerly known as 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), Kees Versluijs, Jan-Peter Lesschen, Geerten Hengeveld and Peter Kuikman (Alterra, Land Use), Gerben Geilenkirchen (Transport), Romuald te Molder (Key Sources), Jan Dirk te Biesebeek, Monique Nijkamp (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

Publiekssamenvatting

In 2012 is de totale uitstoot van broeikasgassen van Nederland, zoals CO_2, methaan en lachgas, met ongeveer 1,7 procent gedaald ten opzichte van 2011. Deze daling komt vooral door een lager brandstofgebruik in de energiesector (toename import elektriciteit) en een afname van het wegtransport.

Cijfers

De totale broeikasgasemissie wordt uitgedrukt in CO_2-equivalenten en bedraagt in 2012 191,7 teragram (megaton of miljard kilogram) . Ten opzichte van de uitstoot in het Kyoto-basisjaar (213,2 Tg CO_2-equivalenten) is dit een afname van ongeveer 10 procent. Het basisjaar, dat afhankelijk van het broeikasgas 1990 of 1995 is, dient voor het Kyoto-protocol als referentie voor de uitstoot van broeikasgassen. De uitstoot van de overige broeikasgassen zoals lachgas en methaan is sinds het basisjaar met 51 procent afgenomen. De CO_2-uitstoot daarentegen is in deze periode met 4 procent gestegen.

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). In bovengenoemde getallen zijn deze zogeheten LULUCF-emissies (*Land Use, Land Use Change and Forestry*) niet meegenomen.

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 2012 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 Bewakingsmechanisme Broeikasgassen van de Europese Unie.

Trefwoorden: broeikasgassen, emissies, trends, methodiek, klimaat

Abstract

Total greenhouse gas emissions from the Netherlands in 2012 decreased by approximately 1.7 per cent, compared with 2011 emissions. This decrease is mainly the result of decreased fuel combustion in the Energy sector (increased electricity import) and in road transport.
In 2012, total direct greenhouse gas emissions (excluding emissions from LULUCF – land use, land use change and forestry) in the Netherlands amounted to 191.7 Tg CO_2 eq. This is approximately 10 per cent below the emissions in the base year (213.2 Tg CO_2 eq.). The 51% reduction in the non-CO_2 emissions in this period is counterbalanced by 4 per cent increase in CO_2 emissions since 1990.

This report documents the Netherlands' 2014 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

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

Contents

Samenvatting

Het National Inventory Report (NIR) 2014 bevat de rapportage van broeikasgasemissies (CO_2, N_2O, CH_4 en de F-gassen) over de periode 1990 tot en met 2012. De emissiecijfers in de NIR 2014 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.rvo.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 2013 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:

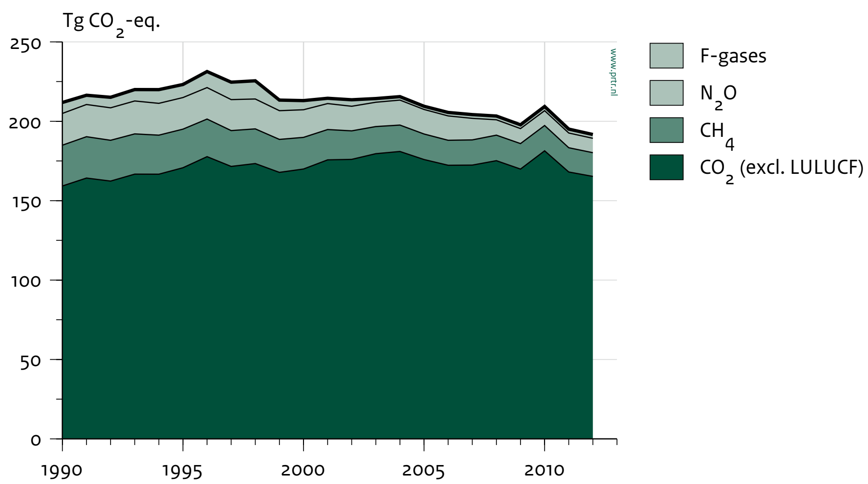
- trendanalyses voor de emissies van broeikasgassen in de periode 1990-2012;
- een analyse van zogenaamde sleutelbronnen en de onzekerheid in hun emissies volgens de 'Tier 1'-methodiek van de IPCC Good Practice Guidance;
- documentatie van gebruikte berekeningsmethoden, databronnen en toegepaste emissiefactoren;
- 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 zesde Nationale Communicatie onder het Klimaatverdrag, die eind 2013 is verschenen.

Figure ES.1 Broeikasgassen: emissieniveaus en emissietrends (exclusief LULUCF), 1990-2012.



Ontwikkeling van de broeikasgasemissies

De emissieontwikkeling in Nederland wordt beschreven en toegelicht in dit National Inventory Report (NIR 2014). Figuur ES.1 geeft het emissieverloop over de periode 1990-2012 weer. De totale emissies bedroegen in 2012 circa 191,7 Tg (Mton ofwel miljard kg) CO_2 equivalenten en zijn daarmee circa 10 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 4 procent toegenomen, terwijl de emissies van de andere broeikasgassen met circa 50 procent zijn afgenomen ten opzichte van het basisjaar.

In 2012 daalde de CO_2 emissie met circa 2 procent (ten opzichte van het jaar 2011) ten gevolge van een daling van het brandstofgebruik in de energiesector, de petrochemische industrie en ten behoeve van ruimteverwarming. De emissie van CH_4 daalde in 2012 licht ten opzichte van 2011, met ongeveer 2 procent. De N_2O emissie daalde eveneens in 2012 met circa 2 procent ten gevolge van ontwikkelingen in de landbouw. De emissie van F-gassen daalden in 2012 met 2 procent ten opzichte van 2011. De totale emissie van broeikasgassen in 2012 ligt daarmee 2 procent lager dan het niveau in 2011.

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 2012 is geschat op circa 2 procent; dat wil zeggen dat de emissietrend in die periode met 95 procent betrouwbaarheid ligt tussen de -8 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.rvo.nl/nie. De protocollen zijn opgesteld door Rijksdienst voor Ondernemend Nederland (voorheen 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 zijn in de emissieberekeningen voor de jaren 2008 tot en met 2012 gehanteerd. In deze submissie zijn een aantal kleine methodewijzigingen doorgevoerd als follow up van de reviews (EU en UNFCCC) van respectievelijk de NIR 2012 en NIR 2013. 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' 2014 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 are aimed at facilitating verification, technical assessment and expert review of the inventory information by independent Expert Review Teams (ERTs) of the UNFCCC. The inventories should, therefore, 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) 2014, therefore, provides explanations of the trends in greenhouse gas emissions, activity data and (implied) emission factors for the period 1990–2012. It also summarizes 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 Netherlands Environmental Assessment Agency (PBL) and the 6th National Communication (NC6) 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 http://english.rvo.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 adds up to 95 per cent of the national total, are 32 sources for annual level assessment and 33 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 the 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 43 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, 5 key categories are found in the Land use, land use change and forestry (LULUCF) sector (sector 5), after inclusion of 9 LULUCF subcategories in the key category analysis.

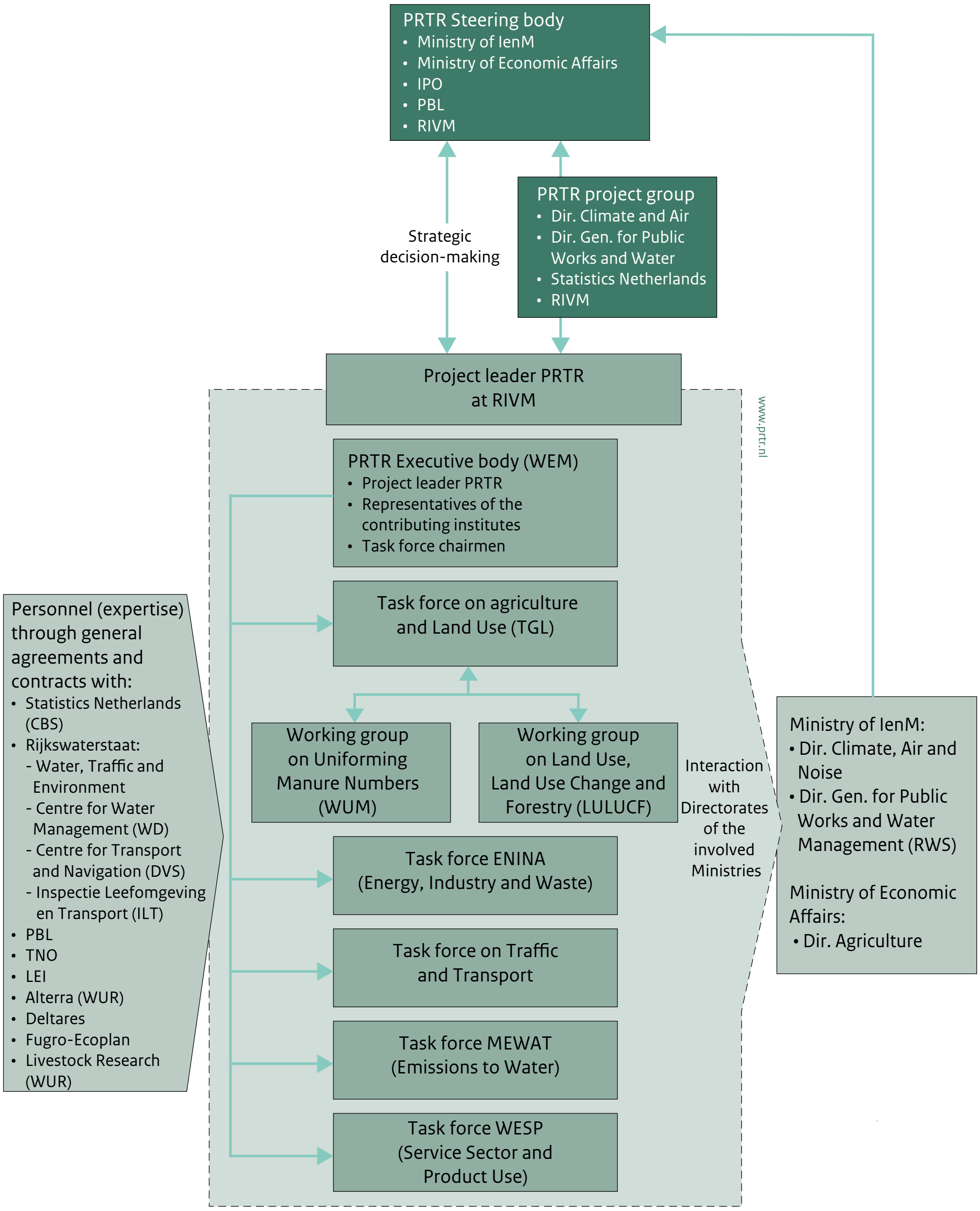
Institutional arrangements for inventory preparation

The greenhouse gas inventory of the Netherlands is based on the national Pollutant Release and Transfer Register (PRTR). The general process of inventory preparation has existed for many years and is organized as a project with an annual cycle. In 2000, an improvement programme was initiated under the leadership of the Netherlands Enterprise Agency (formerly known as NL Agency) to transform the general process of the greenhouse gas inventory of the PRTR into a National System, in accordance with 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 completion of the CRF (see Figure ES.2). The Netherlands Enterprise 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

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

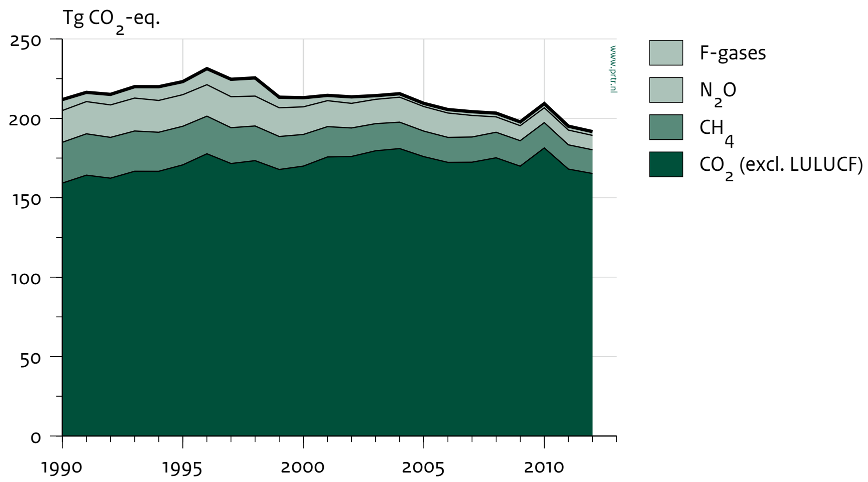


for sinks, the methodologies and processes are elaborated, reassessed and revised where required. The final revision was done after review of the National System (including the protocols). The present CRF/NIR is based on methodologies approved during/after the review of the National System and the calculation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

Organization of the report

This report is in line with the prescribed NIR format, starting with an introductory Chapter 1, which contains 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 (EFs) and a description of the quality assurance system, along with verification activities applied to the data. Chapter 2 provides a summary of trends for

Figure ES.3 An overview of the emission trends for greenhouse gas emissions (excl. LULUCF) 1990-2012.



aggregated greenhouse gas emissions by gas and by the main source. Chapters 3 to 9 present detailed explanations for emissions in different sectors. Chapter 10 presents information on recalculations, improvements and responses to issues raised in former reviews and the UNFCCC desk review of the NIR 2013. In addition, the report provides detailed information on key categories, methodologies and other relevant reports in 10 annexes. In part II of this report, the supplementary information required under Article 7, paragraph 1 of the Kyoto Protocol is reported.

ES2 Summary of national emissions and removal-related trends

In 2012, total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands were estimated at 191.7 Tg CO2 equivalents (CO_2 eq). This is approximately 10 per cent below the emissions in the base year (213.2 Tg CO_2 eq). In the Netherlands, the base year emissions are 1990 for CO_2, CH_4 and N_2O and 1995 for fluorinated gases. CO_2 emissions (excluding LULUCF) increased by about 4 per cent from 1990 to 2012, mainly due to the increase in the emissions in the 1A1a (Public electricity) and 1A3 (Transport) categories. CH_4 emissions decreased by 42 per cent in 2012, compared with the 1990 level, mainly due to a decrease in the Waste sector and the Agricultural sector and in fugitive emissions in the Energy sector. N_2O emissions decreased by 55 per cent in 2012 compared with 1990, mainly due to a decrease in emissions from Agriculture and from Industrial processes, which partly compensated for N_2O emission increases from fossil fuel combustion (mainly from transport). The emissions of fluorinated greenhouse gases (HFCs, PFCs and SF_6) decreased in the period 1995 (chosen as the base year) to 2012 by, respectively, 66 per cent, 92 per cent and 32 per cent. Total emissions of all F-gases decreased by approximately 71 per cent compared with the 1995 level. Between 2011 and 2012, CO_2 emissions decreased (excluding LULUCF) by 2.7 Tg. The emissions of CH_4 also showed a decrease of 0.3 Tg between the years 2011 and 2012. In this period, the N_2O emissions decreased by 0.2 Tg CO_2 eq. Emissions of HFCs and PFCs did not change significantly in 2012. SF_6emissions increased by 0.05 Tg CO_2.

Overall, total greenhouse gas emissions decreased by about 1.7 per cent compared to 2011.

ES3 Overview of source and sink category emission estimates and trends

Tables ES.1 and ES.2 provide an overview of the emissions trends (in CO_2 equivalents) per gas and per IPCC source category. The Energy sector (category 1) is by far the largest contributor to national total greenhouse gas emissions. The emissions of this sector increased substantially compared 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) and 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.

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	214.9	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	25.3	20.7	5.0	2.1	0.1	222.7	220.0
1994	169.3	166.7	24.6	20.0	6.5	2.0	0.2	222.6	219.9
1995	173.5	170.7	24.3	19.9	6.0	1.9	0.3	226.0	223.2
1996	180.3	177.7	23.7	19.8	7.7	2.2	0.3	234.0	231.3
1997	174.4	171.5	22.6	19.5	8.3	2.3	0.3	227.5	224.6
1998	176.2	173.4	21.8	18.8	9.3	1.8	0.3	228.3	225.5
1999	170.6	167.8	20.8	18.1	4.9	1.5	0.3	216.2	213.3
2000	172.2	169.9	19.9	17.4	3.9	1.6	0.3	215.4	213.0
2001	177.9	175.7	19.1	16.3	1.6	1.5	0.3	216.8	214.5
2002	178.2	176.0	18.0	15.5	1.7	2.2	0.2	215.8	213.5
2003	181.8	179.6	17.1	15.3	1.5	0.6	0.2	216.6	214.3
2004	183.2	181.0	16.6	15.7	1.6	0.3	0.3	217.8	215.5
2005	178.1	175.9	16.1	15.5	1.5	0.3	0.2	211.7	209.4
2006	174.5	172.3	15.7	15.3	1.7	0.3	0.2	207.8	205.6
2007	174.6	172.4	15.8	13.6	1.9	0.3	0.2	206.4	204.2
2008	177.3	175.2	16.1	9.7	1.9	0.3	0.2	205.5	203.3
2009	173.0	169.9	16.0	9.5	2.1	0.2	0.2	201.0	197.8
2010	184.6	181.4	15.9	9.3	2.3	0.2	0.2	212.6	209.3
2011	171.4	168.1	15.3	9.3	2.1	0.2	0.1	198.5	195.1
2012	168.7	165.3	14.9	9.1	2.1	0.2	0.2	195.2	191.7

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	214.9	211.8
1991	158.9	21.2	0.5	23.0	2.7	12.9	NA	219.1	216.4
1992	157.5	21.5	0.5	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	222.6	219.9
1995	165.7	23.6	0.4	22.2	2.8	11.3	NA	226.0	223.2
1996	173.4	24.8	0.4	21.8	2.7	10.9	NA	234.0	231.3
1997	166.2	26.1	0.4	21.3	2.9	10.6	NA	227.5	224.6
1998	168.1	26.5	0.4	20.4	2.8	10.2	NA	228.3	225.5
1999	162.4	21.2	0.4	19.9	2.9	9.4	NA	216.2	213.3
2000	164.7	20.3	0.3	18.8	2.4	8.9	NA	215.4	213.0
2001	171.0	16.7	0.3	18.4	2.3	8.1	NA	216.8	214.5
2002	171.3	17.1	0.3	17.5	2.3	7.4	NA	215.8	213.5
2003	174.8	15.5	0.2	17.1	2.3	6.7	NA	216.6	214.3
2004	176.1	16.0	0.2	17.1	2.3	6.2	NA	217.8	215.5
2005	171.0	15.8	0.2	16.9	2.3	5.6	NA	211.7	209.4
2006	167.8	15.5	0.2	16.9	2.3	5.2	NA	207.8	205.6
2007	167.6	14.8	0.2	16.7	2.2	4.9	NA	206.4	204.2
2008	171.5	10.2	0.2	16.8	2.2	4.6	NA	205.5	203.3
2009	166.6	10.0	0.2	16.7	3.2	4.4	NA	201.0	197.8
2010	177.9	10.4	0.2	16.7	3.3	4.1	NA	212.6	209.3
2011	164.4	10.4	0.2	16.1	3.4	3.9	NA	198.5	195.1
2012	161.9	9.9	0.2	15.9	3.5	3.7	NA	195.2	191.7

ES4 Other information

General uncertainty evaluation

The results of the uncertainty estimation according to the IPCC Tier 1 uncertainty approach are summarized in Annex 1 of this report. The Tier 1 estimation of annual uncertainty in CO_2 eq emissions results in an overall uncertainty of 3 per cent, based on calculated uncertainties of 2 per cent, 16 per cent, 43 per cent and 40-42 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 non-reported sources. Therefore, the actual uncertainty of total annual emissions per compound and of the grand total will be somewhat higher; it is currently estimated by RIVM at:

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

Annex 1 summarizes the estimate of the trend uncertainty 1990–2012 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 1990–2012 (1995 for F-gases) of ±2 percentage points. This means that the trend in total CO_2 eq emissions between 1990 and 2012 (excluding LULUCF), which is calculated to be a 10 per cent decrease, will be between a 12 per cent decrease and an 8 per cent decrease. Per individual gas, the trend for uncertainty in total emissions of CO_2, CH_4, N_2O and the total group of F-gases has been calculated at ±2 per cent, ±5 per cent, ±8 per cent and ±13 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 almost all sources identified by the revised Intergovernmental Panel on Climate Change (IPCC) Guidelines (IPCC, 1996). As of this submission, we included new emission estimates for enteric fermentation and manure management for mules and asses.
The following very minor sources are not included in the inventory:

- 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 2014 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 finalized in December 2005. In past years, the results of various improvement actions have been implemented in the methodologies and processes of the preparation for the greenhouse gas inventory of the Netherlands. Compared with the NIR/CRF 2013 and based on the results of the UNFCCC reviews, some improvements of the inventory (including minor recalculations) were undertaken in the last year. The main methodological change was in the agricultural sector. 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 2014 compared with the NIR 2013.

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 2012 by 56 per cent and 69 per cent, respectively. For SO_2, the reduction was 83 per cent and, for NO_x, the 2012 emissions were 59 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 2012 for all sources.

Table ES.3 Differences between NIR 2013 and NIR 2014 due to recalculations and the resubmitted data from October 2013 (Unit: Tg CO_2 eq, F-gases: Gg CO_2 eq).

Gas	Source	1990	1995	2000	2005	2009	2010	2011
CO_2 (Tg)	NIR 2014	**162.2**	173.5	172.2	178.1	173.0	184.6	171.4
Incl. LULUCF	NIR 2013	**162.2**	173.6	172.8	178.9	172.7	184.4	170.8
	Difference	0.0%	0.0%	-0.4%	-0.5%	0.2%	0.1%	0.3%
CO_2 (Tg)	NIR 2014	**159.2**	170.7	169.9	175.9	169.9	181.4	168.1
Excl. LULUCF	NIR 2013	**159.2**	170.7	169.9	175.9	169.9	181.4	167.6
	Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
CH_4 (Tg)	NIR 2014	**25.7**	24.3	19.9	16.1	16.0	15.9	15.3
	NIR 2013	**25.7**	24.3	19.9	16.1	16.1	15.9	15.3
	Difference	0.0%	-0.2%	0.1%	-0.2%	-0.6%	0.1%	0.1%
N_2O (Tg)	NIR 2014	**20.0**	19.9	17.4	15.5	9.5	9.3	9.3
	NIR 2013	**20.0**	19.9	17.4	15.4	9.4	9.2	9.1
	Difference	0.0%	0.1%	0.4%	0.6%	1.1%	2.4%	1.9%
PFCs (Gg)	NIR 2014	2264	**1938**	1581	265	168	209	183
	NIR 2013	2264	**1938**	1581	265	168	209	183
	Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HFCs (Gg)	NIR 2014	4432	**6019**	3891	1511	2070	2257	2132
	NIR 2013	4432	**6019**	3892	1512	2072	2260	2133
	Difference	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%
SF_6 (Gg)	NIR 2014	218	**287**	295	240	170	184	147
	NIR 2013	218	**287**	295	240	170	184	147
	Difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	NIR 2014	214.9	226.0	215.4	211.7	201.1	212.6	198.5
(Tg CO_2 eq.)	NIR 2013	214.8	226.0	215.9	212.5	200.7	212.2	197.6
Incl. LULUCF	*Difference*	0.0%	0.0%	-0.2%	-0.4%	0.1%	0.2%	0.4%
Total	NIR 2014	211.8	223.2	213.0	209.4	197.8	209.3	195.1
[Tg CO_2 eq.]	NIR 2013	211.8	223.2	213.0	209.5	197.9	209.2	194.4
Excl. LULUCF	*Difference*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	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	2012
Total NO_x	567	469	387	325	256	230
Total CO	1,259	971	865	686	602	557
Total NMVOC	479	340	237	170	166	144
Total SO_2	198	138	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 took effect 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 2012 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 out from the coastline and also inland water bodies. It excludes Aruba, Curaçao and Sint Maarten, which are constituent countries of the Kingdom of the Netherlands. It also excludes 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 2012 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 (IPCC, 2003). 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, Fifth and Sixth 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), the 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 organizations 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 latter three are called 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 1990–2012 period and summarizes 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 according to Article 5.1 of the Kyoto Protocol, methodologies were established (and documented) in monitoring protocols. These protocols are annually reassessed and revised, if needed – e.g. based on recommendations of UN reviews. The monitoring protocols and the general description of the National System are available on the website http://english.rvo.nl/nie. The emissions reported in the NIR 2014 are based on these methodologies, which have been incorporated in the National System for greenhouse gases. The emissions are also available, with a delay of some months, 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 2013. The National System has remained unchanged with the exception of an organizational change made on 1 January 2010. On that date, co-ordination of the aforementioned PRTR (emissions registration) project shifted from the PBL (Netherlands Environmental Assessment Agency) to RIVM (National Institute for Public Health and the Environment). In 2010, arrangements were made to ensure the quality of the products of the PRTR project in the new setting.

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

Greenhouse gas emissions presented in this report are given in gigagrams (Gg) and teragrams (Tg). Global warming potential (GWP) weighted 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-2014-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 and this report comprise the National Inventory Report (NIR) and are published on the website http://english.rvo.nl/nie.
Other information, such as the 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 1990–2012 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 pertains to activities under Article 3, paragraph 3. Information on the accounting of Kyoto units is also provided in the SEF file SEF_NL_2014_1_13-52-30 13-1-2014.xls.

1.2 Institutional arrangements for inventory preparation

1.2.1 Overview of institutional arrangements for the inventory preparation

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

In August 2004, the IenM assigned SenterNovem (now Netherlands Enterprise Agency) executive tasks bearing on the National Inventory Entity (NIE), the single national entity required under the Kyoto Protocol. In December 2005, the Netherlands Enterprise Agency was designated by law as the NIE. In addition to co-ordinating the establishment and maintenance of a National System, the tasks of the Netherlands Enterprise 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 greater detail in the Fourth, Fifth and Sixth National Communications (VROM 2006b, 2009).

Since 1 January 2010, RIVM has been assigned by the IenM as the co-ordinating institute for compiling and maintaining the pollutants emission register/inventory (PRTR system), which contains approximately 350 pollutants, including the greenhouse gases. The PRTR project system is used as the basis for the NIR and for completing the CRF. After the general elections held 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 approximately 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 also serves as the basis for the national greenhouse gas inventory. The overall co-ordination of the PRTR is outsourced by the Ministry of IenM to RIVM.

The main objective of the PRTR is to produce an annual set of unequivocal emission data that is up-to-date, complete, transparent, comparable, consistent and accurate. In addition to RIVM, various external agencies contribute to the PRTR by performing calculations or submitting activity data. These include: CBS (Statistics Netherlands), PBL (Netherlands Environmental Assessment Agency), TNO (Netherlands Organization 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 RIVM as part of the PRTR project. Most institutes involved in the PRTR also contribute to the NIR (including CBS and TNO). In addition, the Netherlands Enterprise Agency is involved in its role as NIE. The Netherlands Enterprise 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 Ministry of 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, as required according to Article 2 of the Kyoto Protocol, is reported in the NIR part 2. This information is prepared by the Netherlands Enterprise Agency using information from various other organizations involved, such as the NEa (Dutch Emissions Authority), the WUR and the Ministry of 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 summarized in Figure 1.1. This process comprises three major steps, which are described in greater 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 Task Force Agriculture) oversees data management, the preparation of the reports for LULUCF, and the QA/QC activities, and decides on further improvements.

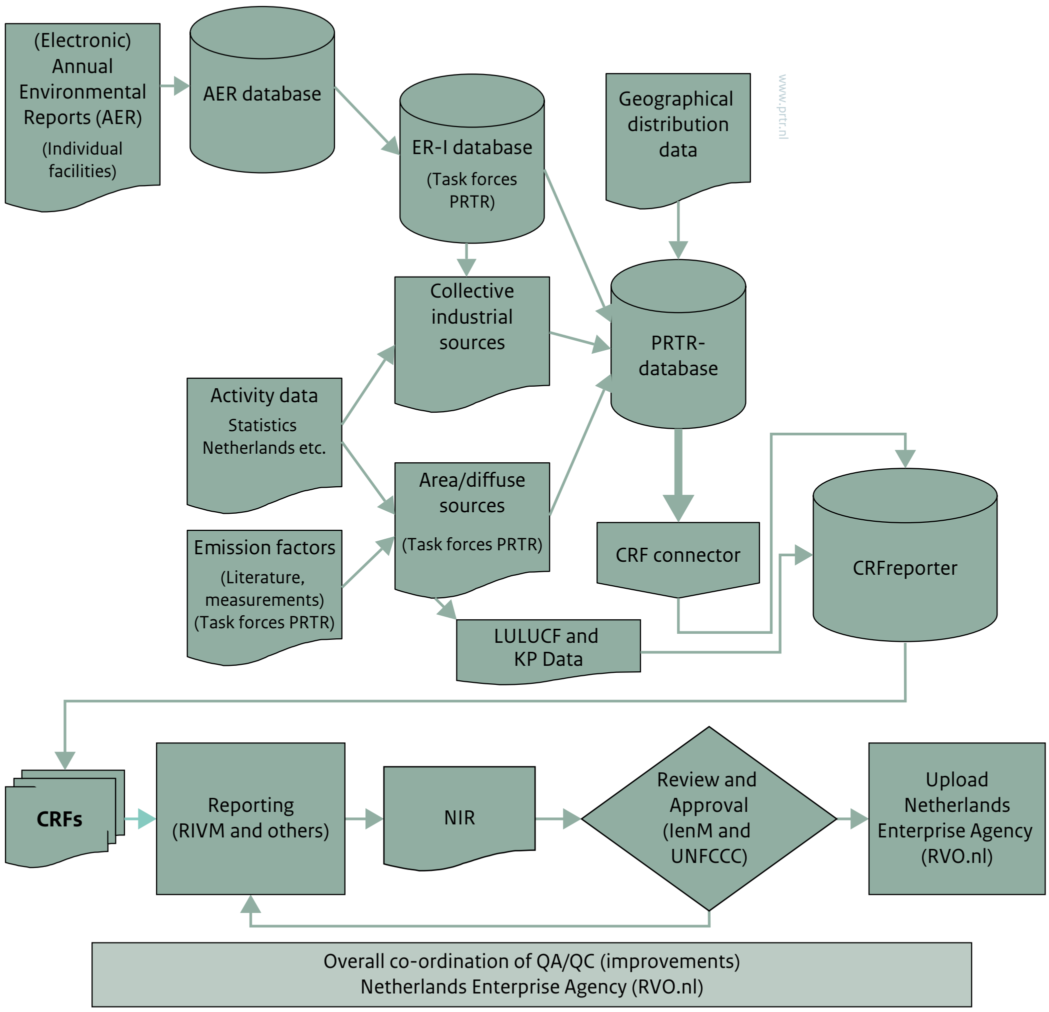
1.3.2 Data collection processing and storage

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

Figure 1.1 Main elements in the greenhouse gas inventory process.



arrangements. These include national statistics from Statistics Netherlands (CBS) and a number of other sources of data on sinks, water and waste. The provision of relevant data for greenhouse gases is guaranteed through covenants and an Order in Decree, the latter being prepared by the Ministry of 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 Economic Affairs (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). 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. Whenever 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 AERs, as are the calculated emissions from precursor gases (CO, NO_x, NMVOC and SO_2). As reported in previous NIRs, only those AERs with high-quality and transparent data are used as a basis for calculating total source emissions in the Netherlands.

Additional greenhouse gas-related data

Additional greenhouse gas-related data are provided by other institutes and consultants that are specifically contracted to provide information on sectors not sufficiently covered by the above-mentioned data sources. For greenhouse gases, contracts and financial arrangements are made (by RIVM) with, for example, various agricultural institutes and TNO. In addition, the Netherlands Enterprise Agency contracts out various tasks to consultants (such as collecting information on F-gas emissions from cooling and product use, and on contracts to improve the methods). During 2004, the ministry of EZ so 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 EZ and RIVM, these activities are also part of the PRTR.

Data Processing and storage

Data processing and storage are co-ordinated by 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 for 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 or source categories:

- 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 – RIVM, 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. RIVM commissioned TNO to assist in the compilation of the CRFs.

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

The NIR is prepared by RIVM with input from the relevant PRTR Task Forces and from the Netherlands Enterprise Agency. The preparation of the NIR also includes the documentation and archiving of base data and QA/QC activities. The Ministry of IenM formally approves the NIR before it is submitted; in some cases approval follows consultation with other ministries. The Netherlands Enterprise 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. The Netherlands Enterprise Agency is also responsible (in collaboration with RIVM) for co-ordinating the submission of supporting data to the UNFCCC review process.

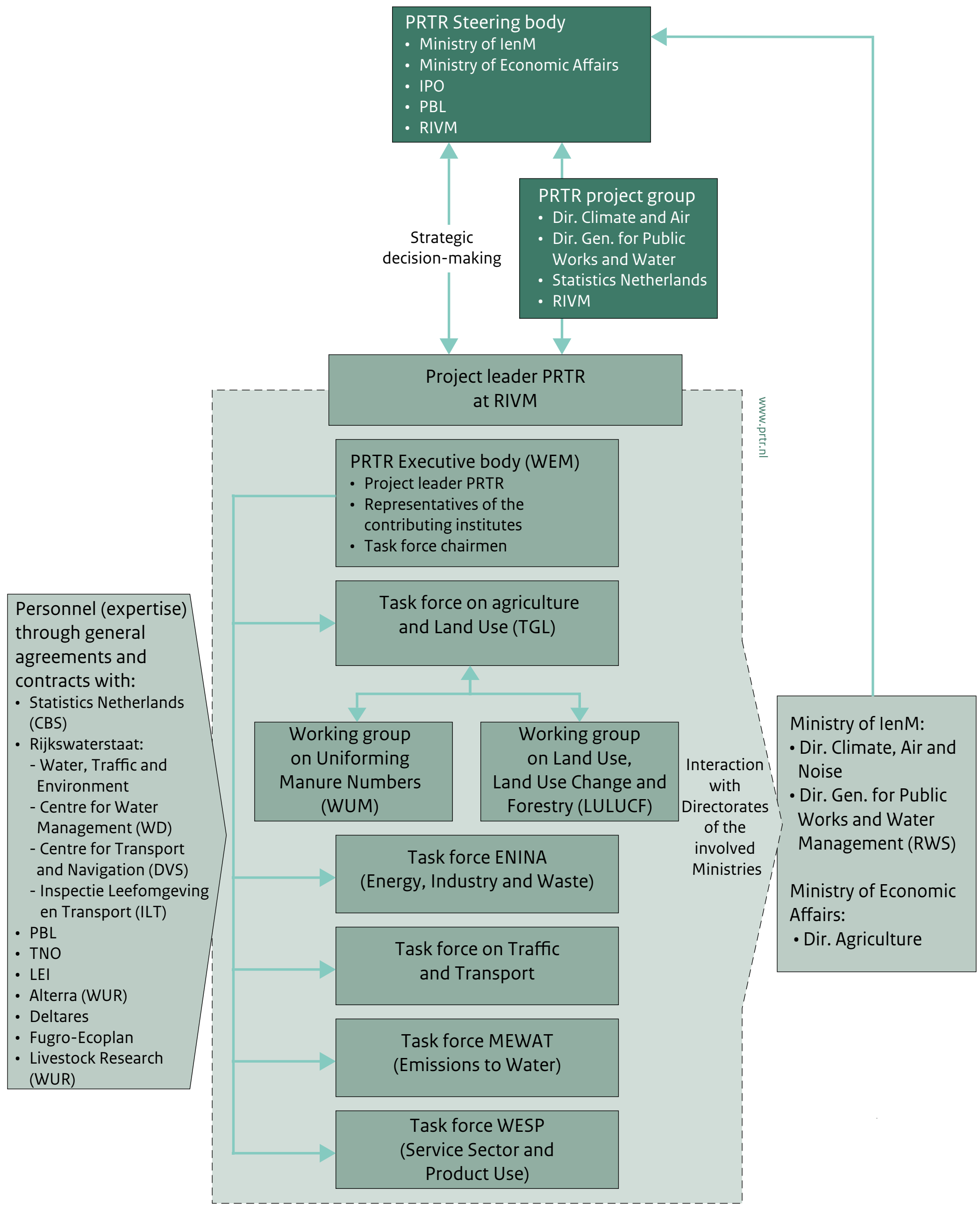
For KP-LULUCF, consistency with the values submitted for the Convention is assured by using the same base data and calculation structure. The data, as required in the KP-LULUCF CRF tables, are derived from these base data using specific calculations. The data and calculations are thus subject to the same QA/QC procedures (Arets et al., 2014).

The calculated values were generated in the LULUCF reporting system at Alterra and checked by the LULUCF sectoral expert. They were then sent to the Dutch inventory, which entered the data into the CRF database for all sectors and checked them again. 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 Organization of the United Nations (FAO). The total area of forest is systematically lower in the FAO estimates. This is the result of differences in the methodology used for data collection. For a more detailed discussion on the differences, see Nabuurs et al. (2005) and Arets et al, 2014. 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 reforested/afforested land give a conservative figure for net forest increase in the Netherlands.

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.

Figure 1.2 Organisational arrangements for PRTR-project.



Considering that different conversion factors were used, the estimates are close, while the difference has the tendency to widen. On the basis of the recently executed 6th Dutch Forest Inventory, the data reported to FAO and UNFCCC will be further aligned.

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, documenting the methodologies and data sources used in

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**	**OTH,T1,T1b,T2,T3**	**CS,D,OTH,PS**	**T1,T2**	**CS,D**
A. Fuel Combustion	D,T1,T2	CS,D	T1,T2,T3	CS,D	T1,T2	CS,D
1. Energy Industries	T2	CS,D	T1,T2	CS,D	T1,T2	CS,D
2. Manufacturing Industries and Construction	T2	CS,D	T1,T2	CS,D	T1	D
3. Transport	T1,T2	CS,D	T1,T2,T3	CS,D	T1,T2	CS,D
4. Other Sectors	T2	CS,D	T1,T2	CS,D	T1	D
5. Other	D,T2	D	T2	CS	T2	CS
B. Fugitive Emissions from Fuels	CS,T1,T2,T3	CS,D,PS	OTH,T1,T1b,T2,T3	CS,D,OTH,PS	NA	NA
1. Solid Fuels	T2	CS	OTH	OTH	NA	NA
2. Oil and Natural Gas	CS,T1,T2,T3	CS,D,PS	T1,T1b,T2,T3	CS,D,PS	NA	NA
2. Industrial Processes	**CS,T1,T1a,T1b,T2**	**CS,D,PS**	**CS,T1**	**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	D	T2	PS
C. Metal Production	T1a,T2	CS,D	NA	NA	NA	NA
D. Other Production	T1	CS				
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6						
G. Other	T1	D	CS	CS	CS	CS
3. Solvent and Other Product Use	**CS**	**CS**			**CS**	**CS**
4. Agriculture			**T1,T2**	**CS,D**	**T1,T1b,T2**	**CS,D**
A. Enteric Fermentation			T1,T2	CS,D		
B. Manure Management			T1,T2	CS,D	T2	D
C. Rice Cultivation			NA	NA		
D. Agricultural Soils			NA	NA	T1,T1b,T2	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,T1**	**CS,D**
A. Forest Land	CS,T1,T2	CS,D	CS	D	CS	D
B. Cropland	CS,T1	CS,D	NA	NA	D,T1	CS
C. Grassland	CS,T1,T2	CS,D	CS	D	CS	D
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	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						
C. Metal Production			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

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 notation keys used:

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

All key documents are electronically available in PDF format at http://english.rvo.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 of the methodologies applied for estimating the emissions for each key source.

Data sources

The monitoring protocols provide detailed information on the 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 (Energy Monitor); (2) natural gas and diesel consumption in the agricultural sector (Agricultural Economics Institute, LEI); (3) (residential) bio fuel data: national renewable energy statistics from CBS (Renewable Energy);
- Transport statistics: (1) monthly statistics for traffic and transport; (2) national renewable energy statistics from CBS (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;
- Fertilizer 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 digitized 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. It should be noted, however, 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, harmonized and validated digital topographical maps dated 1 January 1990, 2004, 2009 and 2013 were used (Kramer et al., 2009; Van den Wyngeart et al., 2012; Arets et al., 2014). The results were national scale land use and land-use change matrices (1990-2004, 2004-2009 and 2009-2013).
To distinguish between mineral soils and peat soils, overlays were made with 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 2013, whether it is located on a mineral soil or on an organic soil and, if on a mineral soil, what the aggregated soil type is.

Data sources

The changes in land use are based on comparisons of detailed maps that best represent land use on 1 January 1990, 2004, 2009 and 2013. All four data sets on land use were especially developed to support the temporal and spatial development in land use. The first three maps were especially designed to support policy in the field of nature conservation, while the 2013 land-use map was specifically designed for KP-LULUCF to support the end-of-period reporting. The methodology, however, is the same used for the 2009 map.

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.

Distinct from the key source analysis for the NIR 2013 submission, one new key category is identified:

- 5B2 Land converted to cropland (CO_2)

1B1b Coke production (CO_2) is no longer a key source. This is due to the use of new emission data and (in the case of 1B1b) new data on uncertainty.

1.5.2 KP-LULUCF inventory

With -510.51 Gg CO_2, the annual contribution of reforestation/afforestation under the Kyoto Protocol is below the smallest key category (Tier 1 level analysis including LULUCF). Deforestation under the Kyoto Protocol in 2012 causes an emission of 873.63 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 finalized and established at the end of 2005. As part of this system, the Act on the Monitoring of Greenhouse Gases also took effect 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 should be based on methodologies and processes laid down in the monitoring protocols. In a subsequent regulation, the Minister appointed the Netherlands Enterprise Agency (formerly known as the 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, 2013) are briefly summarized in this chapter, notably those related to the current NIR.

1.6.1 QA/QC procedures for the CRF/NIR 2014

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 of and procedures for 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.

- Several 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 given by the Task Forces 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 reassess and update both the information on uncertainties and the information on sector-specific QC activities (Ecofys, 2010). The PRTR Task Forces continue to work on the implementation of the recommendations from this report in 2014, 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 2014, changes were incorporated in and references were updated to the National System website (http://english.rvo.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 are aimed at covering issues such as the consistency, completeness and correctness of the CRF data. The general QC for the present inventory was largely performed at the institutes involved as an integrated part of their PRTR work (Wever, 2012). The PRTR Task Forces fill in a standard-format database with emission data for 1990–2012 (with the exception of LULUCF). After a first check of the emission files by RIVM and TNO for completeness, the (corrected) data are available to the specific Task Force for 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 organized by RIVM (December 2013; see Box 1.1). The result of this workshop, including actions for the Task Forces to resolve the identified clarification issues, are documented at RIVM. Required changes to the database are then made by the Task Forces.
Basic LULUCF data (e.g. forest inventories, forests statistics and land-use maps) have a different routing compared 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 2014. Results of this review are summarized 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 include the results of the 2013 review (see Chapter 10.4 for an overview).

The QA/QC activities generally aim at achieving 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 means, the focal points of the QA/QC activities are:

- The *QA/QC programme* (NL Agency, 2013) 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 the implementation of the activities. It is updated annually as part of an 'evaluation and improvement cycle' for the inventory and National System and is kept available for review.
- The *adaptation of the PRTR project to the quality system* of RIVM (ISO 9001:2008 system), completed in 2012;
- The annual *project plan* of RIVM (RIVM, 2013). 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 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 consolidation of the database following approval of the involved institutions.
  - Documentation of the consistency, completeness and correctness of the CRF data (also see 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 the Netherlands Enterprise Agency and institutions not fundamentally involved in the PRTR process;
  - Public review of the draft NIR: Every year, the Netherlands Enterprise Agency organizes 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 will inform RIVM concerning possible internal audits. Furthermore, the Netherlands Enterprise Agency is assigned the task of organizing audits, if needed, of relevant processes or organizational issues within the National System. The next audit (on waste) has been scheduled for the end of March 2014.
  - Archiving and documentation: Internal procedures are agreed (in the PRTR annual activity programme, amongst others) for general data collection and the storage of fixed datasets in the RIVM database, including the documentation/archiving of QC checks. As of the 2012 submission, the RIVM database holds storage space where the Task Forces can store the crucial data for their emission calculations. The use of this feature is voluntary, as storage of essential data is also guaranteed by the quality systems at the outside agencies.
  - The improved monitoring protocols have been documented and will be published on the website http://english.rvo.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. The Netherlands Enterprise 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.
- *Annual inventory improvement:* Within the inventory project, there are resources available to keep the total inventory up to the latest standards. In an annual cycle, the taskforces are invited to draft proposals to improve their emission estimations. All the proposals are ranked by priority in a consensus process and budgets are made available for the selected improvements. The available resources have to be shared between the different items of the inventory (GHG, CLRTAP and water emissions). GHG-related issues are given high priority when they relate to improvements of key source estimates and/or if the reviews ask for specific improvements in methods or activity data. Proposals for improvements that contribute to a decrease of the uncertainty surrounding the emission estimates are given higher priority than others. All planned improvements are documented in the annual work plan.
- *Evaluation*: 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 reviews and evaluations 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 reduce uncertainties substantially through independent verification (measurements) – at least not on a national scale – this issue has received less priority. In the PRTR project over the last two years, efforts have been made to reassess and update the assessment of uncertainties and the sector-specific QC activities. In the next submission, this will lead to a revised uncertainty assessment of Dutch GHG emissions.

In 2014, 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 approximately 40 per cent of the CO_2 emissions in the Netherlands in 2012. The differences could be explained reasonably (e.g. different scope) within the time available for this action (De Ligt, 2014).

1.6.2 Verification activities for the CRF/NIR 2014

Two weeks prior to a trend analysis meeting, a snapshot from the database was made available by 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 those 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 greater detail. The results of these checks were then brought up for 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 2012 were checked in two ways:

1. The datasets from previous years' submissions were compared with the current submission; emissions from 1990 to 2011 should (with some exceptions) be identical to those reported last year;
2. the data for 2012 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.

Table 1.2 Key items of the verification actions CRF/NIR 2014.

Item	Date	Who	Result	Documentation
Comparison sheets to check for accidentally changed historical data	3-12-2013	RIVM	Input for trend analyses	Historische reeksen vergeleken LUCHT versie 2 december 2013.xls
Comparison sheets dataset years 2011-2012	02-12-2013	RIVM	Input for trend analysis	Verschiltabel definitieve emissiecijfers 2 december 2013 LUCHT IPCC.xls
List of required actions (action list)	02-12-2013	RIVM	Input for trend analysis	Actiepuntendefinitieve cijfers 2012 v 2 december 2013.xls
Trend analysis	10-12-2013	Task Forces	Updated Action list	Actiepuntendefinitieve cijfers 2012 v 10 december 2013.xls
Resolving the issues of the Action list	Until 13-12-2013	Task Forces	Final data set	Actiepuntendefinitieve cijfers 2012 v 13 december 2013.xls
Comparison sheets to check for accidentally changed historical data	3-12-2013	RIVM/NIC/ TNO	Input for trend analyses	Historische reeksen vergeleken LUCHT versie 2 december 2013.xls
Comparison of data in CRF and EPRTR database	Until 10-01-2014	RIVM	Final CRF sent to the EU	RECALCULATIONS_MK2.xls And NLD-2014-v1.1.xml
Writing and checks of NIR	Until 1-04-2014	NIC/TNO	Draft texts	S:\\NI National Inventory Report\NIR 2014\NIR2014-werkversie
Generate tables for NIR from CRF	Until 1-04-2014	Task Forces/ NIC/TNO/NIE	Final text and tables NIR	NIR2014 Tables and Figures v4.xlsx

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 2013 showed the following issues per source category:
- Changes in historical emissions of the Oil and natural gas [1B2]
- category should be addressed in the Energy chapter.
- Changes in historical emissions of the Transport category should be addressed in the Energy chapter.
- The historical emissions of F-gases changed. Because detailed data became available in 2013, this should be documented.
- Changes in emissions in sector 4, Agriculture (whole time series), should be explained in Chapter 6.

All above-mentioned checks were included in the annual project plan for 2013 (RIVM, 2013). Furthermore, data checks (also for non-greenhouse gases) were performed. To facilitate the data checks and the trend verification workshop, three types of data sheets were prepared from the PRTR emissions database:
- Based on the PRTR emissions database, a table with a comparison of emissions in 2011 and 2012. In this table, differences of >5 per cent at sector level were marked for documenting trends;
- Based on the PRTR emissions database, a table with a comparison of the complete inventories of 2012 versus those of 2013, to check that no historical data had been accidentally changed;
- 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.

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 was 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 2014.
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 to by the two principal institutes: RIVM and Statistics Netherlands (CBS). The acceptance of the dataset was, furthermore, a subject of discussion in the PRTR executive body (WEM).

In the period from 15-1-2014 to 14-2-2014, the text of the NIR was improved based on internal reviews. The subsequent versions and all documentation (e-mails, data sheets and checklists) are stored electronically on a server at RIVM.

1.6.3 Treatment of confidentiality issues

Some of the data used in the compilation of the inventory are confidential and cannot be published in print or electronic format. For these, the Netherlands uses the code 'C' in the CRF. Although this requirement impairs the transparency of the inventory, all confidential data nevertheless can be made available to the official review process of the UNFCCC.

1.7 Evaluating general uncertainty

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

1.7.1 GHG inventory

The following information sources were used for estimating the uncertainty in activity data and emission factors (Olivier et al., 2009):

- Estimates used for reporting uncertainty in greenhouse gas emissions in the Netherlands that were discussed at a national workshop in 1999 (Van Amstel et al., 2000a);
- Default uncertainty estimates provided in the IPCC Good Practice Guidance (IPCC, 2001);
- RIVM fact sheets on calculation methodology and data uncertainty (RIVM, 1999);
- Other 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). The expert judgements are based on independent uncertainties estimates from experts. Their views were discussed to reach consensus estimates. This was followed by an estimation of the uncertainty in the emissions in 1990 and 2012 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 larger percentage was used in the calculation.

The results of the uncertainty calculation according to the IPCC Tier 1 uncertainty approach are summarized in Annex 7 of this report. The Tier 1 calculation of annual uncertainty in CO_2 equivalent emissions results in an overall uncertainty of approximately 3 per cent in 2012, based on calculated uncertainties of 2 per cent, 16 per cent, 43 per cent and 42 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 non-reported sources. Therefore, the Tier 2 uncertainty of *total annual emissions* per compound (and the total of all gases) 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 2012, 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 2012' in Table A7.1).

Comparing these data with the NIR 2013, 1A2 Stationary combustion: Manufacturing Industries and Construction, liquids has replaced 6A1 CH_4 emissions from solid waste disposal sites.
This is the result of using the new 2012 emission and uncertainty data. Table A7.1 of Annex 7 summarizes the estimate of the trend uncertainty for 1990–2012 calculated according to the IPCC Tier 1 approach in the IPCC Good Practice Guidance (IPCC, 2001). The result is a trend uncertainty in total CO_2-equivalent emissions (excluding LULUCF) for 1990–2012 (1995–2012 for F-gases) of ± 2 per cent. This means that the trend in total CO_2-equivalent

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

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

Table 1.4 Ten sources contributing most to total annual uncertainty in 2012.

IPCC category	Category	Gas	Combined uncertainty as a percentage of total national emissions in 2012
4D3	Indirect N2O emissions from nitrogen used in agriculture	N_2O	1.5%
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	1.1%
4D1	Direct N2O emissions from agricultural soils	N_2O	1.0%
1A1b	Stationary combustion: Petroleum refining: liquids	CO_2	1.0%
4B1	Emissions from manure management: cattle	CH_4	0.9%
1A4a	Stationary combustion: Other: Commercial/ Institutional, gases	CO_2	0.6%
4D2	Animal production on agricultural soils	N_2O	0.5%
4B	Emissions from manure management	N_2O	0.5%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	0.5%
1A4b	Stationary combustion: Other, Residential, gases	CO_2	0.5%

Table 1.5 Ten sources contributing most to trend uncertainty in the national total in 2012.

IPCC category	Category	Gas	Uncertainty introduced into the trend in total national emissions
4D3	Indirect N2O emissions from nitrogen used in agriculture	N_2O	1.6%
4D2	Animal production on agricultural soils	N_2O	0.8%
6A1	CH4 emissions from solid waste disposal sites	CH_4	0.7%
1A4a	Stationary combustion: Other Sectors: Commercial/ Institutional, gases	CO_2	0,7%
1A4b	Stationary combustion: Other, Residential, gases	CO_2	0.6%
1A4c	Stationary combustion: Other, Agriculture/Forestry/ Fisheries, gases	CO_2	0.5%
2F	Emissions from substitutes for ozone-depleting substances (ODS substitutes): HFC	HFC	0.5%
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	0.3%
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	0.3%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	0.3%

emissions between 1990 and 2012, which is calculated as -10 per cent (decrease), will be between -12 per cent and -8 per cent (increase).
For each 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, ±5 per cent, ±8 per cent and ±13 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 the calculated trend uncertainty 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, that for some sources activity data or EFs are correlated, which may change the overall uncertainty of the sum to an unknown extent. It is also known that for some sources the uncertainty is not distributed normally; particularly

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%

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 used in 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 (approximately 1.5 per cent higher) than the uncertainty for the 2004 emissions. Finally, the resulting distribution for total CO_2-equivalent emissions in the Netherlands turns out to be clearly positively skewed.

As part of the aforementioned 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, 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 have increased the 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 the 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 about 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 the 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. A more independent verification of the emissions level and emissions trends using, for example, comparisons with atmospheric concentration measurements is, therefore, 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 that were 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 estimated for the total time series (as a result of the UNFCCC reviews).

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

Forest fertilization does not occur in the Netherlands and therefore fertilization in reforested/afforested areas is reported as not occurring.

2 Trends in greenhouse gas emissions

2.1 Emissions trends for aggregated greenhouse gas emissions

Chapter 2 summarizes the trends in greenhouse gas emissions during the period 1990–2012 by greenhouse gas and by sector. Detailed explanations of these trends are provided in Chapters 3–8. In 2012, total direct greenhouse gas emissions (excluding emissions from LULUCF) in the Netherlands were estimated at 191.7 Tg CO_2 eq. This is 10.1 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 1990–2012, 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 42 per cent, 55 per cent and 71 per cent, respectively.

Emissions of LULUCF-related sources increased by about 4 per cent in 2012 compared with 2011. In 2012, total greenhouse gas emissions (including LULUCF) decreased by 2.7 Tg CO_2 eq compared with 2011 (195.1 Tg CO_2 eq in 2012).

2.2 Emission trends by gas

2.2.1 Carbon dioxide

Figure 2.2 shows 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 1990–2012, national CO_2 emissions increased by 3.8 per cent (from 159.2 to 165.3 Tg). The Energy sector is by far the largest contributor to CO_2 emissions in the Netherlands (95 per cent), with the categories 1A1 Energy industries (33 per cent), 1A4 Other sectors (24 per cent) and 1A3 Transport (16 per cent) as the largest contributors in 2012.

The relatively high levels of CO_2 emissions in 1996 and 2010 are mainly explained by two very cold winters, 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

Figure 2.1 Greenhouse gases: trend and emission levels (excl. LULUCF), 1990–2012.

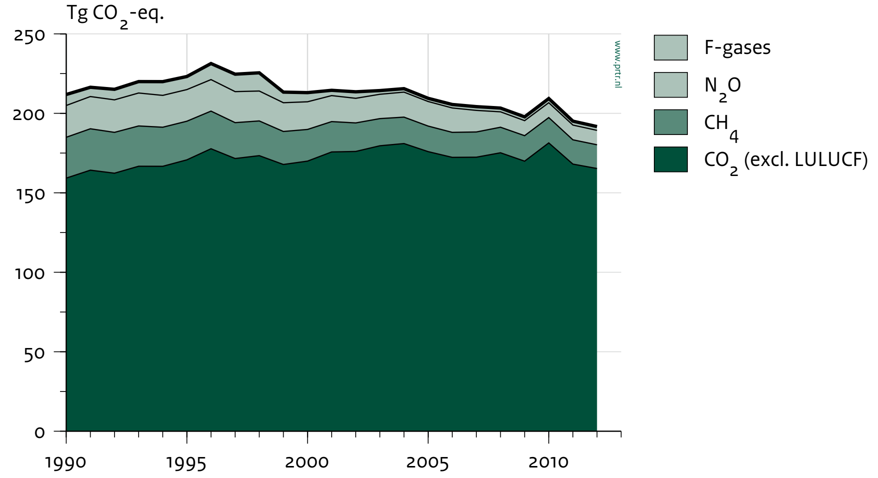
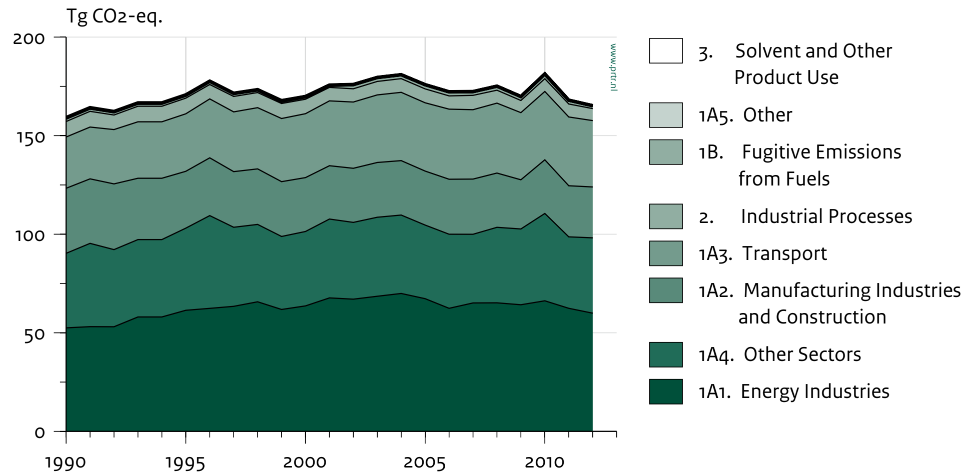


Figure 2.2 CO_2: trend and emission levels of sectors (excl. LULUCF), 1990–2012.



electricity decreased.
In 2012, CO_2 emissions decreased by 1.6 per cent compared with 2011, mainly due to decreased fuel combustion in the Energy sector (increased import of electricity).

2.2.2 Methane

Figure 2.3 shows the contribution of the most important IPCC sectors to the trend in total CH_4 emissions. National CH_4 emissions decreased by 42 per cent, from 1.22 Tg in 1990 to 0.71 Tg in 2012 (25.7 to 14.9 Tg CO_2 eq). The Agriculture and Waste sectors (62 per cent and 23 per cent, respectively) were the largest contributors in 2012. Compared with 2011, national CH_4 emissions decreased by about 2.1 per cent in 2012 (0.3 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 shows 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 55 per cent, from 64.5 Gg in 1990 to 29.2 Gg in 2012 (20.0 to 9.1 Tg CO_2 eq). The sector contributing the most to this decrease in N_2O emissions was Industrial processes (whose emissions decreased by more than 84 per cent compared with the base year).

Figure 2.3 CH_4: trend and emission levels of sectors, 1990-2012.

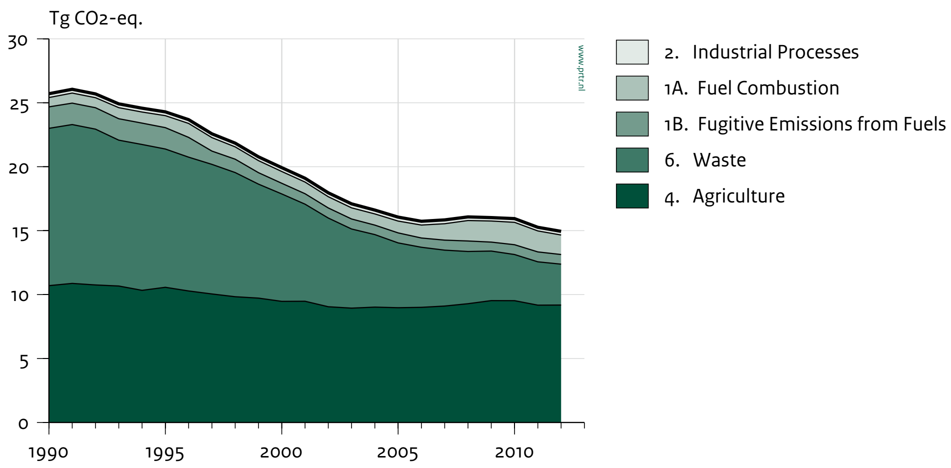
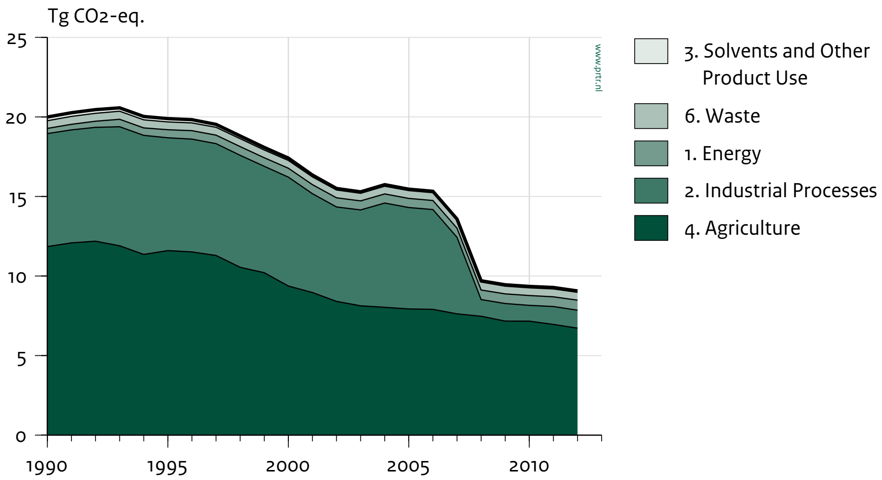


Figure 2.4 N_2O: trend and emission levels of sectors, 1990–2012.



Compared with 2011, total N_2O emissions decreased by 2.4 per cent in 2012 (–0.20 Tg CO_2 eq), mainly due to decreased emissions from agricultural soils.

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 71 per cent between 1995 and 2012, from 8.2 Tg CO_2 eq in 1995 (base year for F-gases) to 2.4 Tg CO_2 eq in 2012. Emissions of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) decreased by approximately 66 per cent and 92 per cent, respectively, during the same period, while sulphur hexafluoride (SF_6) emissions decreased by 31 per cent.

Emissions between 2011 and 2012 decreased by 3.6 per cent and 17 per cent, respectively, for HFCs and PFCs. SF_6 emissions increased by 33.7 per cent in the last year. The aggregated emissions of F-gases decreased by 2.4 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 2 per cent, based on the IPCC Tier 1 Trend Uncertainty Assessment; see section 1.7. For each 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

Figure 2.5 Fluorinated gases: trend and emission levels of individual F-gases, 1990–2012.

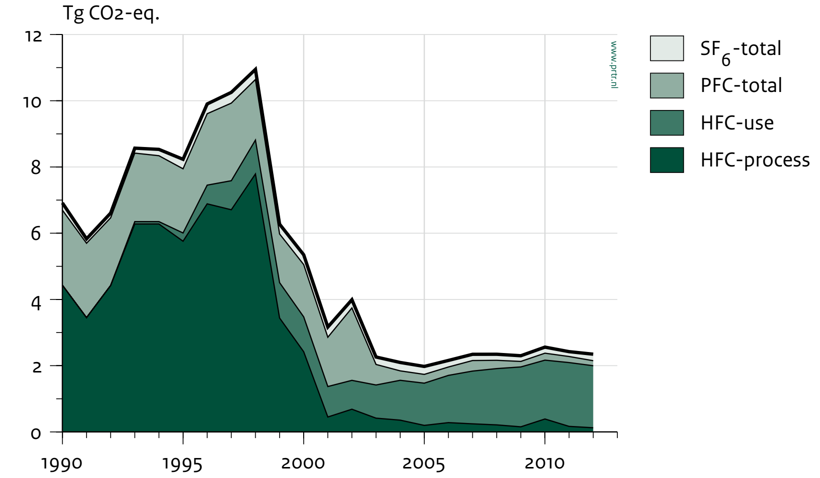
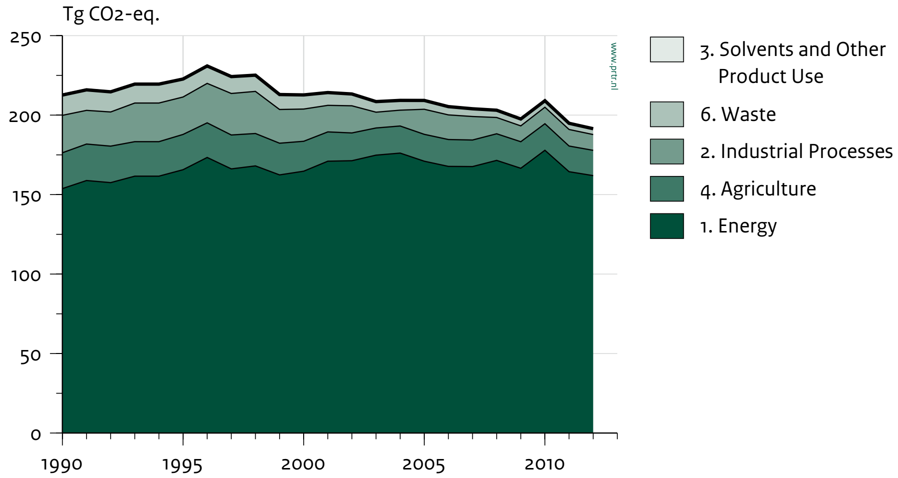


Figure 2.6 Aggregated greenhouse gases: trend and emission levels of sectors (excl. LULUCF), 1990-2012.



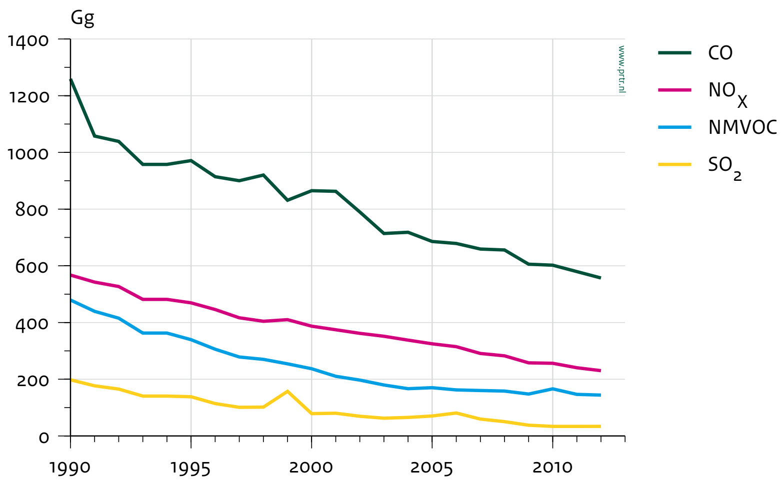
be ±2 per cent, ± 5 per cent, ±8 per cent and ± 13 per cent, respectively. For all greenhouse gases taken together, the uncertainty estimate in annual emissions is ±3 per cent and for CO_2 ±2 per cent. The uncertainty estimates in annual emissions of CH_4 and N_2O are ±25 per cent and ±50 per cent, respectively, and for HFCs, PFCs and SF_6, ±50 per cent (see section 1.7).

2.3 Emissions trends specified by source category

Figure 2.6 provides an overview of emissions trends for each 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 73 per cent in the base year and 85 per cent in 2012; the relative share of the other sectors decreased correspondingly). The emissions level of the Energy sector increased by approximately 5.3 per cent in the period 1990–2012, and total greenhouse gas emissions from the Waste, Industrial processes and Agriculture sectors decreased by 71 per cent, 58 per cent and 29 per cent, respectively, in 2012 compared with the base year. Compared with 2011, greenhouse gas emissions in the Energy sector decreased by some 2.5 Tg in 2012 as a result of an increase in electricity import (less E-production in the Netherlands). Trends in emissions by sector category are described in detail in Chapters 3–8.

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



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, ± 12 per cent, ±27 per cent, ±38 per cent and ± 17 per cent, respectively; for the LULUCF sector [5] the uncertainty is estimated at ±100 per cent. The uncertainty in the trend of CO_2-equivalent emissions per sector is calculated for sector 1 (Energy) at ±2 per cent in the 5 per cent increase, for sector 2 (Industrial processes) at ± 8 per cent in the 58 per cent decrease, for sector 4 (Agriculture) at ±11 per cent in the 29 per cent decrease and for sector 6 (Waste) at ± 2 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 2012 were reduced by 56 per cent and 70 per cent, respectively. For SO_2, the reduction was as much as 83 per cent; and for NO_x, 2012 emissions were 59 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 have not been verified. Experts have suggested, however, 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 the 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 2013	
Emissions:	Compared with 2011, the GHG emissions in the energy sector decreased by 1.5% due to the increased import of electricity in 2012 (which resulted in a decrease in production).
Key sources:	Coke production (CO_2) (1B1b) is no longer a key source
Methodologies:	No methodological changes

3.1 Overview of sector

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 2012, natural gas contributed to about 42.0 per cent of the total primary fuels used in the Netherlands, followed by liquid fuels (38.5 per cent) and solid fossil fuels (10.5 per cent). The contribution of non-fossil fuels, including renewables and waste streams, was small.

Part of the supply of fossil fuels is not used for energy purposes. It is either used as feed stocks in the (petro-) chemical or fertilizer industries (20.6 per cent) or lost as waste heat in cooling towers and cooling water in power plants (13.6 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 reassessed 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 reallocate 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 1990–2012 period, total fossil fuel combustion increased by 14 per cent, due to a 5 per cent increase in gas consumption, while liquid fuel use increased by 33 per cent. At the same time, the combustion of solid fuels decreased by 6 per cent.

Total fossil fuel consumption for combustion decreased by about 0.4 per cent between 2011 and 2012, mainly due to a 4 per cent decrease in gas consumption, a 10 per cent increase in solid fuel consumption and a 1 per cent increase in liquid fuel consumption. The increase in solid fuel consumption and decrease in gaseous fuel consumption was mainly caused by the relatively low prices of coal in the public electricity sector and the increased import of electricity.

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 compared to the other years.

3.1.1 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 transport.

The Energy sector is the most important sector in the Dutch greenhouse gas emissions inventory and is responsible for approximately 96 per cent of the 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 85 per cent in 2012. 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 the:

- 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.

These activities give rise to combustion and fugitive emissions. Emissions from the energy sector are reported in the source category split as shown in Figure 3.2.

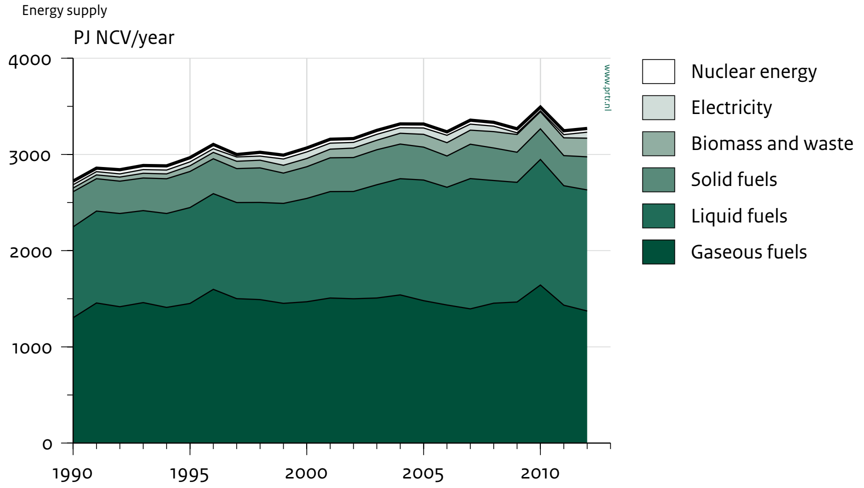
Overview of shares and trends in emissions

Table 3.1 and Figure 3.2 show the contributions 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

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 details.) 'Electricity' refers to the imported electricity only.



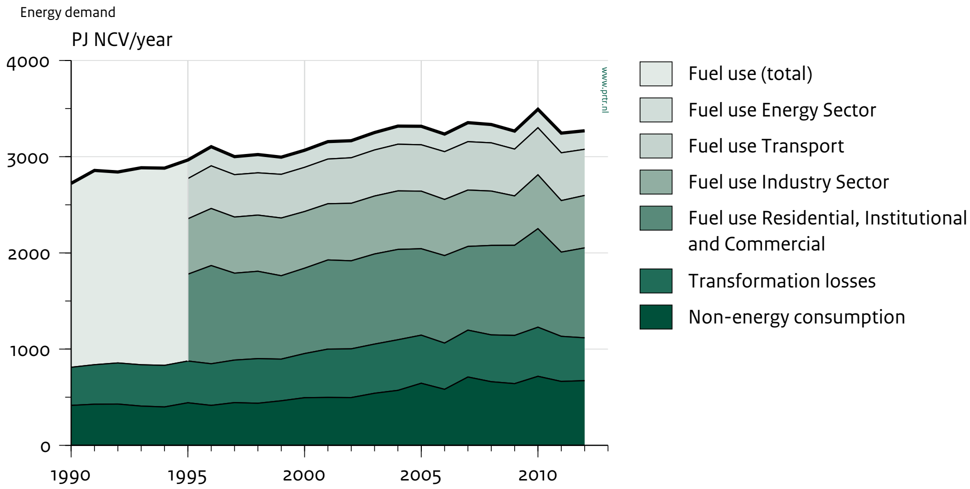


Figure 3.2 Sector 1 Energy: trend and emissions levels of source categories, 1990–2012.

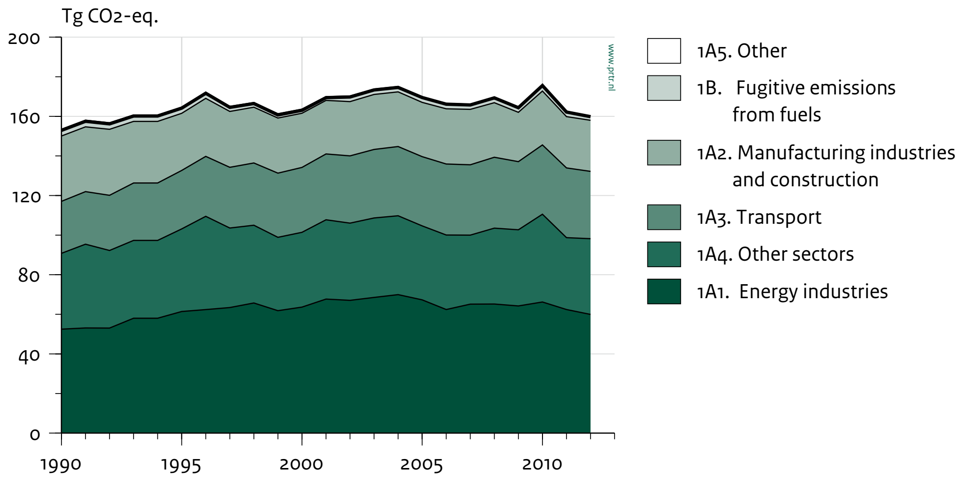


Table 3.1 Contribution of main categories and key sources in CRF sector 1 Energy.

Sector/category	Gas	Key	Emissions in Tg CO_2 eq Base year	2011	2012	Change 2011 - 2012	Contribution to total in 2012 (%) by sector	of total gas	of total CO_2 eq
1 Energy	CO_2		151.0	161.4	159.0	-2.3	98.2	96.2	83.0
	CH_4		2.4	2.4	2.3	-0.1	1.4	15.3	1.2
	N_2O		0.3	0.6	0.6	0.0	0.4	7.0	0.3
	All		153.8	164.4	161.9	-2.5	100.0		84.5
1A Fuel combustion	CO_2		149.9	159.8	158.0	-1.9	97.5	95.6	82.4
	CH_4		0.7	1.6	1.5	-0.1	0.9	10.2	0.8
	N_2O		0.3	0.0	0.6	0.0	0.4	7.0	0.3
	All		150.9	162.1	160.1	-2.0	98.9		83.5
1A Emissions from stationary combustion	CH_4	L,T	0.6	1.6	1.5	-0.1	0.9	9.9	0.8
1A1 Energy industries	CO_2		52.5	62.4	59.9	-2.5	37.0	36.3	31.3
1A1a Public electricity and heat production	CO_2		39.9	50.5	48.1	-2.4	29.7	29.1	25.1
1A1a liquids	CO_2	L1,T1	0.2	0.9	1.0	0.1	0.6	0.6	0.5
1A1a solids	CO_2	L	25.8	23.3	25.9	2.6	16.0	15.7	13.5
1A1a gas	CO_2	L1,T1	13.3	23.7	18.6	-5.1	11.5	11.2	9.7
1A1a other fuels: waste incineration	CO_2	L,T	0.6	2.6	2.6	0.0	1.6	1.6	1.4
1A1b petroleum refining	CO_2		11.0	9.9	9.8	-0.2	6.0	5.9	5.1
1A1b liquids	CO_2	L,T	10.0	6.3	6.4	0.1	4.0	3.9	3.4
1A1b gases	CO_2	L1,T1	1.0	3.6	3.3	-0.3	2.1	2.0	1.7
1A1c manufacture of solid fuels and other energy industries	CO_2		1.5	2.0	2.1	0.1	1.3	1.3	1.1
1A1c gases	CO_2	L	1.5	2.0	2.1	0.1	1.3	1.3	1.1
1A2 Manufacturing industries and construction	CO_2		33.0	25.9	25.8	-0.1	15.9	15.6	13.5
1A2 liquids	CO_2	L,T1	9.0	8.7	8.6	-0.2	5.3	5.2	4.5
1A2 solids	CO_2	L,T1	5.0	4.0	4.0	0.0	2.5	2.4	2.1
1A2 gases	CO_2	L,T1	19.0	13.2	13.2	0.1	8.2	8.0	6.9
1A2a iron and steel	CO_2		4.0	4.3	4.3	0.0	2.7	2.6	2.2
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	12.4	12.3	-0.1	7.6	7.5	6.4
1A2d pulp, paper and print	CO_2		1.7	1.1	1.1	0.0	0.7	0.7	0.6
1A2e food processing, beverages and tobacco	CO_2		4.1	3.4	3.4	0.0	2.1	2.1	1.8
1A2f other	CO_2		5.8	4.6	4.5	-0.1	2.8	2.7	2.3

Sector/category	Gas	Key	Emissions in Tg CO_2 eq Base year	2011	2012	Change 2011 - 2012	Contribution to total in 2012 (%) by sector	of total gas	of total CO_2 eq
1A3 Transport	CO_2		26.0	34.9	33.7	-1.2	20.8	20.4	17.6
	N2O		0.1	0.3	0.3	0.0	0.2	3.1	0.1
	All		26.3	35.2	34.0	-1.2	21.0		17.7
1A3a civil aviation	CO_2		0.03	0.02	0.02	0.0	0.0	0.0	0.0
1A3b road	CO_2		25.5	34.1	32.9	-1.3	20.3	19.9	17.1
1A3b gasoline	CO_2	L,T1	10.9	13.1	12.6	-0.4	7.8	7.6	6.6
1A3b diesel oil	CO_2	L,T	11.8	20.2	19.3	-0.8	11.9	11.7	10.1
1A3b LPG	CO_2	L1,T1	2.7	0.8	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	3.1	0.1
1A3c railways	CO_2		0.1	0.1	0.1	0.0	0.1	0.1	0.0
1A3d navigation	CO_2	L1,T1	0.4	0.7	0.7	0.0	0.4	0.4	0.4
1A4 Other sectors	CO_2		37.8	36.3	38.2	2.0	23.6	23.1	19.9
	CH_4		0.5	1.4	1.3	-0.1	0.8	8.9	0.7
	All		38.3	37.7	39.5	2.0	24.4		20.6
1A4 Liquids (excl. from 1A4c)	CO_2	T	1.4	0.5	0.5	0.1	0.3	0.3	0.3
1A4a commercial/ institutional	CO_2		8.4	10.0	11.1	1.1	6.8	6.7	5.8
1a4a gas	CO_2	L,T	7.6	9.7	10.8	1.1	6.7	6.5	5.6
1A4b residential gas	CO_2	L,T1	19.5	17	18	1.1	11.1	10.9	9.4
	CH_4		0.4	0.3	0.3	0.0	0.2	2.3	0.2
1A4b gases	CO_2		18.7	16.6	17.7	1.0	10.9	10.7	9.2
1A4c agriculture/ forestry/fisheries	CO_2		9.9	9.4	9.2	-0.2	5.7	5.6	4.8
1A4c liquids	CO_2	L,T	2.6	1.7	1.7	0.0	1.0	1.0	0.9
1A4c gases	CO_2	L,T	7.3	7.7	7.5	-0.2	4.6	4.5	3.9
1A5 Other	CO_2		0.6	0.4	0.3	0.0	0.2	0.2	0.2
1B Fugitive emissions from fuels	CO_2		1.2	1.5	1.1	-0.5	0.7	0.6	0.6
	CH_4		1.7	0.8	0.8	0.0	0.5	5.1	0.4
	All		2.9	2.3	1.8	-0.5	1.1		1.0
1B1b coke production	CO_2	L2,T2	0.4	0.6	0.3	-0.4	0.2	17.2	0.1
1B2 Venting/flaring	CO_2	T	0.3	0.0	0.0	0.0	0.0	0.1	0.0
	CH_4	T	1.2	0.3	0.3	0.0	0.2	2.0	0.2
Total national emissions	CO_2		159.2	168.1	165.3	-2.8			
	CH_4		25.7	15.3	14.9	-0.3			
	N_2O		20.0	9.3	9.1	-0.2			
National total GHG emissions (excl. CO_2 LULUCF)	All		213.2	195.1	191.7	-3.4			

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

in the total of national greenhouse gas emissions, it is not surprising that a large number of CO_2 sources are identified as key categories. The total CH_4 emissions from stationary combustion sources taken together are also identified as a key category.

Compared with the previous submission, CO_2 from 1B1b coke production is no longer a key source.

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
2012	Supply	Primary production	0	63	2,406
		Total imports	780	8,223	783
		Stock change	56	-101	-4
		Total exports	-492	-6,208	-1,812
		Bunkers	0	-717	0
	Gross inland consumption	Gross inland consumption	-344	-1,260	-1,373
	Demand	Final non-energy consumption	-8	-616	-84

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 2012 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; 75 per cent of the gas produced is exported. Natural gas represents a very large share of the national energy supply. Using the 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 oxidized in any process within the country. To allow this, international bunkers are to be considered as 'exports' and subtracted from gross national consumption.

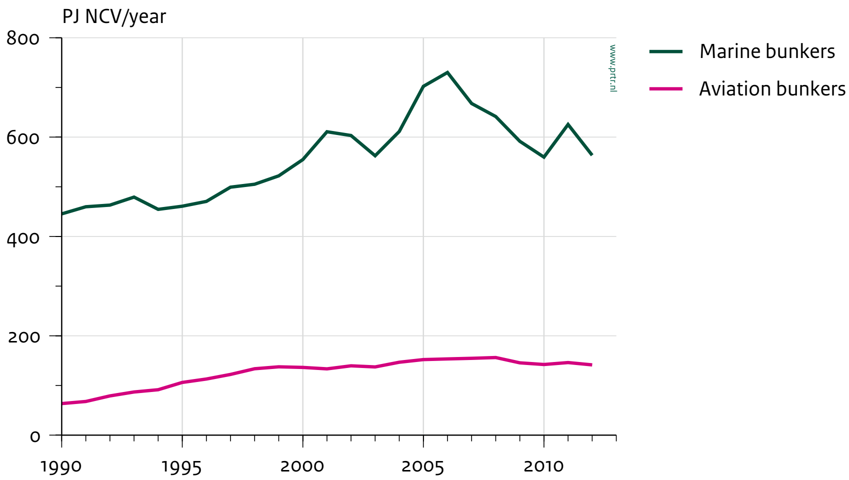
3.2.2 International bunker fuels

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 shown in Figure 3.3.
The Dutch refineries also produce considerable amounts of aviation fuel that is 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 shows 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 2012, 49 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 natural gas (6 per cent, mainly in ammonia production) and coal (2 per cent, mainly in iron and steel production) was used for non-energy applications and hence not directly oxidized. In many cases, these products are finally oxidized in waste incinerators or during use (e.g. lubricants in two-stroke engines). In the reference approach, these

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



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' is the main source category contributing to the Energy sector, accounting for 37 per cent of the greenhouse gas emissions from this sector in 2012. In this category, three source categories are included:

- 'public electricity and heat production' (1A1a),
- 'petroleum refining' (1A1b)
- 'manufacture of solid fuels and other energy industries' (1A1c).

Within these source categories, natural gas and coal combustion in public electricity and heat production, and oil combustion in petroleum refining are the biggest key sources. 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 the 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 2012, CO_2 emissions from category 1A1 was responsible for 31 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 37 per cent in 2012 (see Figure 3.2), partly due to a change in ownership of CHP plants (joint ventures, which are allocated to this source category; see also the next paragraph).

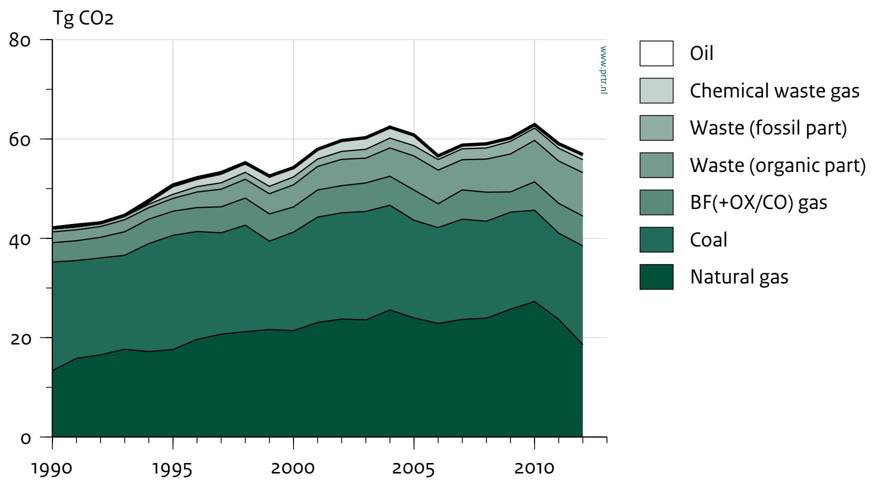
Between 1990 and 2012, total CO_2 emissions from Energy industries increased by 14 per cent (see Figure 3.4). In 2012, CO_2 emissions from Energy Industries decreased 4.0 per cent compared with 2011.

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. The public electricity and heat production 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 significant part of the coke oven gas produced by the one iron and steel

Figure 3.4 1A1 Energy industries: trend and emissions levels of source categories, 1990–2012.

Figure 3.5 Trend in sources of CO_2 from fuel use in power plants. The abbreviation BF(+OX/CO) refers to blast furnace gas, oxygen furnace gas and coke oven gas.



plant in the Netherlands is combusted in the public electricity sector (see Figure 3.5).

In 2012, 1A1a (public electricity and heat production) was the largest source category within the 1A1 Energy industries category, accounting for 80 per cent of the total greenhouse gas emissions from this category (see Figure 3.4 and Table 3.1). CO_2 emissions from the waste incineration of fossil carbon represent 5 per cent of the total greenhouse gas emissions in 1A1a. In 2012, the emissions of CO_2 from the combustion of fossil fuels in this source category decreased by 4.8 per cent compared with 2011.
Between 1990 and 2012, total CO_2 emissions from Public electricity and heat production increased by 20.5 per cent. The increasing trend in electric power production corresponds to a substantial increase in CO_2 emissions from fossil fuel combustion by power plants, which is partly compensated for by a shift from coal to natural gas and the increased efficiency of power plants.
The CO_2 emission level from the waste incineration of fossil carbon increased from 0.6 Tg CO_2 in 1990 to 2.6 Tg CO_2 in 2012, due to the increasing amounts of municipal waste that are combusted instead of being deposited in landfills, which is the result of environmental policy aimed at reducing waste disposal in landfills as well as the import of waste (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 the implied emission factor (IEF) for CO_2 from biomass is due to the increase in the share of pure biomass (co-combusted with coal-firing), as opposed to the organic carbon in waste combustion with energy recovery, which traditionally contributes the most to biomass combustion. For the former type, a lower EF is applied than is done for the latter.

Between 1990 and 1998, a change in the 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 by a few large chemical waste gas-fired steam boilers being shifted from Manufacturing industries to 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.

Emissions from waste incineration are included in this category because they all recover heat and produce electricity. Most of the combustion of biogas recovered at landfill sites occurs in CHP plants operated by utilities; therefore, it is allocated to 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 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 by a significant shift from coal to chemical waste gas and natural gas 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 CO_2 emissions in 2006 decreased as a result of an increased import of electricity, while the CO_2 emissions in 2010 increased again as a result of the increased export of electricity.

The strong increase in liquid fuel use in 1994 and 1995, with a sharp increase in 1995, was due to the use of chemical waste gas 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]

There are five large refineries in the Netherlands, which export approximately 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 2012. The combustion emissions from this category, however, should be viewed in relation to the fugitive emissions reported under category 1B2. Between 1990 and 2012, 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 CO_2.

For 1A1b (petroleum refining), the calculation of emissions from fuel combustion is based on the sectoral energy statistics, using fuel consumption for energy purposes, and activity data (including the consumption of residual refinery gases). From 2002 onwards, the quality of the data has been improved by incorporating the CO_2 emissions reported by the individual refineries in environmental reports.

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 from 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 from 2002 onwards has also caused 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 the total CO_2 emissions calculated and the total CO_2 emissions officially reported by the refineries. Besides this non-energy/feedstock use of fuel for hydrogen production in the years prior to 2002, the energy and carbon balance between the oil products produced does not match the total crude oil input and fuel used for combustion. The conclusion to be 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. It is therefore assumed, for the years running up to 2002, that part of the residual refinery gases and other residual fuels were 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 have been 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 have also been 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 proportion (between 45 per cent and 60 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 to estimate otherwise missing CO_2 emissions (but not used for CH_4 and N_2O). From 2002 onwards, however, 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 a by-product), the emissions of which 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 affect the calculated carbon content of the combusted refinery gas and thus the IEF of CO_2 for liquid fuel. CO_2 emissions obtained 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), whose operations ceased 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 proportion of 1A1c (manufacture of solid fuels (coke) and other energy industries; fuel production) in total greenhouse gas emissions from the category 1A1 (Energy industries) was approximately 3 per cent in 1990 and 3 per cent in 2012. This category comprises mostly CO_2 emissions from the combustion of natural gas. The combustion emissions from oil and gas production refer to 'own use' for energy purposes by the gas and oil production industry (including transmission), 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 2.1 Tg CO_2 in 2012, mainly due to the operation of less favourable production sites for oil and gas production compared with those operated in the past. This fact explains the steady increase over 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 (MJV) of the gas transport company and are included in this category.

Methodological issues

The emissions from this source category are essentially estimated by multiplying fuel use statistics by the IPCC default and country-specific EFs (Tier 1 and Tier 2 method for CO_2, Tier 2 method for CH_4 and Tier 1 method 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, IPCC default EFs are used (see Annex 2, Table A2.1), with the exception of CO_2 for natural gas, coal, waste, blast furnace gas, coke oven gas, oxy gas, phosphor gas, coke oven / gas coke, gas-/diesel oil, gasoline, LPG, liquid biomass and gaseous biomass, for which country-specific EFs are used. When available, company-specific or sector-specific EFs have been used, particularly for derived gases such as refinery gas, chemical waste gas, blast furnace gas, coke oven gas, oxy gas and phosphor 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), except for the use of natural gas in gas engines (see the monitoring protocols for more details on the CH4 EF of gas engines).
For N_2O, IPCC default EFs are used.

Emission data from individual companies are used when companies report a different CO_2 EF for derived gases. For this, emission data from the Environmental Reports (MJV) and the Emission Trading Scheme (ETS) from selected companies are used. The data have been validated by the competent authority. If the data are not accepted by the competent authority, then the CO_2 emission data are not used for the emission inventory. Instead, country specific EFs are used. This situation only occurs as an exception and the emissions are recalculated when the validated

Table 3.3 Overview of emission factors used in 2012 in the category Energy Industries [1A1].

Fuel	Amount of fuel used in 2012 (TJ NCV)	Implied Emission factors (g/GJ)		
		CO_2 (x 1000)	N_2O	CH_4
Natural gas	422,609	56.7	0.15	7.05
Coal	211,320	94.2	1.40	0.44
Waste Gas	98,529	64.4	0.10	3.59
Waste, biomass	39,627	126.2	5.66	0
Solid biomass	31,582	82.2	4.48	0
Waste, fossil	30,974	109.6	4.00	30.00
Other	24,544	NA	NA	NA

data from these companies become available.
Data from the environmental reports and the emission trading scheme are compared (QC check) and the data which provide the best amount of detail for the relevant fuels and installations are used. The reported CO_2 emission is combined with the energy use in the energy statistics to derive a company-specific emission factor.

- Refinery gas: Since 2002, company-specific emission factors have been derived for all companies and are used in the emission inventory. For the years prior to this, emission factors from the Netherlands list of fuels (Vreuls and Zijlema, 2013) are used.
- Chemical waste gas: Since 1995, company-specific emission factors have been derived for a selection of companies. For the remaining companies, the default emission factor is used. In 2012, this selection of companies consisted of 10 companies, but it was fewer in the years previous. If any of the 10 companies were missing, then a company-specific emission factor for the missing company was used (derived in 1995). For the period 1990-1994, a country-specific emission factor has been used based on an average emission factor for 4 companies.
- Blast furnace gas: Since 2007, company-specific emission factors have been derived for most companies. Since blast furnace gas is only produced at the only iron and steel company in the Netherlands, it is expected that all blast furnace gas has the same content and the derived emission factor is used for all companies using blast furnace gas. For years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Coke oven gas: Since 2007, company-specific emission factors have been derived for most companies. Since coke oven gas is only produced at the only iron and steel company in the Netherlands, it is expected that all coke oven gas has the same content and the derived emission factor is used for all companies that use coke oven gas. For years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Phosphor gas: Since 2006, company-specific emission factors have been derived for one company and are used in the emission inventory. For years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Coal: Since 2006, company-specific emission factors have been derived for most companies and for the remaining companies the default emission factor is used. For years previous, emission factors from the Netherlands list of fuels (Vreuls and Zijlema, 2013) are used.
- Coke oven / gas coke: Since 2006, a company-specific emission factor has been derived for one company. For the other companies, a country-specific emission factor is used. For the years prior to this, a country-specific emission factor is used.

In 2012, approximately 92% emissions were calculated using country-specific or company-specific emission factors. The remaining 8% of CO_2 emissions were calculated using default IPCC emission factors. This mainly consists of solid biomass, petroleum cokes and part of the chemical waste gas.

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. Due to confidentiality, detailed data on fuel consumption and emission factors per CRF category and fuel are not presented in the NIR, but are available for the reviewers upon request.

Explanation for the source-specific emission factors:

- The standard CH_4 emission factor for natural gas is 5.7 g/GJ. Only in category 1A1c 'Other energy industries' is "wet" 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. Also, 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 combustion of crude gas “wet” natural gas.

- The CO_2 emissions from coal are CO_2 emissions occurring in the public electricity sector. The emissions are based on emission data from ETS.
- 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 emission data from ETS.
- The N_2O emission factor from waste combustion (fossil and biomass), depending on the amount of waste incinerated in incinerators, is either 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 NL Agency, 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 dependent on the carbon content of the waste, which is determined annually (Rijkswaterstaat, 2013b).

More details on EFs, methodologies, the data sources used and country-specific source allocation issues are provided in the monitoring protocols (see http://english.rvo.nl/nie, Protocol 14-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels and Protocol 14-038: 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 which are verified as part of the European Emission Trading Scheme. The two exceptions are solids in power generation and liquids in refineries, which have a larger estimated uncertainty (1 per cent and 5 per cent, respectively) based on the proportion of blast furnace gas in total solid consumption and the ‘unaccounted for’ liquids calculated for refineries (Olivier et al., 2009). A higher uncertainty in the liquids in refineries applies to the years prior to 2002, for which accurately 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 therefore a high uncertainty of 20 per cent has been assigned. For other fuels, a 2 per cent uncertainty is used, which relates to the amount of fossil waste being incinerated and therefore 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 approximately 0.5 per cent. In 1990 and 1998, however, the EF varied ±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, approximately 1 per cent. Analysis of the default CO_2 emission factors for coke oven gas and blast furnace gas reveals uncertainties of approximately 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 approximately 15–20 per cent, the overall uncertainty in the CO_2 emission factor of solids in power generation is estimated to be approximately 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. So, for liquid fuels in these sectors, a higher uncertainty of 20-25 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 relates 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 in the waste composition and therefore the carbon fraction per waste stream. The uncertainty in the EFs of CH_4 and N_2O from stationary combustion is estimated at approximately 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.
CO_2 emissions reported by companies (both the Environmental Report (MJV) and Emission Trading Scheme (ETS)) are validated by the competent authority and they are intercompared. For more information, see Chapter 3.2.6.2.
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 2012. 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 14-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels.

Source-specific recalculations

Emissions have been recalculated for the sector 1A1c for 2009 (CO_2 and CH4), 2010 (CO_2, CH4 and N2O) and 2011 (CO_2). The emissions have been corrected in the oil and gas exploration sector. Over the last year, the competent authority of the Oil and Gas operators has made an effort to correct emission data in the Environmental Reports (MJVs) for the years 2009 and 2010. These corrections show up in this year's CRF submission. In addition, an error correction for the CO_2 offshore emission of one large oil and gas operator in 2011, which was missing in the previous submission, was implemented.

Source-specific planned improvements

The Netherlands' list of fuels is currently under investigation to include some new fuels and emission factors. This will result in country-specific emission factors of chemical waste gas and refinery gas. Also, for several other fuels, the (country-specific) emission factors will be updated.

3.2.7 Manufacturing industries and construction [1A2]

Source category description

This source category consists of the six sub-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). As mentioned before (see paragraph 3.2.6), 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 was 108.3 PJ and natural gas use was 91.4 PJ in 2012. 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 (30.3 PJ in 2012) are almost exclusively used in 1A2a (iron and steel). In this industry, a small amount of natural gas is also used. All other industries almost completely operate on natural gas.

In 2012, the share of CO_2 emissions from 1A2 (Manufacturing industries and construction) in the total national greenhouse gas emissions inventory was 13 per cent, compared with 15 per cent in 1990. In contrast, the share of the other greenhouse gas emissions in this category was relatively small. Category 1A2c (chemicals) was the largest contributor to CO_2 emissions, accounting for approximately 48 per cent of the total emissions from manufacturing industry in 2012.

In the period 1990–2012, 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 this decrease in emissions in this source category, with its contribution to CO_2 emissions decreasing by 4.8 Tg. Total CO_2 emissions from 1A2 in 2012 decreased 0.4 per cent compared with 2011.

The derivation of these figures, however, should also be viewed in the context of the allocation of industrial process emissions of CO_2. Most industry process emissions of CO_2 (soda ash, ammonia, carbon electrodes and

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**	**2012**
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	2.7
Chemicals	166.8	134.8	115.7	99.7	92.7	91.4
Pulp, Paper and Print	30.2	24.4	27.4	29.7	21.0	19.5
Food Processing, beverages and Tobacco	63.7	68.3	73.7	67.1	59.0	58.2
Other	58.6	63.0	66.8	59.9	55.9	50.2
Liquid fuels						
Iron and Steel	0.3	0.3	0.2	0.2	0.2	0.2
Non-Ferrous Metals	0.0	0.0	0.3	0.0	NO	0.0
Chemicals	116.2	82.0	81.7	92.7	112.9	108.3
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	0.4
Other	27.7	25.4	25.0	22.1	19.4	19.9
Solid fuels						
Iron and Steel	29.8	35.0	25.2	29.0	27.8	26.7
Non-Ferrous Metals	0.0	NO	NO	NO	NO	NO
Chemicals	12.8	0.2	2.1	1.7	1.2	1.0
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	1.1
Other	3.7	2.2	2.4	1.6	1.7	1.6

Figure 3.6 1A2 Manufacturing industries and construction: trend and emissions levels of source categories, 1990–2012.

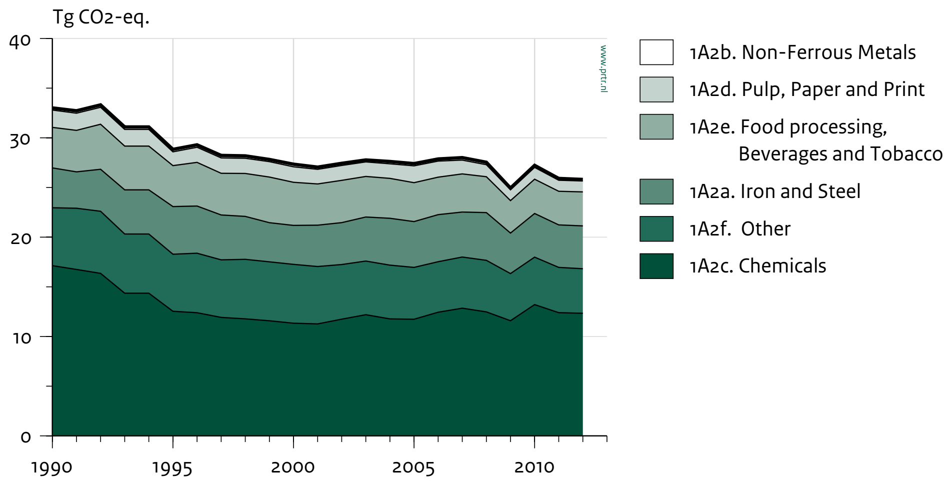
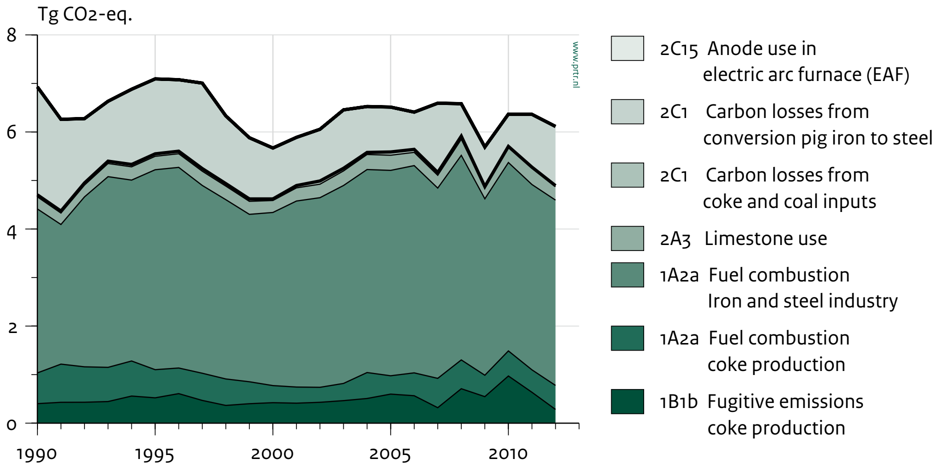


Figure 3.7 Emission levels (Gg-eq) from the iron and steel industry.



industrial gases such as hydrogen and carbon monoxide) are reported in CRF sector 2 (Industrial processes). However, in manufacturing processes, the 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; the corresponding CO_2 emissions are then 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 almost 7,000 ktons of crude steel (in addition to approximately 100 ktons 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 approximately 12 per cent in 1990 and 17 per cent in 2012.

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 used in this sector.

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 (see Figures 3.7 and 3.8). Total CO_2 emissions from the iron and steel sector decreased by 12% in the period 1990–2012, even though production increased by approximately 34 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 the variable shares of BF/OX gas and coke oven gas, which have much higher and lower EFs, respectively, than do hard coal and coke. The low IEFs in 1990–1994, compared with later years, were 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 in these years was not accounted for in the energy statistics separately, but was 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 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

Figure 3.8 CO_2 emissions (Gg) from the iron and steel industry compared to the iron and steel production (ktonnes).

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 2012. The combustion of natural gas and liquid fuels accounted for 42 per cent and 57 per cent, respectively, 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 45 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 in the ownership of a large cogeneration plant – one using chemical waste gas – to a joint venture, thus reallocating 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.
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 were used from 1995 onwards based on data from selected years. For 16 individual plants, residual chemical gas from liquids was 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 compositions explain the increase in the IEF for liquid fuels from approximately 55 to approximately 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 of 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 the year 2000, which explains the increase in the IEF for solid fuels to some 149.5 kg/GJ. For more details, see Appendix 2 of the NIR 2005 and paragraph 3.6.3.2.

Pulp, paper and print [1A2d]

The contribution of 1A2d (pulp, paper and print) to CO_2 emissions from 1A2 (Manufacturing industries and construction) was approximately 5 per cent in 1990 and around 4 per cent in 2012. In line with the decreased consumption of natural gas, CO_2 emissions have decreased by approximately 37 per cent since 1990, a substantial fraction of which has been used for cogeneration. The relatively low CO_2 emissions in 1995 can be explained by the reallocation of emissions to the Energy sector, due to

the aforementioned 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 2012. CO_2 emissions decreased by 16 per cent in the period 1990–2012. This is due to the reallocation (since 2003) of joint ventures at cogeneration plants, whose emissions were formerly allocated to 1A2e but are now reported under 'public electricity and heat production' (1A1a).
In 2012, CO_2 emissions from gaseous fuel combustion in this source category decreased by about 1.5 per cent compared with the 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 for agriculture (liquid fuels). The last group 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 2012. Most of the 4.5 Tg CO_2 emissions from this source category in 2012 stemmed from gas combustion (2.8 Tg), while the remaining CO_2 emissions were mainly associated with the combustion of biomass (1.1 Tg CO_2) and the combustion of liquid fuels (1.5 Tg CO_2), of which off-road machinery accounted for 1.2 Tg CO_2. CO_2 emissions from this source category have decreased by 23 per cent since 1990. In 2012, total CO_2 emissions from the other manufacturing industries decreased by 1.5 per cent compared with 2011.

Methodological issues
The emissions from this source category are essentially estimated by multiplying fuel use statistics by IPCC default and country-specific EFs (Tier 1 and Tier 2 method for CO_2, Tier 2 method for CH_4 and Tier 1 method 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, IPCC default EFs are used (see Annex 2, Table A2.1), with the exception of CO_2 for natural gas, coal, waste, blast furnace gas, coke oven gas, oxy gas, phosphor gas, coke oven / gas coke, gas/diesel oil, gasoline, LPG, liquid biomass and gaseous biomass, 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, blast furnace gas, coke oven gas, oxy gas and phosphor 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 were taken from Scheffer and Jonker (1997), except for the use of natural gas in gas engines (see the monitoring protocols for more details on the CH4 EF of gas engines).
For N_2O, IPCC default EFs were used.

Emission data from individual companies is used when companies report a different CO_2 EF for derived gases. For this, emission data from the Environmental Reports (MJV) and the Emission Trading Scheme (ETS) from selected companies is used. The data have been validated by the competent authority. If the data are not accepted by the competent authority, then the CO_2 emission data are not used for the emission inventory. Instead, country-specific EFs are used. This situation only occurs as an exception and the emissions are recalculated when the validated data from these companies become available.
Data from the environmental reports and the emission trading scheme are compared (QC check) and the data which provide the best amount of detail on the relevant fuels and installations are used. The reported CO_2 emission is combined with the energy use in the energy statistics to derive a company specific emission factor.
- Refinery gas: Since 2002, company-specific emission factors have been derived for all companies and are used in the emission inventory. For years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Chemical waste gas: Since 1995, company-specific emission factors have been derived for a selection of companies and for the remaining companies the default emission factor was used. In 2012, the selection of companies consisted of 10 companies, but this was fewer for the years previous. If any of the 10 companies were missing, then a company-specific emission factor

Table 3.5 Overview of emission factors used (in 2012) in the sector Manufacturing Industries and Construction [1A2].

Fuel	Amount of fuel used in 2012 (TJ NCV)	Implied emission factors (g/GJ) CO_2 (x 1000)	N_2O	CH_4
Natural gas	233,792	56.5	0.10	6.86
Waste gas	104,626	64.9	0.10	3.60
Gas / Diesel oil	20,359	74.3	0.60	4.80
Coke Oven Gas	13,938	42.8	0.10	2.80
Blast Furnace Gas	12,459	240.9	0.10	0.35
Solid biomass	10,659	109.0	4.00	32.26
Other	4,292	NA	NA	NA

for the missing company was used (derived in 1995). For the period 1990-1994, a country-specific emission factor has been used based on an average emission factor for 4 companies.

- Blast furnace gas: Since 2007, company-specific emission factors have been derived for most companies. Since blast furnace gas is only produced at the only iron and steel company in the Netherlands, it is expected that all blast furnace gas has the same content and the derived emission factor is used for all companies using blast furnace gas. For the years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Coke oven gas: Since 2007, company-specific emission factors have been derived for most companies. Since coke oven gas is only produced at the only iron and steel company in the Netherlands, it is expected that all coke oven gas has the same content and the derived emission factor is used for all companies using coke oven gas. For the years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Phosphor gas: Since 2006, company-specific emission factors have been derived for one company and are used in the emission inventory. For the years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Coal: Since 2006, company-specific emission factors have been derived for most companies and, for the remaining companies, the default emission factor has been used. For the years previous, emission factors from the Netherlands' list of fuels (Vreuls and Zijlema, 2013) are used.
- Coke oven / gas coke: Since 2006, a company-specific emission factor has been derived for one company. For the other companies, a country-specific emission factor is used. Also for the years previous, a country-specific emission factor is used.

For 2012, approximately 90% emissions were calculated using country-specific or company-specific emission factors. The remaining 10% of CO_2 emissions were calculated with default IPCC emission factors. This mainly consist of chemical waste gas (partly), solid biomass and some other oil, residual fuel oil and lignite.

More details on methodologies, data sources used and country-specific source allocation issues are provided in the monitoring protocols (see http://english.rvo.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. Due to confidentiality, detailed data on fuel consumption and emission factors per CRF category and fuel are not presented in the NIR, but are available for the reviewers upon request.

Explanations for 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 ETS. 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 http://english.rvo.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 (see Figure 3.7). 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 14-002: 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 uncertainty 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 25 per cent uncertainty estimate in the CO_2 emission factor for liquids is based on an uncertainty of 30 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 due to 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.
CO_2 emissions reported by companies (both the Environmental Report (MJV) and Emission Trading Scheme (ETS)) are validated by the competent authority and they are intercompared. For more information, see Chapter 3.2.7.2.
More details on the validation of the energy data are found in the monitoring protocol 14-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels.

Source-specific recalculations

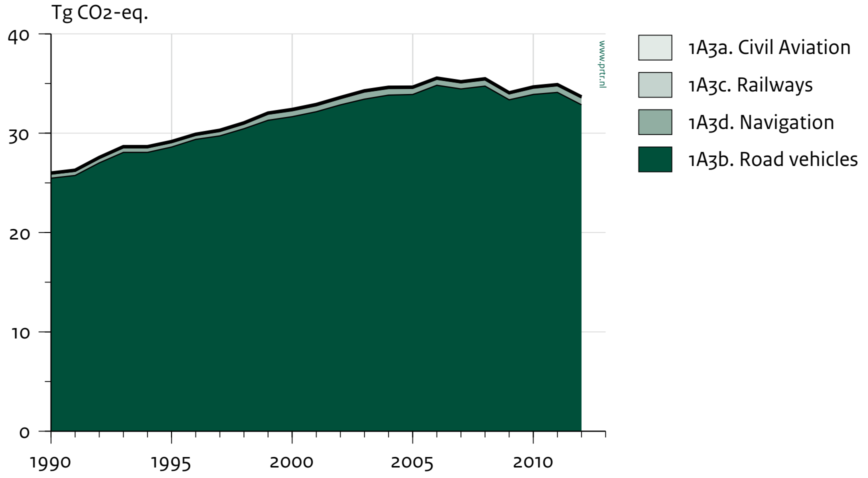
Emissions have been recalculated for the Food Processing, Beverages and Tobacco (1A2e) and Other Manufacturing Industries (1A2f).

- In the Food Processing, Beverages and Tobacco sector (1A2e), emissions have been recalculated for the years 2011. Part of the cokes in this sector had previously been included as energetically used cokes, while it should have been non-energetically. The cokes and the CO_2 emissions have been reallocated to sector Food and Drink (2D2).
- In the Other Manufacturing Industries (1A2f), emissions have been recalculated for mobile machinery in the construction sector in 2011. The activity data has been updated and based on the new activity data; the emissions of CO_2, CH4 and N2O have been recalculated.

Source-specific planned improvements

The Netherlands' list of fuels is currently under investigation to include some new fuels and emission factors. This will result in country-specific emission factors of chemical waste gas and refinery gas. Also for several

Figure 3.9 1A3 'Transport': trend and emission levels of source categories, 1990-2012.



other fuels, the (country-specific) emission factors will be updated.

3.2.8 Transport [1A3]

Source category description

The source category 1A3 (Transport) comprises the following sources: 'civil aviation' (1A3a), 'road transport' (1A3b), 'railways' (1A3c), 'water-borne navigation' (1A3d) and 'other transport' (1A3e). The source category 'civil aviation' only includes emissions from domestic civil aviation, i.e. civil aviation with departure and arrival in the Netherlands. Similarly, the source category 'water-borne navigation' only includes emissions from domestic inland navigation. Emissions from fuels delivered to 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 are included in 1A5 (Other; see section 3.2.10). The source categories 'road transport' and 'railways' include all emissions from fuel sold to road transport and railways in the Netherlands.

The source category 'other transport' (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 2012. Between 1990 and 2012, greenhouse gas emissions from transport increased by 29 per cent to 34.0 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 summarized in Figure 3.9. CO_2 emissions from 1A3b (road transport) are dominant in this source category, accounting for 98 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, in line with the increase in road transport volumes. 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 from transport 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. In 2012, total greenhouse gas emissions from transport decreased by 3.5% (1.2 Tg CO_2 eq) compared with 2011, mainly due to a decrease in fuel consumption in road transport (-3.7%).

Civil aviation [1A3a]

The share of civil aviation (1A3a) in total greenhouse gas emissions in the Netherlands was less than 0.1 per cent in both 1990 and 2012. 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. Emissions therefore remain constant over the time series.

The use of aviation gasoline (AVGAS) for domestic civil aviation is derived from the Energy Balance from Statistics Netherlands (CBS). The use of AVGAS for domestic civil aviation is limited in the Netherlands. Total AVGAS fuel consumption decreased from 0.16 PJ in 1990 to 0.07 PJ in 2012. Greenhouse gas emissions decreased accordingly.

Road transport [1A3b]

The contribution of Road transport (1A3b) to total national greenhouse gas emissions was 12.1 per cent in 1990 and 17.3 per cent in 2012. Between 1990 and 2012, greenhouse gas emissions from road transport increased from 25.7 to 33.2 Tg CO_2 equivalents. This increase was mainly caused by a large increase in diesel fuel consumption. Between 1990 and 2012, diesel fuel consumption in road transport increased by 101 PJ (64 per cent). This increase was, in turn, caused by a large growth in freight transport 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 transport (PJ) increased from 45 per cent to 56 per cent between 1990 and 2012, as is shown in Figure 3.10. The share of LPG decreased significantly between 1990 and 2012, while the share of gasoline decreased slightly.

The use of natural gas in road transport 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 2012 it was estimated to be 726 TJ, according to the Energy Balance.
In 2012, CO_2 emissions from road transport decreased by 3.7 per cent (1.3 Tg) compared with 2011. The use of diesel in road transport decreased by 4.1 per cent (11 PJ), whereas the use of petrol (gasoline) decreased by 3.2 per cent (6 PJ) in 2012 compared with 2011. The decrease in fuel consumption (i.e. fuel sold) can partially be attributed to the overall decrease in transport volumes in 2012 in the Netherlands. Total kilometrage by light duty vehicles (passenger cars and light duty trucks) decreased by approximately 1%, whereas total kilometrage for heavy duty vehicles decreased by 2% according to Statistics Netherlands. This decrease in kilometrage can mainly be attributed to the economic recession in 2012. The improving energy efficiency of road transport also contributed to the decrease in overall fuel consumption.

As a result of the EU CO_2 emission legislation combined with national fiscal measures, the fuel efficiency of new passenger cars and light-duty trucks has been improving rapidly in recent years. Consequently, the average fuel efficiency of the entire vehicle fleet is also improving gradually.

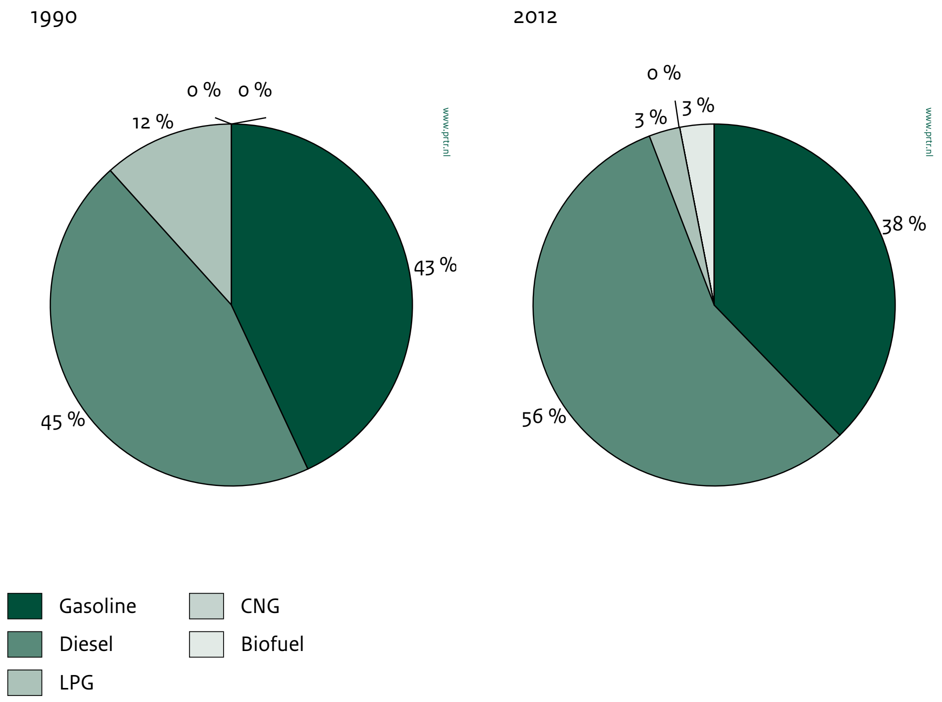
The share of CH_4 in total greenhouse gas emissions from road transport (in CO_2 eq) is very small (0.1 per cent in 2012). CH_4 emissions from road transport fell from 7.5 Gg in 1990 to 2.2 Gg in 2012, which translates to a decrease of approximately 71 per cent. Between 2011 and 2012, CH_4 emissions from road transport decreased by approximately 6 per cent (0.14 Gg). The continuing decrease in CH_4 emissions is caused by a reduction in total VOC emissions from road transport, resulting from the implementation and subsequent tightening of European Union emission legislation for new road vehicles. Total combustion and evaporative VOC emissions from road transport decreased by approximately 84 per cent between 1990 and 2012, primarily due to the penetration of catalyst-equipped and canister-equipped vehicles in the passenger car fleet. Since total CH_4 emissions are estimated as a proportion of total VOC emissions, the decrease in total VOC emissions throughout the time series also results in a major decrease in CH_4 emissions.

The share of N_2O in total greenhouse gas emissions from road transport (in CO_2 eq) is also small (0.8 per cent in 2012). 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. The increase in N_2O emissions up to 1997 can be explained by the increasing 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 2012, despite a further increase in transport volumes, can be explained by a mixture of developments:

- Subsequent generations of TWCs appear to have lower N_2O emissions (Gense and Vermeulen, 2002), causing N_2O emissions from new petrol passenger cars to decrease again after 1997.
- Recent generations of heavy duty diesel trucks, equipped with selective catalytic reduction (SCR) catalysts 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 in recent years, which more or less offsets the decrease in N_2O emissions from petrol-powered passenger cars.

Between 2011 and 2012, N_2O emissions from road transport remained constant at 0.89 Gg, with the decrease in emissions from petrol-powered passenger cars being offset by the increase in emissions from heavy duty trucks.

Figure 3.10 Shares of petrol (gasoline), diesel and LPG in fuel sales to 'Road Transport' 1990 and 2012.



Railways [1A3c]

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). In 2012, diesel fuel consumption by railways (1A3c) was 1.1 PJ, a decrease of 17 per cent (0.3 PJ) compared with 2011. This decrease in diesel fuel consumption can mainly be attributed to the increasing electrification of rail freight transport. Freight transport volumes by rail decreased by 3 per cent in 2012, but due to the increasing number of electric locomotives used in rail freight transport in the Netherlands, diesel fuel sales in 2012 decreased by 17%.

Passenger transport by diesel trains accounts for approximately 0.4 PJ of diesel fuel consumption annually, the remainder being used for freight transport. Most rail transport in the Netherlands is electric, with total electricity use for rail transport amounting to over 6 PJ annually in recent years. In 2012, 15% of total energy use for rail transport was derived from diesel fuel.

Water-borne navigation [1A3d]

Total greenhouse gas emissions from domestic water-borne navigation (1A3d) increased from 0.4 Tg CO_2 equivalents in 1990 to 0.7 Tg in 2012, which amounts to a 72% increase. This increase is caused by an increase in freight transport volumes by inland shipping. In 2012, diesel fuel consumption and resulting greenhouse gas emissions increased by 6 per cent compared with 2011, as a result of an increase in transport volumes in domestic inland navigation.

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 petrol (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 trend assessment. CO_2 emissions from petrol (gasoline) and diesel use in road transport are also key sources in the Tier 2 level assessment and diesel and LPG are key sources in the Tier 2 trend assessment as well. N_2O emissions from road transport are a key source in the Tier 2 level and 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 true for the combined N_2O and CH_4 emissions from water-borne navigation, railways and civil aviation.

Activity data and (implied) emission factors

This section gives a general description of the methodologies and data sources used to calculate greenhouse gas emissions from transport in the Netherlands. A detailed description is provided in Klein et al. (2014) and in the monitoring protocols that can be found at http://english.rvo.nl/nie and are listed in section 3.1.

Civil aviation [1A3a]

Greenhouse gas emissions resulting from the use of aviation petrol (gasoline) for domestic civil aviation in the Netherlands are estimated using a Tier 1 methodology. Consumption of aviation petrol (gasoline) for domestic aviation as reported in the inventory is derived from the Energy Balance of Statistics Netherlands (CBS). The EFs used to calculate CO_2 emissions from aviation petrol (gasoline) are derived from Vreuls and Zijlema (2013). IPCC default EFs for aviation petrol (gasoline) are used to calculate emissions of CH4 and N2O. Since civil domestic aviation is a minor source of greenhouse gas emissions in the Netherlands and is not a key source in the inventory, the use of a Tier 1 method to estimate emissions from aviation petrol (gasoline) is deemed sufficient.

Greenhouse gas emissions resulting from kerosene use for domestic aviation are calculated using a Tier 2 methodology. Since 2011, Statistics Netherlands has also reported deliveries of jet kerosene for domestic civil aviation and military aviation separately in the Energy Balance. But these figures are not yet used in the inventory. A comparison with the figures from the Ministry of Defence that are currently used to estimate greenhouse gas emissions from military aviation show that domestic deliveries of jet kerosene for military aviation in the Netherlands in 2011, as reported by Statistics Netherlands, were lower. Statistics Netherlands is currently trying to 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. Instead, kerosene fuel consumption by domestic civil aviation has been roughly estimated based on the 2000 fuel consumption figures for domestic flights in the Netherlands reported by the Civil Aviation Authority Netherlands (Pulles, 2000). The EFs used to calculate CO_2 emissions from kerosene are derived from Vreuls and Zijlema (2013). IPCC default EFs for kerosene are used to calculate emissions of CH_4 and N_2O.

The EFs used to calculate CO_2 emissions from kerosene and aviation petrol (gasoline) are derived from Vreuls and Zijlema (2013). IPCC default EFs for kerosene and aviation petrol (gasoline) are used to calculate emissions of CH4 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 Release and Transfer Register and refer to aircraft emissions during landing and 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 negligible.

Road transport [1A3b]

An IPCC Tier 2 methodology is used for calculating CO_2 emissions from road transport, using national data on fuel sales for road transport from Statistics Netherlands (CBS) and country-specific EFs, as reported in Klein et al. (2014) and in Vreuls and Zijlema (2013). See Annex 2 for details. The country-specific CO_2 emission factors for road transport fuels are derived from the analysis of 50 fuel samples taken in 2004 in the Netherlands (Olivier, 2004). The country-specific EFs are slightly higher than the IPCC default 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 2004 measurement programme (Dröge and Coenen, 2011). In the study, TNO recommends using the current country-specific EFs for the entire Kyoto commitment period; therefore, the CO_2 emission factors remain unchanged in the current submission.

An IPCC Tier 3 methodology is used for calculating CH_4 emissions from road transport, using national data on fuel sales for road transport 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 with a bottom-up approach using data on vehicle-kilometres driven, 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. (2014). The calculation methodology for total VOC emissions recognizes several vehicle characteristics, such as vehicle type, age, fuel type and weight. In addition, the methodology recognizes three different 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 is used for CH_4, combining a bottom-up approach to estimate average EFs per unit of fuel used with fuel sales data from Statistics Netherlands. The EFs for petrol and LPG-powered passenger cars and light-duty vehicles are partially based on country-specific data (Gense and Vermeulen, 2002) and Riemersma et al. (2003). For recent generations of road vehicles, no country-specific EFs are available, so IPCC default EFs are used. A research project conducted by TNO in 2012 showed that recent measurement data for N_2O are scarce; it is therefore recommended that defaults be used instead (Kuiper and Hensema, 2012).

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 biofuels in road transport are reported separately in the CRF. The emission calculation for biofuels is comparable to that for fossil fuels and is based on sales data for 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 are used for fossil diesel and petrol (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 are estimated using a Tier 1 methodology, employing 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 statistics (CBS, 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.

Water-borne navigation [1A3d]

An IPCC Tier 2 methodology is used for calculating CO_2 emissions from domestic water-borne navigation, using country-specific emission factors (Olivier, 2004); see Annex 2 for details. Domestic commercial inland vessels are allowed to use bunker fuels (sold without levies and VAT). Bunker fuel sales to domestic inland navigation are not reported separately by Statistics Netherlands; therefore the Energy Balance is not used for water-borne navigation. Instead, a bottom-up approach is used to estimate fuel consumption for domestic water-borne navigation. Using the Dutch Emission Monitor Shipping (EMS), it is possible to distinguish between national and international navigation based on kilometres travelled by different types of ships (Hulskotte & Bolt, 2012). EMS is therefore used to derive total fuel consumption for domestic waterborne navigation.

CH_4 and N_2O emissions from domestic water-borne navigation are derived using a Tier 1 method based on default IPCC emission factors.

Uncertainties and time series consistency

The uncertainty in fuel sales in 1A3b (road transport) 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 used for road transport is changing due to things such as the tightening of European fuel quality standards. Since no recent measurements have been performed, the uncertainty is thought to have increased and is currently estimated to be ±2 per cent for all three fuel types. This estimate is based on expert judgment, taking into account the uncertainty range for the CO_2 emission factors from road fuels in the 1996 and 2006 IPCC Guidelines. 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 from road transport is roughly estimated to be ±30 per cent. The uncertainty concerning 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 rather uncertain (estimated at ±50 per cent).

The uncertainty in the amount of fuel used by domestic civil aviation is estimated to be approximately ±50 per cent for jet kerosene and -10 per cent/+50 per cent for aviation petrol (gasoline). The uncertainty for jet kerosene is high due to the lack of recent data on fuel sales specifically for domestic flights. The uncertainty for aviation petrol (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 petrol (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 the amount of fuel used in rail transport is estimated to be ±5 per cent, whereas the uncertainty in fuel used in domestic water-borne navigation is estimated to be approximately ±20 per cent. The uncertainty in fuel used in rail transport is smaller because fuel sales are reported to Statistics Netherlands (CBS), whereas fuel used for 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 transport) are calculated on the basis of fuel sales data. To check the quality of the emission totals, CO_2 emissions from road transport are also calculated using a bottom-up approach based on vehicle-kilometres travelled and specific fuel consumption per vehicle-kilometre for different vehicle types. A comparison between the fuel sales data and the bottom-up calculation of 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 closely corresponds 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, however, with diesel fuel sales figures being higher than the bottom-up calculated diesel fuel consumption (fuel used). Differences vary between 13 and 26 per cent, with the difference having grown 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 is therefore 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 light duty trucks (almost all of which are diesel vehicles in the Netherlands). This makes the bottom-up calculation of total diesel fuel consumption for these vehicles 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 2012, fuel sales data for LPG are on average approximately 18 per cent higher than the bottom-up calculated LPG consumption in road transport on Dutch territory. 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 the difference between the fuel sales and the bottom-up calculation of fuel consumption of LPG.

The time series for the bottom-up calculated diesel and LPG consumption in road transport on Dutch territory (i.e. fuel used) does show trends similar to the fuel sales data from Statistics Netherlands (i.e. fuel sold).

To validate energy use by railways and for water-borne navigation, trends are compared with trends in traffic volumes. Trends in energy use for water-borne navigation show rather close correspondence with trends in transport volumes. For railways, the correspondence between energy use and transport volumes is less good. This can be explained by the electrification of rail freight transport, as described above. In recent years, more electric locomotives have been used for freight transport by rail in the Netherlands. Figures compiled by Rail Cargo (2007 & 2013) show that in 2007 only 10 per cent of all locomotives used in the Netherlands were electric, whereas in 2012 the proportion of electric locomotives increased to over 40 per cent. For this reason, there has been a decoupling of transport volumes and diesel fuel consumption in recent years in the time series.

In 2013, CE Delft conducted a sample check on the greenhouse gas emissions from transport as reported in the 2013 inventory report. They concluded that the reporting of underlying figures and assumptions was generally quite good. CE (2014) was able to reproduce the reported emissions of N_2O and CO_2 from road transport using the NIR and the underlying protocols and method report (Klein et al., 2013). They did recommend the improvement of consistency in reporting between the NIR and the underlying protocols and method report and the re-evaluation of the reported Tiers for estimating the emissions for the different source categories. Based on these recommendations, the descriptions in the underlying protocols were updated to ensure consistency and the Tiers for civil aviation and inland navigation were adjusted in the current inventory report.

Source-specific recalculations

New kilometrage for motorcycles, mopeds and special-purpose vehicles

In this year's submission, N_2O and CH_4 emissions from road transport have been recalculated for the entire 1990-2012 time series using new annual kilometrage for motorcycles, mopeds and special-purpose vehicles derived by Statistics Netherlands. Average annual kilometrage for all three vehicle categories had last been estimated in the nineties, therefore an update was required.

To estimate new annual kilometrage for motorcycles and mopeds, Statistics Netherlands held a survey among owners in both 2012 and 2013. Based on the responses, average annual kilometrage was estimated for different types of motorcycles and mopeds, depending on cylinder capacity and age (Kampert et al., 2014). The new estimates were consequently incorporated in the emission model for two wheelers that was developed by TNO in 2010 (Dröge et al., 2011).

The new average annual kilometrage for motorcycles is higher than previously estimated, leading to higher total kilometrage and subsequently also higher emissions estimates. Increases in total kilometrage vary between 5 and 20 per cent in the 1995-2011 period.

The new average annual kilometrage for mopeds is significantly higher than previously estimated. Because of a lack of data on the number of mopeds in the vehicle fleet in the Netherlands, total kilometrage for mopeds was previously derived from a travel survey conducted by Statistics Netherlands. The total kilometrage for mopeds was estimated at approximately 1 billion kilometres annually. Since a couple of years, all mopeds are required to have a license plate. Therefore, the number of mopeds in the Netherlands is now monitored properly. Combining these figures with the new annual kilometrage derived from the surveys, Statistics Netherlands now estimates the total kilometrage of all mopeds in the Netherlands in 2011 at approximately 2.2 billion kilometres.

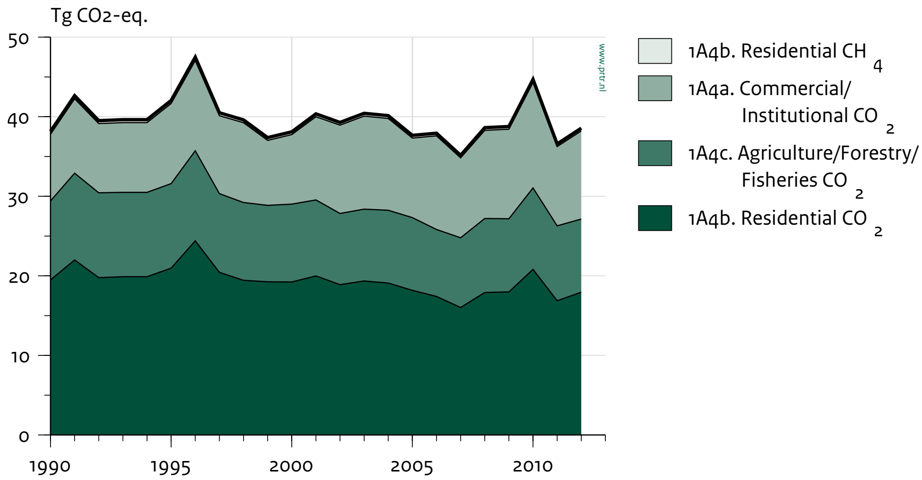
Statistics Netherlands also derived a new time series for the annual kilometrage of so-called 'special-purpose vehicles' (Molnár et al., 2014). This vehicle category includes, among other things, campers, mobile cranes, garbage trucks and fire trucks. Average annual kilometrage was estimated using odometer readings and is reported per fuel type and per age category. The new time series for total kilometrage for special-purpose vehicles in the Netherlands is for the most part slightly lower than the old time series, leading to a decrease in emission totals.

Since the average N_2O and CH_4 emission factors (per unit of fuel consumed) from road transport are calculated using a bottom-up approach based on vehicle-kilometers travelled, the new kilometrage for two-wheelers and special purpose vehicles also leads to new time series for emission totals of N_2O and CH_4. Total N_2O emissions from road transport are slightly lower (<1%) for the early years of the time series, whereas for the recent years emissions are slightly higher (up to 2%) than reported last year. Total CH_4 emissions from road transport are higher than reported last year, with differences varying between 5 and 12 per cent throughout the time series. Mopeds are a major source of VOC emissions and therefore also contribute substantially to CH_4 emissions from road transport. But, as described above, the share of CH_4 and N_2O in total greenhouse gas emissions from road transport is still very small.

Minor adjustments to time series

The time series for fuel use in domestic inland navigation (1A3d) has been slightly adjusted downwards for the 2005–2011 period in this year's submission due to an error correction. 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. To accommodate the increasing size of recent generations of inland waterway vessels, two new size classes were added to the EMS methodology in 2012 (Hulskotte & Bolt, 2012). The length of one of these classes was incorrectly set at 135 metres. This has been corrected in the current inventory to 110 meter. The length of the ship influences the specific fuel consumption of the ship, so this error

Figure 3.11 1A4 (other sectors): trend and emissions levels of source categories, 1990–2012.



correction led to a minor adjustment of the historic time series: estimated fuel consumption by inland navigation has been adjusted downwards by 0.3 to 0.8 per cent for the 2005-2011 period.

Source-specific planned improvements
In the coming year, the Netherlands plans to further 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, as described above. These EFs are subsequently combined with fuel sales data to estimate the emissions of CH_4 and N_2O from 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. In 2013, the bottom-up approach was updated by Statistics Netherlands and TNO for passenger cars and heavy-duty trucks, using recent insights into specific fuel consumption by TNO and average annual kilometrage by different types of cars and trucks, as derived by Statistics Netherlands using odometer readings. In 2014, the bottom-up approach for light-duty trucks will be updated in similar fashion.

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 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) increased by 1.1 per cent in the period 1990–2012 (see Figure 3.11). In 2012, CO_2 emissions from 1A4 increased by 5.4 per cent compared with the 2011.

The share of CO_2 emissions from 1A4 in total national CO_2 equivalent emissions (excluding LULUCF) was approximately 18 per cent in 1990 and 20 per cent in 2012. The share of CH_4 emissions from this source category in the national total of 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,

responsible for approximately 9 per cent of the total national CO_2 equivalent emissions.
Approximately 15 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 77 per cent of these CH_4 emissions stem from natural 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 9 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 32 per cent. The emission trends should not be considered to be very robust. The consumption of natural gas and the small use 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 the 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 solid fuels was different from the adjoining years of 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 in this sector refers mainly to the combustion of biogas recovered by wastewater treatment plants (WWTP), which shows a rather steadily increasing trend, and biomass consumption by industrial companies, which is classified in this economic sector – e.g. landfill gas used as fuel.

Residential [1A4b]

When corrected for the interannual variation in temperatures, the trend in total CO_2 – i.e. in gas consumption – becomes quite steady, 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 consists of almost all wood (fuel wood, other wood). For details see the monitoring protocol 14-038 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 hot-water production devices. This second component is not accounted for in the IPCC default nor in the EFs used by most other countries.
In the 'residential' category, CO_2 emissions have decreased by 8 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.

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 82 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 by 7% since 1990, mainly due to a decrease in gas consumption for stationary combustion as a result of various energy conservation measures (e.g. 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 national grid. It should also be noted that the increased use of internal combustion engines in combined heat power plants operating on natural gas has increased the IEF for methane in this category, as these engines are characterized 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 fertilization in greenhouse horticulture, thereby avoiding some CO_2 emissions otherwise generated by CHP facilities merely by producing CO_2 for horticulture. Total annual amounts, however, will be limited to a few tenths of 1 Tg CO_2. Additionally, in 2012 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 2012 amounted to 1.1 Tg, whereas total greenhouse gas emissions from fisheries amounted to

Table 3.6 Overview of emission factors used (in 2012) in the Other Sectors [1A4].

		Emission factors (g/GJ)		
Fuel	**Amount of fuel used in 2012 (TJ NCV)**	CO_2 **(x 1000)**	N_2O	CH_4
Natural gas	637,003	56.5	0.10	92.20
Gas/Diesel Oil	22,991	74.3	0.60	4.85
Other	142,35	NA	NA	NA

about 0.5 Tg CO_2 equivalent. CO_2 emissions from fisheries have shown a decreasing trend in recent years. This has been caused by a decrease in the number of ships in the Netherlands: between 1990 and 2012 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 2012, CO_2 emissions from agricultural machinery remained stable compared with 2011.

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.

The emissions from this source category are essentially estimated by multiplying fuel-use statistics by IPCC default and country-specific EFs (Tier 1 and Tier 2 method for CO_2 and CH_4 and Tier 1 method for N_2O).

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 the 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) are determined by subtracting the energy consumption allocated to the other source categories (1A1, 1A2, 1A3) and other categories (1A4b, 1A4c and 1A5) from the total energy consumption, which means that the resulting activity data are the least accurate of all three categories.

For CO_2, IPCC default EFs are used (see Annex 2, Table A2.1), with the exception of CO_2 for natural gas, gas/diesel oil, LPG and gaseous biomass, for which country-specific EFs are used. For CH_4, country-specific EFs are used, with the exception of CH_4 for solid biomass and charcoal and CH_4 for diesel use in the fisheries sector. For the use of natural gas in gas engines, a different EF is used (see the monitoring protocols for more details on the CH_4 EF of gas engines). The CH_4 country-specific emission factor for residential gas combustion includes start-up losses, a factor mostly neglected by other countries. For N_2O, IPCC default EFs are used. (see Annex 2 and the monitoring protocols on http://english.rvo.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 14-010 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 made about 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 petrol (gasoline) and LPG is small and not specifically part of the national energy statistics. Instead, it is part of the total use of petrol (gasoline) and LPG in the transport sector.

In 2012, 95% of the CO_2 emissions were calculated using country-specific factors (mainly natural gas). The remaining 5% of CO_2 emissions were calculated with default IPCC emission factors. These mainly consist of solid biomass and some other kerosene, residual fuel oil charcoal and lignite.

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. Due to confidentiality, detailed data on fuel consumption and emission factors per CRF category and fuel is not presented in the NIR, but is available for the reviewers upon request.

Explanations for 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 http://english.rvo.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 in the 'services' and – to some extent – 'agriculture' categories (particularly in the latest year) is monitored less accurately than it is in 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 approximately 7 per cent, with an uncertainty concerning the composite parts of approximately 5 per cent for the 'residential' category, 10 per cent for the 'agriculture' category and 10 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 10 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 it is with large numbers, as indicated by the high interannual variability of the data, the uncertainty in solid-fuel consumption is estimated to be even higher, i.e. 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 'Energy', 'Industry' and 'Transport'. 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 CO_2 emission factors for liquids and solids, uncertainties of 2 per cent and 10 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' has varied 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 14-002: CO_2, CH_4 and N_2O from Stationary combustion: fossil fuels.

Source-specific recalculations

Emissions have been recalculated for the Commercial/Institutional sector (1A4a), Residential sector (1A4b) and the Agriculture/Forestry/Fisheries sector (1A4c).
- In the Commercial/Institutional sector (1A4a), emissions have been recalculated for the use of natural gas and LPG. Based on new activity data for the agricultural sector, activity data and emissions have been reallocated between 1A4a and 1A4c for the years 2008-2011.
- In the Residential sector (1A4b), emissions have been recalculated for the use of charcoal in 2011. The activity data has been updated and the emissions have been recalculated based on the new activity data.
- In the Agriculture/Forestry/Fisheries sector (1A4c), emissions have been recalculated for the use of natural gas and LPG in the agricultural sector. New activity data have been provided for the years 2008-2011 and since the total energy use in the Netherlands has not changed, this only causes a reallocation of activity data and subsequent emissions between 1A4a and 1A4c.

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

Category		CO_2	N_2O	CH_4
Military ships	Emission factor (g/GJ)	75,250	2.64	1.87
Military aviation	Emission factor (g/GJ)	72,900	10.00	5.80
Total	Emissions in 2012 (Gg)	340.90	0.03	0.02

Source: Hulskotte, 2004a

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 0.3 Tg, with some interannual variation caused by different levels of operation, 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 http://english.rvo.nl/nie.

Uncertainties and time series consistency
The uncertainty in CO_2 emissions from fuel combustion from 1A5 (Other) is estimated to be approximately 20 per cent. 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
No recalculations.

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 1.36 per cent in 1990 and 0.95 per cent in 2012. Table 3.1 shows that total greenhouse gas emissions in 1B decreased from 2.9 Tg CO_2 eq to 1.8 Tg CO_2 eq between 1990 and 2012.

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 mine water 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 one large production location until 2009 that served most of the Netherlands and also occupied a large share of the market for 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 0.3 Tg CO_2 eq in 2012.

Methodological issues

The CO_2 emissions related to transformation losses (1B1) from coke ovens are only a small part of the total emissions of the iron and steel industry in the Netherlands. Emission totals for the iron and steel industry and the CRF category that they are reported in can be found in paragraph 3.2.7 Manufacturing industries and construction [1A2]. The emissions from the transformation losses 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 for the coke oven gas produced is not an issue, since the non-captured gas is by definition included in the net carbon loss calculation used for the process emissions. As a result of the 2011 in-country review, a mass balance for the year 2009 has been made available. Due to confidentiality, the mass balance for the iron and steel industry will not be included in the National Inventory Reports but can be made available for review purposes. Detailed information on activity data and EFs can be found in the monitoring protocols on the website http://english.rvo.nl/nie.

Uncertainties and time series consistency

For emissions from 'coke production' (included in 1B1b) the uncertainty in annual CO_2 emissions from this source category is estimated to be about 15 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 (1B2a4). 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, approximately 50 per cent of which 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 proportion of grey cast iron pipelines decreases due to their gradual replacement and the expansion of the network. Their present share of the total 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, particularly for venting and flaring, have been reduced significantly. This is due to the implementation of environmental measures to reduce venting and flaring by optimizing the use of gas that was formerly wasted for energy purposes.
CO_2 emissions from hydrogen plants remained fairly stable between 2002 and 2012. Emissions from oil and gas transport and gas distribution networks also remained fairly stable between 1990 and 2012.

Methodological issues

Country-specific methods comparable to 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 emissions 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 for 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 have been 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, they 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 the IPCC default CO_2 emission factor. The emission 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 refineries (Spakman et al., 2003) and for the most recent years have been directly reported in the environmental reports produced by the refineries. The environmental reports show significant annual fluctuations in CH_4 emissions since the allocation of the emissions to either combustion or process has not been uniform over the years. For more information, see the monitoring protocols available on http://english.rvo.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 are 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 50 per cent. 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 actual leakage measurements 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 has been a small increase in the fugitive emission of CO_2 from gas transmission in 2011 compared with the previous submission since a correction for the increased length of the transmission network was carried out. Over the last year, the competent authority of the Oil and Gas operators has made an effort to correct emission data of the e-MJV reports for the years 2009 and 2010.

Source-specific planned improvements

There are no source-specific improvements planned, although there possibly will be corrections due to the ongoing improvement of the e-MJV data from the Oil and Gas operators in cooperation with their competent authority SodM.

4 Industrial processes [CRF sector 2]

Major changes in the Industrial processes sector compared with the National Inventory Report 2013

Emissions:	The total greenhouse gas emissions of the sector decreased from 10.4 Tg CO_2-eq in 2011 to 9.9 Tg CO_2-eq in 2012. Because more detailed information about the recycled and destroyed amounts of refrigerants have become available, the HFC emissions from Mobile air-conditioning (2F1) have been changed for a number of years. In addition, some minor errors in 'Other use' (2F3) 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 is the case 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. If reviewers sign a confidentiality clause, the Netherlands can provide the confidential information to which the Dutch emission inventory team has access. Some of the confidential information can be viewed by the Dutch emission inventory team and reviewers 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 of 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 http://english.rvo.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 14-003: CO_2, CH_4 and N_2O from Process emissions: fossil fuels;
- Protocol 14-014: CO_2, CH_4 and N_2O from Process emissions and product use;
- Protocol 14-015: N_2O from Nitric acid production (2B2);
- Protocol 14-016: N_2O from Caprolactam production (2B5);
- Protocol 14-017: PFCs from Aluminium production (2C3);
- Protocol 14-018: HFC-23 from HCFC-22 production (2E1);
- Protocol 14-019: HFCs from Handling (2E3);
- Protocol 14-020: HFCs from Stationary refrigeration (2F1);
- Protocol 14-021: HFCs from Mobile air-conditioning (2F1);
- Protocol 14-022: HFCs from Other use (2F2–5);
- Protocol 14-024: SF_6 from Other use (2F9);
- Protocol 14-025: SF_6 and PFCs from Semiconductor manufacturing (2F7);
- Protocol 14-026: 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 the 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 2012, Industrial processes contributed 5.2 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 12.5 per cent of total national N_2O emissions.

Compared with the base year, total CO_2 equivalent greenhouse gas emissions in the sector declined by 13.6 Tg to 9.9 Tg CO_2 eq in 2012 (-58 per cent). CO_2 emissions from industrial processes decreased by 23 per cent during the period 1990–2012. N_2O emissions decreased by 84 per cent in the same period. Total emissions of fluorinated gases (F-gases) were greatly reduced.

In 2012, total greenhouse gas emissions in the sector decreased by 0.5 Tg to 9,9 Tg. Mainly caused by the closure of one of the primary aluminium smelters, CO_2 emissions decreased by 0.5 Tg to 9.9 Tg CO_2 eq in 2012. HFC emissions showed a decrease of 0.08 Tg CO_2 eq, PFC emissions decreased by 0.03 Tg CO_2 eq and SF_6 emissions increased by 0.05 Tg CO_2 eq, while N_2O emissions remained at the same level (1.1 Tg CO_2 eq) as the previous year.

Category 2B (Chemical industry) contributes most to the emissions from this sector. Compared with the base year, the total CO_2 equivalent greenhouse gas emissions in this category declined by 6.6 Tg to 4.6 Tg CO_2 eq in 2012 (-59 per cent).

Figure 4.1 Sector 2 'Industrial processes': trend and emission levels of source categories, 1990 - 2012.

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. Those emissions are therefore 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 Limestone and dolomite use (2A3) originate from:

- Limestone use for flue gas desulphurization (FGD);
- Limestone use in Iron and steel production
- Dolomite consumption (mostly used for road construction).

The only soda ash producer (2A4) in the Netherlands was closed in 2009. 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 1.19 Tg in 2012 (see Table 4.1). Total CO_2 emissions in category 2A decreased from 1.30 Tg in 2011 to 1.19 Tg in 2012.

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 http://english.rvo.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 desulphurizing installations for power plants are based on the environmental reports of the coal-fired power plants. To calculate the CO_2 emissions from the use of limestone 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 report for data on the non-energy use of coke was used. To avoid double counting, the plant-specific data on the non-energy use of coke were subtracted from the non-energy use of coke, earmarked as feedstock, in the National Energy Statistics from Statistics Netherlands. For activity data on soda use, see the following bullet,

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

Sector/category	Gas	Key	Emissions base-year	2011	2012	Absolute 2012 - 2011	Contribution to total in 2012 (%)		
			Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq		by sector	of total gas	of total CO_2 eq
2 Industry	CO_2		7.9	6.6	6.1	-0.5		4	3.2
	CH_4		0.3	0.3	0.3	0.0		1.9	0.1
	N_2O		7.1	1.1	1.1	0.0		12	0.6
	HFC		6.0	2.1	2.1	-0.1		96	1.1
	PFC		1.9	0.2	0.2	0.0		100	0.1
	SF_6		0.3	0.1	0.2	0.0		100	0.1
	All		23.6	10.4	9.9	-0.5			5.2
2A. Mineral Products	CO_2		1.2	1.3	1.2	-0.1	12	0.7	0.6
2B. Chemical industry	CO_2		3.7	3.4	3.2	-0.2	32	1.9	1.7
	N_2O		7.1	1.1	1.1	0.0	11	12	0.6
	All		11.1	4.7	4.6	-0.2	46	2	2.4
2B1 Emissions from ammonia production	CO_2	L1	3.1	2.7	2.6	-0.1	26	2	1.3
2B2 Emissions from nitric acid production	N_2O	T	6.3	0.2	0.3	0.0	3	3	0.1
2B5 Emissions from caprolctam production	N_2O	L	0.8	0.9	0.9	0.0	9	9	0.4
2B5 Other chemical product manufacture	CO_2	L,T2	0.6	0.7	0.6	-0.1	6	0.4	0.3
2C. Metal Production	CO_2		2.7	1.5	1.4	-0.1	14	0.8	0.7
	PFC		1.9	0.1	0.0	0.0	0	25	0.0
	All		2.0	1.6	1.4	-0.2	15		0.8
2C1 Iron and steel production (carbon inputs)	CO_2	L1,T1	2.3	1.1	1.2	0.1	13	0.8	0.6
2C3 PFC emissions from aluminium production	PFC	T	1.9	0.1	0.0	0.0	0.4	25	0.0
2D. Other Production	CO_2		0.1	0.0	0.0	0.0	0.3	0.0	0.0
2E. Production of halocarbons and SF6	HFC		5.8	0.2	0.2	0.0	2	8	0.1
2E1 HFC-23 emissions from HCFC-22 manufacture	HFC	T	5.8	0.2	0.1	0.0	1	6	0.1
2F. Consumption of Halocarbons and SF_6	HFC	L,T	0.2	1.9	1.9	-0.1	19	88	1.0
	PFC		0.04	0.1	0.1	0.0	1	75	0.1
	SF_6		0.3	0.1	0.2	0.0	2	100	0.1
	All		0.6	2.2	2.2	0.0	22		1.1
2G. Other	CO_2		0.2	0.3	0.3	0.0	3	0.2	0.1
	N_2O		0.00	0.01	0.01	0.0	0.1	0.1	0.01
	All			0.3	0.3	0.0	3	0.1	0.1
National Total GHG emissions (excl. CO_2 LUCF)	CO_2		159.2	168.1	165.3	-2.8			
	CH_4		25.7	15.3	14.9	0.0			
	N_2O		20.0	9.3	9.1	0.0			
	HFCs		6.0	2.1	2.1	0.0			
	PFCs		1.9	0.2	0.2	0.0			
	SF_6		0.3	0.1	0.2	0.0			
	All		213.2	195.1	191.7	-3.4			

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

Glass production.
- Glass production (2A7): Activity data are based on data from Statistics Netherlands (CBS) and the trade organization.

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) with a default EF. For that reason, the company has chosen to base the calculation of CO_2 emissions on the carbonate content of the process input. For more information, see section 4.2.5.
- Limestone use: EF = 0.440 t/t (IPCC default);
- Dolomite use: EF = 0.477 t/t (IPCC default);
- Soda ash production: EF = 0.415 t/t (IPCC default);
- Glass production: Plant-specific EFs have been used for the years 1990 (0.13 t CO_2/t glass), 1995 (0.15 t CO_2/t glass) and 1997 (0.18 t CO_2/t glass). For other years in the time series, there were not enough data available to calculate plant-specific EFs. For the missing years 1991–1994 and 1996, EFs have been estimated by interpolation. Because no further measurement data are available, the EF for 1998–2012 is kept at the same level as the EF of 1997 (0.18 t CO_2/t glass). The IPCC 1996 guidelines do not provide a default EF. The IPCC 2006 guidelines, however, provide default values. The EF of 0.18 is in the range of the default EFs provided in the new guidelines. Because no reliable data regarding the growth in the use of recycled scrap glass (cullet) used in the glass production sector are available for the period 1997-2012, the estimation of CO_2 emissions does not take into account the growth in the use of recycled scrap glass (cullet) used in glass production for that period. From next submission onwards, the Netherlands will obtain the emissions directly from the verified EU ETS reports.

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 14-003 and 14-014 on http://english.rvo.nl/nie, as indicated in section 4.1.
- 2A1 (Cement clinker production): The CO_2 process emissions from this source category are from 2002 and 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 from 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 organization responsible for emissions trading (ETS) in the Netherlands. This organization is also responsible for the verification of the reported data of this company. The verified CO_2 emissions are also reported in the AER.
  For the years prior to 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 2002–2012 (IPCC Default = 0.51 t/t clinker).

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	2012
CO_2	0.54	0.54	0.54	0.52	0.51	0.48	0.48	0.52	0.50	0.52	0,51

- 2A3 (Limestone and dolomite use): CO_2 emissions from this source category are based on consumption figures for limestone use for flue gas desulphurization (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) have been 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.
- CO_2 emissions from the use of limestone and dolomite, use of other substances in the glass production sector are included in 2A7, Other.
- 2A4 (Soda ash production and use): Before the closure of the only soda ash producer, CO_2 emissions were 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 the uncertainty is estimated to be 25 per cent and for Other sources to be 50 per cent, based on the relatively high uncertainty in the activity data.

Activity data for Soda ash use, Limestone and dolomite use and Glass production are assumed to be relatively uncertain (respectively 25, 25 and 50 per cent). The uncertainties of the IPCC default EFs used for some processes are not assessed. As these are minor sources of CO_2, however, 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 for 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 2012 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 were negligible since the majority of the light hydrocarbon compounds were extracted during the refining process to produce commercial fuels (IPCC, 2006). This improvement has not been implemented.

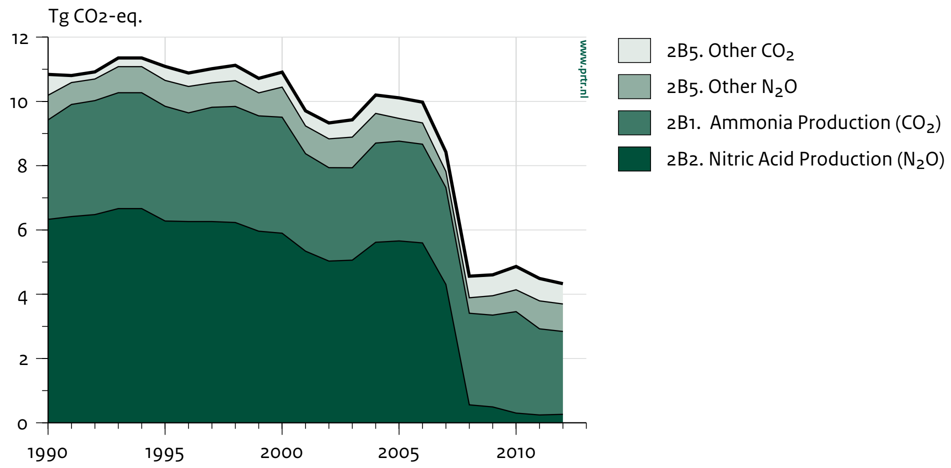
4.3 Chemical industry [2B]

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

Figure 4.2 2B 'Chemical industry': trend and emission levels of source categories, 1990-2012.



(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, during which process CO_2 is produced.
  - Use of petcokes as feedstock and the use of lubricants: These are both very small CO_2 sources.
  - 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 by-product.
  - Ethylene oxide production: CO_2 emissions result from the production of ethylene oxide.
  - Caprolactam production: N_2O emissions result from the production of caprolactam.

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 emission 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 1990–2012. Table 4.1 gives an overview of proportions of emissions from 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 3.3 per cent in 2012. 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 2012.

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
2012	264	856	1,119

From 1990 to 2008, total greenhouse gas emissions from 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 2009–2012, total greenhouse gas emissions from 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. The results of these measurements are confidential information and can be viewed at the company's premises.
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 (optimizing 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 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 was 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 was reflected in the low emissions. The reduction in 2009 was primarily 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 was caused by the improved catalytic effect in two of the plants. In 2012 the N_2O emissions of the nitric acid plants remained almost at the same level as in 2011.

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 organization responsible for EU-ETS in the Netherlands. In 2013, the companies again sent their verified emissions reports (2012 emissions) to the NEa.

The reported and verified (by an independent verifier) emissions (2012) sent by the companies to the NEa were checked against those reported in the CRF tables (2012). 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 emission fluctuations during the period 2003–2010

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
2012	0	26	105	35	196	489
Abatement efficiency 2007 – 2008 [2)]	80.40 %	99.94 %	69.68 %	99.997 %	92.84 %	84.80 %

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

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

were 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 were 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, this submission should include an investigation as to whether it is possible to improve the whole emission time series. Currently, this investigation is still ongoing. But before next submission, it will become clear whether or not 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 14-003, 14-014, 14-015 and 14-016 on the website http://english.rvo.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 period 1990–2012 was received from the company. For ethylene oxide production, only capacity data are available; a default capacity utilization rate of 86 per cent was used, therefore, to estimate CO_2 emissions (based on Neelis et al., 2005). Activity data for estimating CO_2 emissions are based on data for the feedstock use of fuels provided by Statistics Netherlands (CBS).

The EFs used to estimate greenhouse gas emissions from the different source categories originated 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 was used for CH_4.
- Other: Plant-specific N_2O emission factors was used for Caprolactam production (confidential). A default EF of 0.45 tons of CO_2 per ton of ethylene oxide production wass 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, 14-014, 14-015 and 14-016 described on the website http://english.rvo.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 CO_2 emissions from the ammonia production. Until last year, an average storage factor – 17 per cent of the total CO_2 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: With natural gas as input (chemical feedstock) industrial gases, e.g. H2 and CO, are produced. The oxidation fraction of 20% (80% storage) is derived from "Recalculation of Dutch stationary Greenhouse Gas Emissions based on sectoral energy statistics 1990-2002. Statistics Netherlands (CBS), Voorburg. (Huurman J.W.F. 2005a)". The storage factor of 80% is determined as follows:
    From the 2 producers in the Netherlands, the total amount of carbon stored in the produced industrial gasses and the total carbon content of the natural gas used as feedstck are derived from the AERs.
    The storage factor is determined by dividing the total amount of carbon stored in the produced industrial gasses by the carbon content of the natural gas used as feedstock.
  - Use of pcokes and lubricants: CO_2 emissions are estimated on the basis of the use of petcokes and lubricants.
  - The production of 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.
  - The production of 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.
  - The production of Ethylene oxide: CO_2 emissions are estimated on the basis of capacity data by using a default capacity utiliation rate of 86 per cent and applying an EF of 0.45 t/t ethylene oxide. The Netherlands has not verified the AD using ethylene production reported to EUROSTAT for the Prodcom database because there is no real AD available at this moment. The Netherlands is, therefore, still working

with the 86% capacity utilization rate for ethylene oxide production and a default EF.

For the minor sources of CH_4 emissions included in this source category, IPCC Tier 1 methodologies and IPCC default EFs were 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 10 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 from 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, and/or 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).

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
2012	33	5	38

4.4.3 Overview of shares and trends in emissions

Table 4.1 provides an overview of emissions, by proportion, from the main categories.

Total CO_2 emissions from 2C1 (Iron and steel production) decreased by 1.2 Tg during the period 1990–2012. In 2011, CO_2 emissions increased by 0.4 Tg compared with 2010 due to a higher production level in 2011. In 2012, CO_2 emissions increased by 0.1 Tg compared with 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 depended mainly 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 1990–2012. Zalco, the largest company, produced approximately two-thirds of the total national production. The emissions decreased by 98 per cent between 1995 and 2012. 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. Because of the closure of the largest primary aluminium smelter, PFC emissions decreased by 0.4 Tg to 0.4 Tg CO_2 eq in 2012, compared with 2011.

4.4.4 Activity data and (implied) emission factors

Detailed information on activity data and emission factors can be found in the monitoring protocols 14-002, 14-014 and 14-017 on the website http://english.rvo.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.

4.4.5 Methodological issues

The methodologies used to estimate the greenhouse gas emissions for all source categories of Metal production comply with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and EFs can be found in protocols 14-003, 14-014 and 14-017 on the website http://english.rvo.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 serving 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 à 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 1990–2012. 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

No recalculations have been made.

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 oxidized during these processes, resulting in CO_2 emissions.

4.5.2 Key sources

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

4.5.3 Overview of shares and trends in emissions

Emissions vary at around 0.05 Tg and are rounded off to either 0.1 or 0.0 Tg (see Table 4.1).

4.5.4 Activity data and emission factors

Detailed information on the activity data and emission factors can be found in monitoring protocol 14-003 on the website http://english.rvo.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 14-003 on the website http://english.rvo.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 oxidized 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 greater detail. In the uncertainty analysis and the key source analysis, therefore, 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

The CO_2 emission of this source category has been recalculated for the year 2011. Part of the cokes of this source category had previously been included as energetically use of cokes, while it should have been non-energetically. The cokes and the CO_2 emission has been reallocated to this source category.

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. Besides this company, there are many 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 proportions of emissions from the main categories.

Total HFC emissions in category 2E were 5.8 Tg in 1995 and 0.18 Tg CO_2 eq in 2012, with HFC-23 emissions from HCFC-22 production (2E1) being the major source of HFC emissions. HFC emissions from Handling activities (2E3) were responsible for 31 per cent of the total HFC emissions from this category in 2012.

Table 4.6 shows the trend in HFC emissions from the categories HCFC-22 production and HFCs from handling activities for the period 1990–2012. The emissions of HFC-23 increased by approximately 35 per cent in the period 1995–1998, due to the increased production of HCFC-22. In the period 1998–2000, however, 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 that explain the variation in emission levels during the 2000–2008 period.

Table 4.6 Trends in HFC-23 by-product emissions from the Production of HCFC-22 (2E1) and HFC emissions from Handling activities (2E3) (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
2012	125	55	181

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. Primarily as a result of 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. Due to the increasing removal efficiency of the Thermal Converter after 2010, the HFC-23 emissions declined in both 2011 and 2012.

The significant emission fluctuations in category 2E3 during the period 1992–2012 can be explained by the large variety in handling activities, which depended on the demand from customers.

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 14-018 and 14-019 on the website http://english.rvo.nl/nie.

4.6.5 Methodological issues

The methodologies used to estimate the greenhouse gas emissions from this category comply with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the method used and EFs can be found in the protocols 14-018 and 14-019 on the website http://english.rvo.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 approximately 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.
The confidential information is checked and verified as follows:
As mentioned in the protocol, the confidential information ("HFC 23 load in the untreated flow" and "the removal efficiency of the TC") can be viewed at the company's premises. During the annual verification of the AER, the competent authorities check the reliability of the information at the company.
Furthermore, the industrial expert of the Dutch emission inventory team checks the confidential information at the company.

4.6.8 Source-specific recalculations

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

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 via 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 1990–2012 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 91 per cent in 2012. This corresponds to 2.2 Tg CO_2 eq and accounts for 1.1 per cent of the national total greenhouse gas emissions in 2012.

The level of HFC emissions increased by a factor of 8 in 2012 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 in the Semiconductor manufacturing industry. Actual emissions of SF_6 remained fairly stable during the period 1995–2012. Table 4.7 gives an overview of the trends in actual emissions from 1990 to 2012.

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	919	76	63	NO	5	5	1,068	147	295	1,511
2000	825	110	90	NO	7	21	1,052	193	295	1,541
2001	600	147	122	NO	8	44	920	163	308	1,391
2002	462	182	152	NO	9	68	873	120	249	1,241
2003	492	220	183	NO	10	97	1,002	180	225	1,407
2004	546	259	215	NO	11	173	1,204	179	253	1,636
2005	543	294	243	NO	11	184	1,276	178	240	1,694
2006	573	329	272	NO	12	238	1,425	194	199	1,819
2007	652	364	301	NO	13	265	1,595	222	188	2,004
2008	697	394	325	NO	13	270	1,699	180	184	2,062
2009	673	418	342	NO	13	361	1,807	125	170	2,103
2010	660	428	355	NO	13	321	1,776	151	184	2,112
2011	680	430	364	NO	14	439	1,927	101	147	2,175
2012	641	431	374	NO	15	413	1,874	113	196	2,183

4.7.4 Activity data and emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 14-020 and 14-016 on the website http://english.rvo.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) were obtained from the annual report by PriceWaterhouseCoopers (PWC, 2011).
- For Mobile air-conditioning, the number of cars (by year of construction) and the number of scrapped cars (by year of construction) were obtained from Statistics Netherlands (CBS). The recycled and destroyed amounts of refrigerants were obtained via ARN, a waste processing organization.
- Activity data on the use of PFCs in Semiconductor manufacturing and SF_6 in Sound-proof windows and Electron microscopes were 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 from 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 from the only company.

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

Table 4.8 Effects of changes in the use of HFCs (2F1 and 2F3) 1999-2011 (Units: Gg CO_2 eq).

		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
HFCs	NIR 2013	1,069	1,053	921	873	1,003	1,205	1,277	1,427	1,597	1,701	1,809	1,779	1,928
	NIR 2014	1,068	1,052	920	873	1,002	1,204	1,276	1,425	1,595	1,699	1,807	1,776	1,927
	Difference	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-2**	**-2**	**-3**	**-2**	**-3**	**-1**

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 14-020 and 14-016 on the website http://english.rvo.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 54 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 20 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 to be approximately 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 approximately 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 detailed information about the recycled and destroyed amounts of refrigerants has become available, the HFC emissions from Mobile air-conditioning (2F1) have been changed for a number of years.

In addition, some minor errors in 'Other use' (2F3) were detected and corrected for several years.

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.

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 uses).

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 Annex 1).

4.8.3 Overview of shares and trends in emissions

The small CO_2 and CH_4 emissions remained fairly constant between 1990 and 2012.

4.8.4 Activity data and emission factors

Detailed information on the activity data and emission factors can be found in the monitoring protocols 14-003 and 14-014 on the website http://english.rvo.nl/nie.
The activity data used are based on the following sources:
- Fireworks: data on annual sales from trade organization;
- 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 the 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 comply with the IPCC Good Practice Guidance (IPCC, 2001). More detailed descriptions of the methods used and the EFs can be found in protocols 14-003 and 14-014 on the website http://english.rvo.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 50 per cent (5 per cent in activity data and 50 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 2013

Emissions:	As a result of improved Activity data, the N_2O emissions from 3D3 (Aerosol cans) have been recalculated for the whole time series.
Key sources:	There are no key sources in this sector.
Methodologies:	There have been no methodological changes in this sector.

5.1 Overview of sector

Emissions of greenhouse gases in this sector include indirect emissions of CO2 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 N2O emissions originating from the use of N2O 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 http://english.rvo.nl/nie, describes the methodologies applied for estimating CO_2 and N_2O emissions from Solvent and other product use in the Netherlands: Protocol 14-014: CO_2, N_2O andCH$_4$ from 'Other process emissions and product uses'.

Overview of shares and trends in emissions
Table 5.1 shows the proportion of emissions from Solvent and other product use in the Netherlands. Total greenhouse gas emissions from Solvent and other product use in the Netherlands were 0.55 Tg CO_2 eq in 1990 and 0.21 Tg CO_2 eq in 2012 (-62%).

CO_2 emissions from the sector decreased by 62 per cent between 1990 and 2012, 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 the sector decreased by 62 per cent during the period 1990-2012. N_2O emissions from anaesthesia fell by 90 per cent from 1990 to 2012 due to better dosing in hospitals and other medical institutions. Domestic sales of cream in aerosol cans have increased sharply since 1990. For this reason, the emissions of N_2O from food aerosol cans increased by 125 per cent during the period 1990-2012.

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 from solvents through 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 14-014 on the website http://english.rvo.nl/nie.
Activity data: Consumption data and the NMVOC content of products are provided primarily by trade associations, such as the VVVF (for paints), the NCV (for cosmetics) and the NVZ (for detergents). Consumption of almost all solvent-containing products has increased since 1990. However, the general NMVOC content of products (especially paints) has decreased over the last years, resulting in a steady decline in NMVOC emissions since 1990 (see section 2.4). Due to the increased sales of hairspray and deodorant sprays, NMVOC emissions have increased slightly in recent years. It is assumed that the NMVOC content of these products has remained stable.

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

Sector/category	Gas	Key	Emissions base year	2011	2012	Absolute 2012–2011	Contribution to total in 2012 (%)		
			Tg CO_2 eq	Tg CO_2 eq	Tg CO_2 eq		by sector	of total gas	of total CO_2 eq
3 Solvent and other product use	CO_2		0.3	0.1	0.1	-0.003		0.1%	0.1%
	N_2O		0.2	0.1	0.1	-0.006		1.0%	0.05%
	All		0.5	0.2	0.2	-0.009			0.1%
3A Paint application	CO_2		0.2	0.1	0.0	-0.003	24%	0.0%	0.03%
3A Paint application	*All*		0.2	0.1	0.0	-0.003	24%		0.03%
3B Degreasing and drycleaning	CO_2		0.0	0.0	0.0	0.000	1%	0.0%	0.00%
3B Degreasing and drycleaning	*All*		0.0	0.0	0.0	0.000	1%		0.00%
3D Other	CO_2		0.1	0.1	0.1	0.000	34%	0.0%	0.04%
	N_2O		0.2	0.1	0.1	-0.006	42%	1.0%	0.05%
3D1 Anaesthesia	N_2O		0.2	0.0	0.0	-0.007	10%	0.2%	0.01%
3D3 Aerosol cans	N_2O		0.0	0.1	0.1	0.001	32%	0.7%	0.03%
3D Other	*All*		0.3	0.2	0.2	-0.005			0.1%
Total National Emissions	CO_2		159.2	168.1	165.3				
(excl. CO_2 LULUCF)	N_2O		20.0	9.3	9.1				
	All		213.2	195.1	191.7				

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 14-014 on the website http://english.rvo.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 uses) is used to calculate indirect CO_2 emissions. Monitoring of NMVOC emissions from these sources differs according to source. Most of the emissions are reported by branch organizations (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 14-014 on the website http://english.rvo.nl/nie.
Activity data: The major hospital supplier of N_2O for anaesthetic use reports the consumption data for 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.
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 14-014 on the website http://english.rvo.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 on 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 for 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

The Dutch Association of Aerosol Producers (NAV) reports data on the annual sales of N2O-containing spray cans. Since this submission, the annual sales have been based on real sales figures instead of estimated sales. As a result of these improved activity data, the N_2O emissions have been recalculated for the whole time series. The results of the recalculation and changes can be found in Table 5.2.

Table 5.2 Effects of changes in activity data for aerosol cans (3D3) 1990 -2012 (Units: Gg CO_2 eq).

Year	NIR 2014: N_2O emission	NIR 2013: N_2O emission	Difference
1990	94	75	19
1991	99	79	20
1992	104	83	21
1993	123	98	25
1994	125	99	25
1995	160	127	32
1996	192	153	39
1997	171	136	34
1998	188	150	38
1999	174	139	35
2000	147	117	30
2001	117	93	24
2002	110	88	22
2003	116	93	24
2004	157	112	45
2005	164	120	44
2006	175	138	37
2007	154	149	5
2008	170	151	20
2009	213	158	55
2010	210	13	197
2011	208	13	195

5.3.7 Source-specific planned improvements

There are no source-specific improvements planned.

6
Agriculture [CRF Sector 4]

Major changes in sector 4 Agriculture compared to the National Inventory Report 2013

Emissions: Methane (CH_4) emissions from Agriculture remained almost unchanged from 2011 to 2012, while nitrous oxide (N_2O) emissions decreased by 3.4 percent, translating into a 1.4 percent overall decrease in total CO_2 eq produced by this sector.

Although some changes in activity (animal numbers) occur, they pertain to both increases and decreases, eventually evening out in CH_4 emissions. The main driver for the reduction in N_2O emissions are lower N excretions per animal. In cattle, the sector agreed to a covenant specifically aimed at reducing the N in feedstuff used. Pigs also contributed to the decrease, but here the change is more dependent on the price level of inputs.

Key sources: No changes compared to the NIR 2013.

Methodologies: From 2010 onwards, the NEMA model has been used as the basis for emission assessments in the agricultural sector. Although originally an ammonia emission model, it was already calculating the emissions of other N substances from manure management, since it had to adjust for those during manure application. To cover all categories and gases, the emission registration team expanded on this by performing a set of additional calculations. Starting this year, these have been taken up in NEMA, making it an integrated emission model. Methods remained unchanged, but it was discovered that some animal numbers needed small corrections to match official statistics.

The calculation of methane from enteric fermentation in mature dairy cattle has been split for the NW and SE parts of the country (as announced previously). In the process, some small deviations from basic data, mainly in the chemical composition of rations fed, were detected and corrected. As a result, the source total has been adjusted by -76 to +4 Gg CO_2 eq per year of the time series.

Ammonia emission factors for the manure management of mature dairy cattle were updated. This has given rise to changes in N flows, starting in 2002, by reducing N available for application and increasing the N being deposited atmospherically. Overall, the effect on N_2O emissions, however, has been very slight (around +1 Gg CO_2 eq per year).

Over recent years, the use of air scrubbers as an abatement technology for reducing ammonia emissions has seen a rapid increase. Inspection reports have shown that such air scrubbers were not always used where required. Furthermore, until now, the ammonia retained was considered to remain within the animal manure, but the rinsing liquid in actual practice is being used as a chemical fertilizer. Implementation grades have now been corrected for the reported deficiencies and the waste stream has been allocated correctly. This has resulted in somewhat higher N_2O emissions, starting from 1997 onwards and increasing to approximately +10 Gg CO_2 eq for 2011.

Over 2010 and 2011, there appeared to have been a build-up of stored manure. On closer inspection, however, this was found not to have been the case, as there was sufficient capacity available to dispose of all manure produced. Some (in-)direct emissions have therefore been added for these years, amounting to 17 and 13 Gg CO_2 eq respectively.

Following the UNFCCC review, a resubmission of last year's inventory took place in October 2013, adding mules and asses to the inventory. These are now also included in the documentation being presented.

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 through land use in agriculture. These emissions are included in 1A4c 'Agriculture/forestry/fisheries' (section 3.2.9) and in 5 'Land Use, Land Use Change and Forestry' (LULUCF, sections 7.6 and 7.7).

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

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

Manure management (4B) includes all emissions from confined animal waste management systems (AWMS). CH_4 emissions from animal manure produced on pasture land during grazing are included in category 4B 'Manure management'; 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 therefore are not included.

The following protocols on http://english.rvo.nl/nie describe the methodologies, activity data and emission factors (EFs) applied in estimating N_2O and CH_4 emissions from the agricultural sector in the Netherlands:
- Protocol 14-027: CH_4 from Enteric fermentation (4A);
- Protocol 14-029: CH_4 from Manure management (4B);
- Protocol 14-028: N_2O from Manure management (4B);
- Protocol 14-031: N_2O from Agricultural soils: direct emissions and grazing emissions (4D);
- Protocol 14-030: N_2O from Agricultural soils: indirect emissions (4D).

Overview of shares and trends in emissions

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

CO_2 equivalent emissions from Sector 4 'Agriculture' was responsible for 8.3% of total national emissions (without LULUCF) in 2012, compared to 10.6% in 1990. In 2012, emissions of CH_4 and N_2O from agricultural sources accounted for 61 and 74% of the national total CH_4 and N_2O emissions. Category 4A 'Enteric fermentation' is the main source of CH_4 emissions and category 4D1 'Direct soil emissions' is the largest source of N_2O emissions included in this sector.

Total greenhouse gas emissions from Agriculture decreased by approximately 30 per cent between 1990 and 2012, from 22.6 Tg CO_2 eq in 1990 to 15.9 Tg CO_2 eq in 2012 (see 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 fertilizers.

Methane (CH_4) emissions from Agriculture remained almost unchanged from 2011 to 2012 at approximately 9.2 Tg CO_2 eq, in line with comparable levels of activity (i.e. animal numbers). Nitrous oxide (N_2O) emissions decreased by 3.4 percent, from 7.0 to 6.7 Tg CO_2 eq as the result of

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

Sector/category	Gas	Key	Emissions base year	2011	2012	Absolute 2012–2011	Contribution to total in 2012 (%)		
			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
4 Agriculture	CH_4		10.7	9.2	9.2	0.01	57.7	61	4.8
	N_2O		11.9	7.0	6.7	-0.24	42.3	74	3.5
	All		22.6	16.1	15.9	-0.23			8.3
4A Enteric fermentation	CH_4		7.6	6.5	6.6	0.01	41.2	44	3.4
4A1 Cattle	CH_4	L,T1	6.8	5.8	5.8	0.03	36.4	39	3.0
4A8 Swine	CH_4	L2	0.4	0.4	0.4	-0.01	2.4	3	0.2
4A2-7, 9-13 Other animals	CH_4		0.4	0.4	0.4	-0.01	2.4	3	0.2
4B Manure management	CH_4		3.1	2.6	2.6	-0.01	16.5	18	1.4
	N_2O	L	1.2	1.1	1.0	-0.04	6.3	11	0.5
	All		4.2	3.7	3.6	-0.05	22.9		1.9
4B1 Cattle	CH_4	L,T	1.6	1.8	1.8	0.01	11.3	12	0.9
4B8 Swine	CH_4	L,T	1.2	0.8	0.8	-0.01	4.8	5	0.4
4B9 Poultry	CH_4	T2	0.3	0.0	0.0	0.00	0.3	0	0.0
4B2-7, 10-13 Other animals	CH_4		0.0	0.0	0.0	0.00	0.2	0	0.0
4D Agriculture soils	N_2O		10.7	5.9	5.7	-0.19	35.9	63	3.0
4D1 Direct soil emissions	N_2O	L,T	4.1	3.3	3.2	-0.08	20.3	36	1.7
4D2 Animal production on agricultural soils	N_2O	L,T	3.1	1.1	1.0	-0.06	6.6	12	0.5
4D3 Indirect emissions	N_2O	L,T	3.4	1.5	1.4	-0.05	9.0	16	0.7
National Total GHG emissions (excl. CO_2 LULUCF)	CH_4		25.7	15.3	14.9	-0.32			
	N_2O		20.0	9.3	9.1	-0.22			
	All		213.2	195.1	191.7	0.00			

Figure 6.1 Category 4 'Agriculture': trend and emission levels of source categories, 1990-2012.

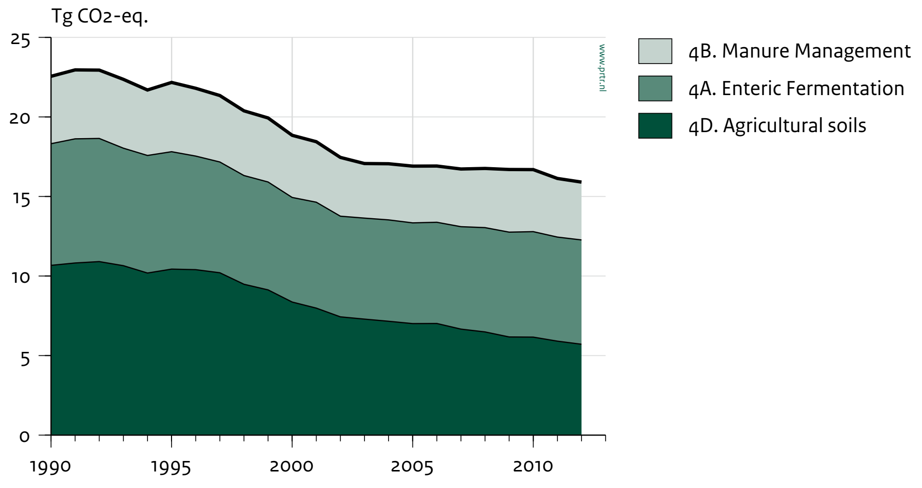


Table 6.2 Numbers of animals in 1990-2012 (1,000 heads) (www.cbs.nl).

Animal type	1990	1995	2000	2005	2010	2011	2012
Cattle	4,926	4,654	4,069	3,797	3,975	3,885	3,879
- mature dairy cattle	1,878	1,708	1,504	1,433	1,479	1,470	1,484
- mature non-dairy cattle	120	146	163	151	115	105	99
- young cattle	2,929	2,800	2,402	2,213	2,381	2,311	2,297
Sheep	1,702	1,674	1,305	1,361	1,130	1,088	1,043
Goats	61	76	179	292	353	380	397
Horses	370	400	417	433	441	436	431
Mules and Asses	NO	NO	NO	NO	1	1	1
Pigs (*1,000)	13.9	14.4	13.1	11.3	12.3	12.4	12.2
Poultry (*1,000)	94.9	91.6	106.5	95.2	103.4	98.9	97.0
Other animals	659	527	641	745	1001	1,016	1,074

lower N excretions per animal. Overall, this translates into a 1.4 percent decrease in total CO_2 eq produced by this sector from 2011 to 2012.

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 for reference years and in background documents (e.g., Van Bruggen et al., 2014). Table 6.2 presents an overview.

The number of privately owned horses is estimated to be approximately 300,000 heads by the Product Boards for Livestock, Meat and Eggs (PVE, 2005). As information on activity data for privately owned horses is scarce, this estimate 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 estimate is being added to the numbers from the agricultural census. It is subsequently used in calculations and reported as part of agriculture.

For cattle, three categories are recognized (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 different age categories for breeding and meat production, including adult male cattle.

Between 1990 and 2012, (dairy) cattle, pig and sheep numbers decreased by 21 per cent, 12 per cent and 39 per cent, respectively. Poultry and horse numbers increased by 2 per cent and 17 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 63 per cent over the 1990–2012 period.

For mature dairy cattle, the decrease in numbers was associated with an increase in milk production per cow between 1990 and 2012. The increased milk production per cow is the result of both genetic changes (due to breeding programmes for milk yield) as well as an increase in feed intake. Total milk production in the Netherlands is determined mainly by European Union (EU) policy on milk quotas, which have remained unchanged for the most part. 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 led to a stabilization in the number of mature dairy cattle. Between 1990 and 2012, the numbers of young (dairy) cattle followed the same trend as the numbers of adult female cattle – namely, a decrease.

The Netherlands' manure and fertilizer policy also influences livestock numbers. Pig and poultry numbers, in particular, decreased as a result of the introduction of measures such as the government buying up part of the pig and poultry production rights (ceilings for total phosphate production by animals) and lowering the maximum application standards for manure and synthetic fertilizer. The decreasing trend of the past has levelled off in the last couple of years.

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 transport 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 was 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 of 6 per cent below the 2002 number in 2012.

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, dairy farmers are tending to change their management towards goats.

Compared with 2011, animal numbers remained fairly stable in 2012. Fewer mature non-dairy cattle were kept (-6.2 per cent), but as this is only a small sub-category it is easily offset by a small increase in mature dairy cattle. Sheep decreased by 4.2 per cent and goats increased by 4.3 per cent. 'Other animals', consisting of fur-bearing animals and rabbits, increased by 5.7%.

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 utilized by micro-organisms under anaerobic conditions. Both ruminant animals (e.g. cattle, sheep and goats) and non-ruminant animals (e.g. pigs, horses and mules and asses) produce CH_4, but per unit of feed intake ruminants generate much more.

In ruminants, the digestive system is specialized to digest fibrous material and has a strongly expanded chamber (the rumen) in front of the stomach. This allows for a selective retention of feed particles and supports an 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 a high production of hydrogen. Methanogens utilize this hydrogen as an energy source with methane as the end product, mainly exhaled through the respiratory system of the host ruminant. With a variation in feed characteristics, there is a variation in extent of rumen fermentation and the amount of hydrogen produced and converted into methane.

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

6.2.2 Overview of shares and trends in emissions

In 2012, 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 the remaining animal categories (sheep, goats, horses and mules and asses) accounted for the remaining 6 per cent.

Trends in CH_4 emission from Enteric fermentation are explained by a change in animal numbers, a change in EF or both. CH_4 emissions from Enteric fermentation decreased from 7.6 Tg CO_2 eq to 6.6 Tg (-13 per cent) between 1990 and 2012, which is almost entirely explained by a decrease in CH_4 emissions from cattle. 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

Detailed information on data sources for activity data and EFs can be found in the following monitoring protocol:
- Protocol 14-027: CH_4 from Enteric fermentation (4A)

All relevant documents concerning methodology, EFs and activity data are published on the website http://english.rvo.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, and a full overview can be found in Van Bruggen et al., 2014.

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

The feed intake is estimated from the energy requirement calculation used in the Netherlands (WUM, 2012) and it is the most important parameter in the calculation of the CH_4 EFs for cattle. For instance, the energy requirement for dairy cows (expressed as net energy value of lactation, or VEM in Dutch) is calculated based on the requirement for total milk production, maintenance and other minor functions. For young cattle, the energy requirement is calculated on the basis of total weight gain.

The energy value of the feed depends on its composition and hence feed composition also determines estimated

Table 6.3 EFs for methane from enteric fermentation specified according to CRF animal category (Unit: kg CH4/animal/year).

	1990	1995	2000	2005	2010	2011	2012
Mature dairy cattle (average)	110.3	114.3	119.9	124.9	128.1	128.3	128.2
Of which NW region	110.9	115.3	121.6	126.3	129.9	130.0	131.0
Of which SE region	109.9	113.5	118.4	123.6	126.8	127.1	126.3
Mature non-dairy cattle	64.9	65.8	66.6	70.8	72.1	73.0	73.0
Young cattle	36.8	37.2	34.7	33.7	34.0	33.8	34.0

feed intake. The intake of fresh grass, grass silage (and hay), maize silage, wet by-products, standard and protein-rich concentrates is estimated from national statistics found at www.cbs.nl.

Mature dairy cattle
The CH_4 emission from enteric fermentation by mature dairy cattle is calculated by a Tier 3 approach using an updated version of the model of Mills et al. (2001), which was published by Bannink et al. (2011). 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, CH_4 EF (in kg CH_4/cow/year) and the methane conversion factor (Y_m; % 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, organic acids and ash) and the intrinsic degradation characteristics of starch, NDF and crude protein in the rumen.

Data on the share of feed components in the diet are found at www.cbs.nl. Data on the chemical nutrient composition of individual roughages are provided by Blgg (a leading laboratory in the Dutch agricultural and horticultural sector with roughage sampling, analytical and advisory activities that is able to deliver data that can be taken as representative of average Dutch farming conditions; www.blgg.com). Because of differences in the rations fed (especially the amounts of maize), calculations are split for the north-west (NW) and south-east (SE) parts of the country. Data used between 1990 and the present are published in an annex to Van Bruggen et al., 2014.

Young cattle and mature non-dairy cattle
The EFs for methane from enteric fermentation in mature non-dairy and young cattle are calculated by multiplying the GE intake by a methane conversion factor (Smink, 2005). Changes in GE intake are based on changes in the total feed intake and on the share of feed components. Data on the amounts of feed components, expressed as dry matter (DM) intake, are found at www.cbs.nl. The equation for calculating the EF (in kg CH_4/animal/year) is:

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

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

And:
GE intake = Dry Matter intake (kg DM/animal/day) × 18.45 MJ/kg DM (IPCC, 2001);
Y_m = 0.04 for white veal calves and 0.06 for the other categories of young cattle and mature non-dairy cattle (IPCC, 2001).

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

Trends in cattle EFs
Table 6.3 shows the EFs of the different cattle categories that are reported, including the subdivision in the NW and SE regions for mature dairy cattle. The EF for young cattle is an average of several subcategories (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 1990–2012. For mature 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 2012 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 EFs with IPCC defaults
Table 6.4 shows that ‘mature dairy cattle’ EF follows the increasing trend in milk production. Compared to the default IPCC EF of 118 kg CH_4 per cow a year (at a milk production rate of 6,700 kg/cow/year), the EF used in the Netherlands is slightly lower. An explanation of the difference can be found in the data on feed intake, dietary composition and nutrient composition of dietary

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	2012
Milk production	6,003	6,596	7,416	7,568	8,075	8,063	8,192
EF for methane	110.3	114.3	119.9	124.9	128.1	128.3	128.2

components as input to an alternative country-specific Tier 3 approach that predicts the methane emission factor for mature dairy cattle (Bannink, 2010).

With increasing milk production per cow, a decrease in the amount of CH_4 emission per unit of milk produced (from 0.018 to 0.016 kg CH_4/kg milk) can be seen.

The higher 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 mature 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, horses and mules and asses, IPCC default EFs are used
(1.5, 8, 5, 10 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, data sources and EFs is found in the protocol on http://english.rvo.nl/nie, as indicated in section 6.2.3. In 2009, a recalculation was carried out with regards to feed intake and the resulting cattle EFs for the whole time series (CBS, 2009 and Bannink, 2011). During the split of the calculation for mature dairy cattle between the NW and SE parts of the country, some small deviations from basic data on the chemical composition of feed components were corrected (Van Bruggen et al., 2014).

The other livestock categories (sheep, goats, horses, mules and asses, 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. EFs used for the source categories swine, sheep, goats, horses, and mules and asses are the 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.

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

Emissions from enteric fermentation are eventually 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 according to IPCC source categories. The uncertainty of CH_4 emissions from Enteric fermentation from cattle sources is based on the judgements of experts and is estimated to be approximately 16% of annual emissions for mature dairy cattle, using a 5% uncertainty for animal numbers (Olivier et al., 2009) and 15% for the EF (Bannink, 2011). For the other cattle categories, this is 21% based on 5% uncertainty in activity data and 20% on the EF. The uncertainty in the EFs for swine and other animal categories is estimated to be 50% and 30%, respectively (Olivier et al., 2009).

Time series consistency

A consistent methodology is used throughout the time series; see 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 over a long period of time (several decades). EFs are either constant (default IPCC) or are calculated/modelled from feed intake data collected by an annual survey published by Statistics Netherlands.

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

In order to comply with requirements set by the Farm Accountancy Data Network (FADN) of the European Union, however, a new definition for farms is being used from 2010 on. Previously, the criterion for inclusion in the agricultural census was three Dutch size units (nge). This has been changed to 3,000 Standard Output (SO). The influence on measured population has been minimalized by setting the new criterion to a value that matches 3 nge. As a result, the official statistics did not have to be 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

Emission factors for mature dairy cattle
Rations fed to mature dairy cattle differ considerably between the NW and SE parts of the country. The country specific Tier 3 approach described by Bannink et al. (2011) accounts for this by calculating an EF (and MCF) for both regions, as well as a weighed overall EF. Until now, the latter was used in calculating the emissions of CH_4 from enteric fermentation in mature dairy cattle. On the national scale, this yielded correct results, but for the subsequent regionalization of emissions the additional information was lost.

From this year on, therefore, the calculation has been split between NW and SE regions with the reported total being the sum of both. Along the way, some small deviations from the basic data, mainly in the chemical composition of the rations fed, were detected and corrected. As a result, source total has been adjusted by -76 to +4 Gg CO_2 eq per year of the time series.

Mules and asses
Following the UNFCCC review, a resubmission of last year's inventory took place in October 2013, adding mules and asses to the inventory. These are now also included in the documentation being presented.

6.2.8 Source-specific planned improvements

None.

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, mules and asses, 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, buffalo and camels and llamas do not occur in the Netherlands. Three animal manure management systems are recognized for use in emission estimates for both CH_4 and N_2O: liquid and solid manure management systems and manure produced on pasture land while grazing. In accordance with IPCC Guidelines, N_2O emissions from manure produced on pasture land during grazing are not taken into account in source category 4B Manure management, but are included in source category 4D Agricultural soils (see section 6.4).

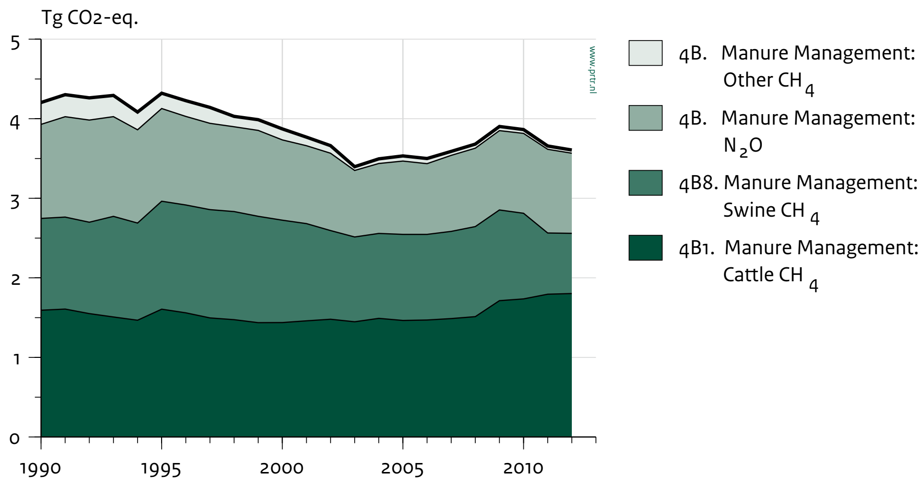
6.3.2 Overview of shares and trends in emissions

In 2012, 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 2012 contributed 11 per cent and 5 per cent, respectively, to 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 6 per cent to total greenhouse gas emissions from the Agriculture sector

CH_4 from manure management
Between 1990 and 2012, 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 34 per cent and 84 per cent, respectively, during this period. With cattle increasingly being kept indoors, a larger proportion of manure excretion was taking place in the animal housing 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

Figure 6.2 Category 4B Manure management: trend and emission levels of source categories, 1990-2012.



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. The decrease is countered, however, 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 animal housing. 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 2012 can be explained only by the shift towards the solid manure management system with an associated lower EF.

From 2010 to 2011, emissions of CH_4 from Manure management saw 9 per cent decrease. New measurements of the volatile solids 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, broilers and horses, and higher values for rose veal (as a part of young stock) and fur-bearing animals (as part of other animals). From 2011 to 2012, emissions remained almost unchanged in line with comparable levels of activity (i.e. animal numbers).

N_2O from Manure management

The emissions of N_2O from Manure management decreased by 15 per cent between 1990 and 2012, from 1.2 to 1.0 Tg CO_2 eq (Table 6.1). Decreasing animal numbers and lower N excretions per animal have been the main cause of this trend. From 2007 on, it changed back to an increase, 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 manure 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.

With the transition now complete, N_2O from Manure management decreased by 4.3 per cent again from 2011 to 2012 as the result of lower N excretions per animal. In cattle, the sector agreed to a covenant specifically aimed at reducing the N in the feedstuff stocks used. Pigs also contributed to the decrease, but here the change was more dependent on the price level of inputs.

6.3.3 Activity data and (implied) emission factors

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

- Protocol 14-029: CH_4 from Manure management (4B)
- Protocol 14-028: N_2O from Manure management (4B)

More details and specific data (activity data and EFs), including data sources, are documented in the background documents. All relevant documents concerning methodology, EFs and activity data are published on the website http://english.rvo.nl/nie.

Table 6.5 CH_4 implied emission factor (kg/head/year) for Manure management as specified by animal category, 1990-2012.

Animal type	1990	1995	2000	2005	2010	2011	2012
Cattle							
- mature dairy cattle	28.04	30.84	33.55	37.95	43.09	43.09	43.09
- mature non-dairy cattle	3.27	3.58	3.50	3.50	3.50	3.53	3.53
- young cattle	7.79	8.32	7.27	6.71	7.77	9.41	9.38
Sheep[1]	0.17	0.18	0.20	0.18	0.16	0.16	0.17
Goats[1]	0.37	0.34	0.33	0.35	0.37	0.33	0.35
Horses	2.90	2.93	2.91	2.90	2.90	1.97	1.97
Mules and Asses	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Swine[2]	3.95	4.49	4.67	4.55	4.18	2.95	2.95
Swine excl. piglets	6.30	7.34	7.64	7.63	7.19	5.14	5.11
- fattening pigs	5.03	6.15	6.40	6.40	5.86	4.20	4.20
- breeding swine	11.52	12.39	13.01	13.11	13.55	9.64	9.62
Poultry	0.14	0.10	0.06	0.03	0.02	0.02	0.02
Other animals	0.13	0.12	0.10	0.09	0.11	0.17	0.17

1 The IEF is calculated based on total sheep and goat numbers, including young and male animals. Manure production of young and male animals has been accounted for in the manure production of female animals.

2 The IEF is calculated based on total pig numbers, including piglets. Manure production by piglets is accounted for in manure production by adult breeding swine.

Activity data on animal numbers can be found on the website www.cbs.nl, in Annex 8, Table A8.1 for reference years and in a background document (Van Bruggen et al., 2014). Data used in the calculation and resulting CH_4 EFs can be found in Annex 8, Tables A8.4 to A8.10.

CH_4 emission factors (EF) for Manure management

A country-specific Tier 2 approach is used to calculate CH_4 EFs for Manure management annually, based on data on manure characteristics and manure management system conditions. The EFs are calculated for the predominate manure management system (i.e. liquid or solid manure) within every animal category and, if applicable, for the manure produced on pasture land during grazing. For laying hens, a further subdivision is made for the liquid and solid manure management systems because of the transition between both (see section 6.3.2). These calculations are based on country-specific data on:

- Manure characteristics: volatile solids (VS, in kg/kg manure) and maximum CH_4 producing potential (Bo, in m^3 CH_4/kg VS);
- Manure management system conditions (storage temperature and period) for liquid manure systems, which determine the methane conversion factor (MCF).

In formula: EF = VS * Bo * MCF * 0.67

Where:

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

Typically in the Netherlands, animal manure is stored in cellars under the slatted floors of animal housing and, when full, is pumped into outside storage facilities. Given this practice, country-specific MCF values were calculated, as demonstrated in Van der Hoek and Van Schijndel (2006). For solid manure systems and manure produced on pasture land while grazing, IPCC default values are used. The IPCC Guidelines recommend a MCF value of 0.01 for stored solid cattle manure and MCF = 0.015 for stored solid poultry manure. The literature shows, however, 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 value for stored solid poultry manure (Van der Hoek and Van Schijndel, 2006).

For the sake of comparison, Table 6.5 shows the implied emission factors (IEF) for manure management per animal category. These are expressed as kg CH_4 per animal per year and were calculated by dividing total emission by animal number in a given category.

Trends in IEF

Mature dairy cattle

The IEF for the Manure management of mature dairy cattle increased between 1990 and 2012 because the increased milk production during that period (Table 6.4) was accompanied by an increase in manure production per cow and an increase in the volatile solids 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 on pasture land). The share of the amount of liquid stable manure increased between 1990 and 2012, while simultaneously the amount of manure produced on pasture land during grazing decreased (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 trend lies in the efficiency gained by keeping the animals indoors for 365 days per year, productions of both grassland and animals themselves can be maximized. With animal housing manure showing a 17-fold higher EF for CH_4 emissions, the new practice of keeping the herd inside the animal housing 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 2012 mainly explains the decrease in CH_4 emissions. 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 2012 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 2 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 the storage of manure under higher temperatures (increased storage capacity below animal housing) and in 1995 due to increasing volatile solids. In 2011 the volatile solids decreased and so did the IEF (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 provides a better understanding of the interannual changes.

Remaining animal categories

Sheep, goats, horses, and mules and asses only produce solid manure, which has a low EF and therefore resulting IEFs are also small. 'Other animals' is comprised of rabbits and fur-bearing animals, which produce solid and liquid manure, respectively. The resulting IEF for this category, therefore, is very dependent on the ratio between both species in a given year.

Comparison with IPCC default methane emission factor

The emission factor per animal category used by the Netherlands cannot be compared directly to the IPCC default values because of the assumptions regarding the share of the different animal manure management systems underlying the IPCC defaults. Furthermore, the Netherlands' country-specific emission factors are expressed as the amount of CH_4 emitted per kg animal manure per year, whereas in the IPCC method the emission factor is expressed as the amount of methane (in kg) emitted per animal per year.

The values of one of the underlying parameters of each manure management system, Volatile Solids (VS), also called Organic Matter (OM) per animal type are also not directly comparable. The Netherlands' approach differs from the IPCC method in that the Netherlands uses the VS content of the manure (kg VS per kg manure) instead of volatile solids VS produced per animal per day (kg per head per day) in the IPCC calculation equations. By multiplying the VS per kg manure by the manure production per year, the annual VS production in manure in the Netherlands can be compared with the annual VS production underlying the default IPCC EFs. More details are presented in Annex 8.

Compared with the IPCC default MCF values, the Netherlands' MCF values for the liquid manure systems for swine (1990-1996) and cattle are slightly lower because part of the manure is stored under cooler conditions. For solid manure systems, the Netherlands uses a MCF of 1.5% for all animal categories (see section 6.3.2); for manure production on pasture, it uses the IPCC default MCF value.

Although the approach of the method applied by the Netherlands for CH_4 calculations differs slightly from the IPCC method, it is in accordance with the IPCC GPG. 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) requirements.

N_2O implied emission factor (IEF) for Manure management

Emissions of N_2O from Manure management are calculated within the National Emission Model for Agriculture (NEMA), in which EFs represent the IPCC 1996/

Table 6.6 N_2O implied emission factor for Manure management and total N-excretion per animal manure management system, 1990-2012 (Units: mln kg/year and kg N_2O/kg manure).

	1990	1995	2000	2005	2010	2011	2012
Total N-excretion	514.5	516.1	432.6	393.6	423.3	423.2	410.6
- liquid system	412.4	411.8	337.7	305.2	326.8	329.4	321.2
- solid storage	102.1	104.3	94.8	88.4	96.5	93.8	89.5
N_2O emission manure management	3.81	3.76	3.26	2.97	3.24	3.39	3.25
N_2O IEF manure management	0.0074	0.0073	0.0075	0.0075	0.0077	0.0080	0.0079

GPG default values for liquid and 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 2012 mainly as a consequence of the decrease in the total N excretion.

6.3.4 Methodological issues

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

Nitrous oxide emissions from animal manure
For the manure management systems and animal categories recognized, 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) by animal numbers. Activity data are collected in compliance with a Tier 2 method. N_2O EFs used for liquid and solid manure management systems are IPCC defaults. The method used fully complies with the IPCC Good Practice Guidance (IPCC, 2001), which is required for this key source. N_2O emissions from manure produced on pasture land 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 is estimated to be approximately 100%. The uncertainty in the amount of animal manure (10%) is based on a 5% uncertainty in animal numbers and a 5–10% uncertainty in manure production per animal. The resulting uncertainty of 7–11% was rounded off to 10%. The uncertainty in the CH_4 EFs for Manure management, based on the judgments of experts, is estimated to be 100% (Olivier et al., 2009).

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

In order to comply with requirements set by the Farm Accountancy Data Network (FADN) of the European Union, a new definition for farms is being used from 2010 on. Previously, the criterion for inclusion in the agricultural census was three Dutch size units (nge). This has been changed to 3,000 Standard Output (SO). The influence on measured population has been minimalized by setting the new criterion to a value that matches 3 nge. As a result, the official statistics did not have to be recalculated and, therefore, the inventory also remained unchanged for historic years.

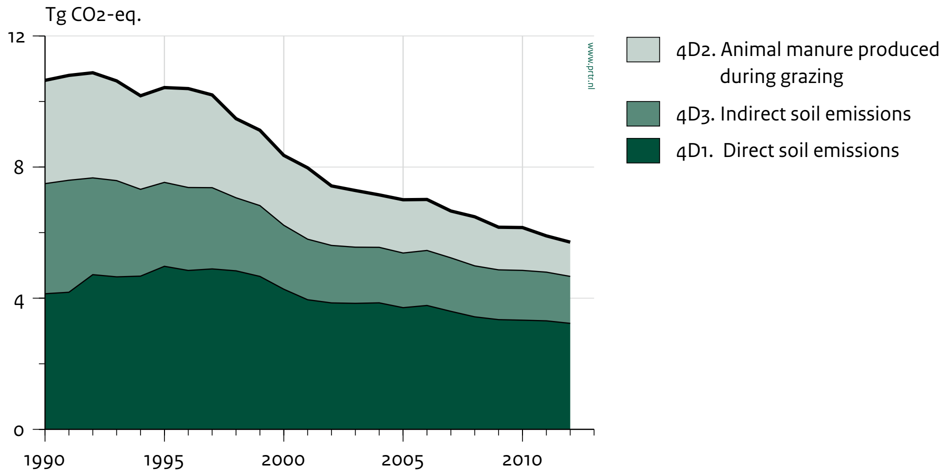
6.3.6 Source-specific QA/QC

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

6.3.7 Source-specific recalculations

Following the UNFCCC review, a resubmission of last year's inventory took place in October 2013, adding mules and asses to the inventory. These are now also included in the documentation being presented. As the emissions were

Figure 6.3 Category 4D Agricultural soils: trend and emission levels of source categories, 1990-2012.



already included in the resubmission of October 2013, the emissions for this source category have not been changed compared with the latest submission.

Furthermore, small errors in activity data (i.e. animal numbers) for Manure management were detected and corrected (CH_4 emissions for 1993 and from 2000 to 2005) while adding the calculations to NEMA.

Both recalculations have improved the completeness and consistency of the inventory, but the effect on reported emissions is only minimal.

6.3.8 Source-specific planned improvements

A possible technical measure to prevent methane emissions caused by Manure management is manure treatment in an anaerobic digester. In 2008, 0.6% of the total liquid manure in animal housing 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) make it clear that further investigations are 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 fertilizers, 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 on pasture land during grazing (4D2);
- Indirect emissions from N leaching and run-off and from N deposition (4D3).

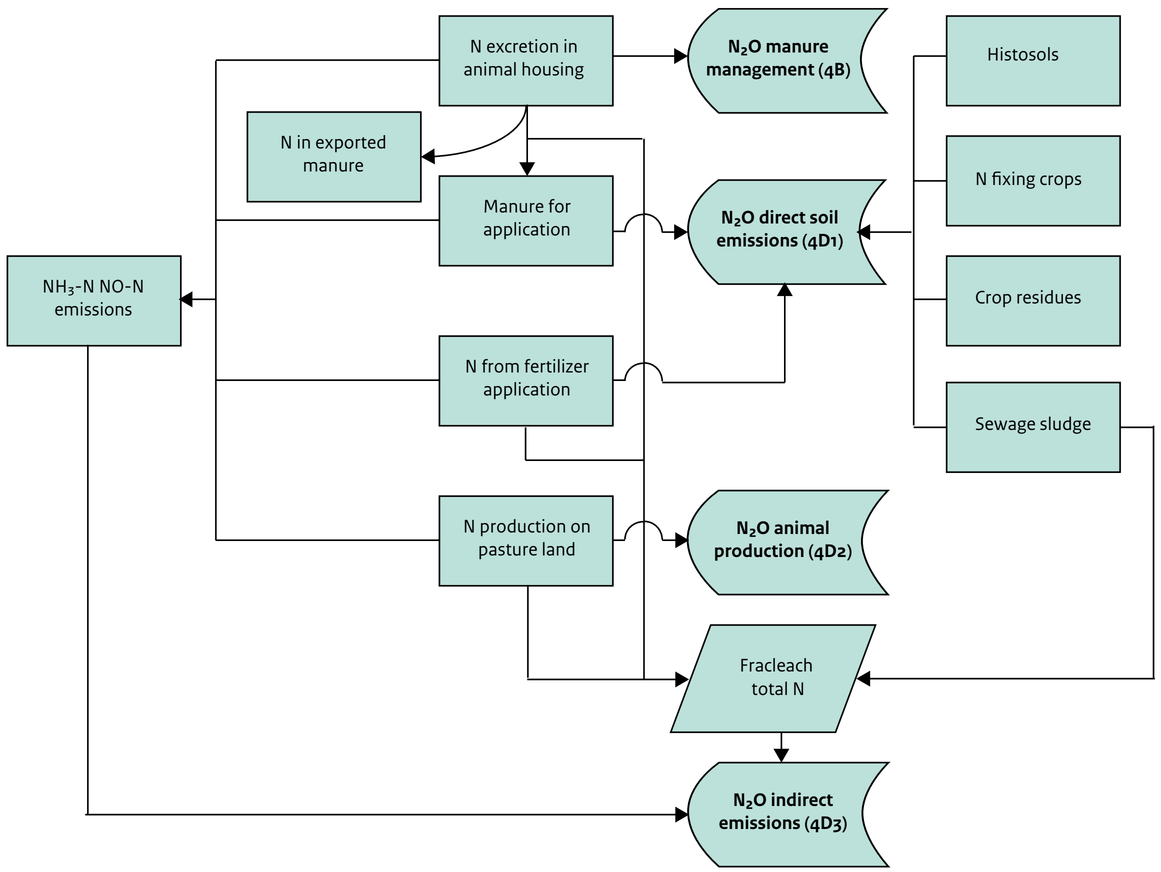
6.4.2 Overview of shares and trends in emissions

In 2012, agricultural soils were responsible for 36 per cent of total greenhouse gas emissions in the Agriculture sector. Direct and indirect N_2O emissions and emissions from animal production on pasture land accounted for 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 2012 (see Figure 6.3). Direct emissions decreased by 22 per cent, while emissions from animal manure produced on pasture land and indirect emissions decreased by 67 per cent and 57 per cent, respectively.

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

Figure 6.4 Schematic representation of N flows in agriculture and the allocation of emissions to source categories.



6.4.3 Key sources

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

6.4.4 Activity data and (implied) emission factors

Detailed information on data sources (for activity data and EFs) can be found in the following monitoring protocols:
- Protocol 14-030: N_2O from Agricultural soils: indirect emissions (4D);
- Protocol 14-031: N_2O from Agricultural soils: direct emissions and grazing emissions (4D).

More details and specific data (activity data and EFs), including data sources, are included in background documents. All relevant documents concerning methodology, EFs and activity data are published on the website http://english.rvo.nl/nie.

Calculations of N_2O emissions from Agricultural soils are based on a variety of activity data. Manure productions are calculated as described in section 6.3.3 and statistics on nitrogen fertilizer application, crop area and the agricultural use of sewage sludge are also used. For an overview of data sources, see the protocols or the background document (Van der Hoek et al., 2007). The activity data and factors for crops can also be found in Annex 8, Tables A8.11 and A8.12.

Nitrogen flows
In Figure 6.4 a schematic representation of N flows and the resulting emissions in agriculture is shown. Gross amounts are used throughout, i.e. emissions of various N substances from a given source are calculated using the same basic nitrogen amount. For instance, with N excretion in animal housing, losses in the form of ammonia, nitric oxide, nitrogen gas or laughing gas are all relative to the amount of N excreted. Only at the end is the combined loss subtracted in order to yield the remaining N available for application.

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

	1990	1995	2000	2005	2010	2011	2012	Change 1990-2012
4B Manure management								
Nitrogen excretion in animal housing	514.5	516.1	432.5	393.5	423.3	423.2	410.6	-20%
of which in solid form	102.1	104.3	94.8	88.4	96.5	93.8	89.5	-12%
of which in liquid form	412.4	411.8	337.7	305.1	326.8	329.4	321.2	-22%
NH_3-N emissions from animal housing	72.3	70.5	56.3	48.9	49.3	46.8	44.2	-39%
NO-N emissions from animal housing	2.4	2.4	2.1	1.9	2.1	2.2	2.1	-15%
N_2O-N emissions from animal housing	2.4	2.4	2.1	1.9	2.1	2.2	2.1	-15%
Other N losses from animal housing[1]	14.6	14.3	12.2	12.4	15.0	17.8	17.6	21%
Nitrogen in exported manure	5.9	22.4	17.9	26.1	35.8	35.8	40.9	598%
Nitrogen in incinerated manure	6.6	4.5	5.6	6.7	19.0	18.3	20.1	203%
4D Agricultural soils								
4D1 Direct soil emissions								
Available manure for application	410.3	399.8	336.3	295.7	300.0	300.2	283.8	-31%
(N excretion in animal housing - total N losses in animal housing - exported/incinerated manure)								
NH_3-N emissions from manure application	182.5	63.6	51.0	43.7	34.9	35.3	31.6	-83%
NO-N emissions from manure application	4.9	4.8	4.0	3.5	3.6	3.6	3.4	-31%
N_2O-N emissions from manure application	1.6	3.5	2.9	2.6	2.6	2.6	2.5	50%
Nitrogen from fertilizer application[2]	412.4	405.8	339.5	279.2	219.5	214.1	213.2	-48%
NH_3-N emissions from fertilizer application	12.0	12.0	10.5	11.4	8.9	9.3	12.0	0%
NO-N emissions from fertilizer application	4.9	4.9	4.1	3.4	2.7	2.7	2.7	-46%
N_2O-N emissions from fertilizer application	5.4	5.3	4.4	3.6	2.9	2.8	2.8	-47%
Nitrogen fixation in arable crops	7.8	4.9	4.7	4.5	4.4	4.2	4.0	-49%
N_2O-N emissions from N fixing crops	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-49%
Nitrogen in crop residues left in field	36.4	34.9	34.1	32.1	25.5	25.8	25.2	-31%
N_2O-N emissions from crop residues	0.4	0.3	0.3	0.3	0.3	0.3	0.3	-31%
Nitrogen mineralisation in histosols	52.4	52.4	52.4	52.4	52.4	52.4	52.4	0%
N_2O-N emissions from histosols	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0%
Nitrogen in sewage sludge on agricultural land	5.0	1.5	1.5	1.2	0.9	0.8	0.8	-84%
N_2O-N emissions from sewage sludge	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-84%
4D2 Animal production on agricultural soils								
Nitrogen excretion on pasture land	195.9	179.9	132.5	101.2	81.3	68.9	65.0	-67%
NH_3-N emissions excretion on pasture land	15.2	13.7	4.5	3.0	1.8	1.3	1.2	-92%
NO-N emissions excretion on pasture land	2.4	2.2	1.6	1.2	1.0	0.8	0.8	-67%
N_2O-N emissions excretion on pasture land	6.5	5.9	4.4	3.3	2.7	2.3	2.1	-67%

	1990	1995	2000	2005	2010	2011	2012	Change 1990-2012
4D3 Indirect emissions								
Atmospheric deposition of NH3-N/NO-N	296.6	174.1	134.0	117.0	104.2	102.1	97.8	-67%
N_2O-N emissions atmospheric deposition	3.0	1.7	1.3	1.2	1.0	1.0	1.0	-67%
Total nitrogen supply to soil	1,121.9	1,080.9	888.0	749.0	689.2	671.2	648.8	-42%
(N excretion in animal housing + N excretion on pasture land + N from fertiliser + sewage sludge - exported manure)								
Nitrogen lost through leaching and run off	157.1	140.5	106.6	90.0	83.0	81.1	78.4	-50%
N_2O-N emissions from leaching and run off	3.9	3.5	2.7	2.2	2.1	2.0	2.0	-50%

[1] Includes N_2-N losses from animal housing, N in the rinsing liquid of air scrubbers and N produced in the free-range for poultry.
[2] Including N in the rinsing liquid of air scrubbers.

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

Source	Default IPCC	EF used	Reference
Nitrogen fertilizer	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 and Van der Sluis, 2011.

Table 6.7 shows the resulting N flows from N excretion in animal housing and on pasture land, as well as synthetic fertilizer and manure application in the Netherlands. Between 70 per cent and 80 per cent of the N excreted in animal housing is eventually applied to soils. A growing proportion of the manure N (from 1 per cent in 1990 to 10 per cent in 2012) is exported; while approximately 10–15 per cent is emitted as ammonia or nitric oxide during storage. Other N losses in various forms, account for the remaining difference.

Of the manure N applied to the soil between 1990 and 2012, the part emitted as ammonia (NH_3) decreased from 44 per cent to 11 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, shifting to manure incorporation into the soil (e.g. shallow injection or ploughing in), resulting in lower NH_3 emissions. Ultimately, between 1990 and 2012, the part of the N in animal manure and synthetic fertilizer emitted as NH_3 (in the animal housing and during storage, grazing and application to the field) decreased from approximately 25 per cent to 13 per cent. In combination with lower nitrogen fertilizer application (-48%) and nitrogen excretion by animals (-33%), this resulted in a reduction of 67 per cent of N that was deposited atmospherically over the 1990-2012 period.

The total nitrogen supply to soil, for calculating leaching and run-off, consists of the manure production in animal housing and on pasture land, fertilizer and sewage sludge application, minus the net export of manure. In accordance with the IPCC Guidelines (IPCC, 1996), no correction is made for the N being emitted since, after atmospheric deposition, these amounts will also be subject to leaching and run-off. Total N supply to the soil decreased by 42 per cent between 1990 and 2012, which can be explained by the Netherlands' manure and fertilizer policy, which is aimed at reducing N leaching and run-off. This policy regulates the amount of manure production

Table 6.9 N_2O IEFs 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
2012	0.009

and its application by the introduction of measures such as pig and poultry manure production rights and maximum nutrient application standards for manure and fertilizer. Since the leaching fraction has also decreased over time, the amount of nitrogen leached or run-off has been reduced by 50% since 1990.

Emission factors

For fertilizer application, the EF for direct N_2O emission from Agricultural soils is a weighed mean for different fertilizer types applied on both mineral and organic soils. The EFs for the application of animal manure or produced on pasture land during grazing are also weighed means over those two soil types. As arable farming hardly ever occurs on organic soils, EFs for N fixation and crop residues are based on mineral soils only. An overview of the EFs used is presented in Table 6.8, with default IPCC EFs included for comparison.

Implied emission factor

Table 6.9 shows the IEFs for direct N_2O emissions from agricultural soils for the application of animal manure. A 117 per cent increase in IEF occurred in the period 1990–2012, which was caused by an ammonia policy-driven shift from the surface spreading of manure to the incorporation of manure into the soil. Combined with a 31 per cent decrease in N manure input to soil (see Table 6.7), this explains the 50 per cent increase in N_2O from manure application.

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 on pasture land 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 fertilizer application, softened by an increase in IEF because of the incorporation into soil.

6.4.5 Methodological issues

Direct and indirect N_2O emissions from Agricultural soils, as well as N_2O emissions by animal production on pasture land, are estimated using country-specific activity data on N input to soil and NH_3 volatilization during grazing, manure management (animal housing 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 http://english.rvo.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 Agricultural soils. Emissions from animal manure application are estimated for two types of manure application methods, i.e. 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 (i.e. hot spots) in comparison with surface spreading and hence the process conditions for nitrification and denitrification can be more suboptimal.

From 2010 on, calculations have been 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 a manure application technique on N_2O emission (Velthof et al., 2010; Velthof and Mosquera, 2011; Van Schijndel and Van der Sluis, 2011).

Animal production on agricultural soils

An IPCC Tier 1b/2 methodology is used to estimate direct N_2O emissions from animal production on agricultural soils. The method calculates the total N excreted during grazing, multiplied by a country-specific EF to yield the emission; see 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 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.

In the Netherlands, no experimental data are available to evaluate the value of the EFs 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.

In order to comply with the requirements set by the Farm Accountancy Data Network (FADN) of the European Union, a new definition for farms has been used from 2010 on. Previously, the criterion for inclusion in the agricultural census was three Dutch size units (nge); this has been changed to 3,000 Standard Output (SO). The influence on measured population has been minimalized by setting the new criterion to a value that matches 3 nge. As a result, the official statistics did not have to be 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

Ammonia emission factors for mature dairy cattle
Ammonia emission factors for the manure management of mature dairy cattle were updated. This gave rise to changes in N flows starting in 2002 by reducing N available for application and increasing the N being deposited atmospherically. Overall, however, the effect on N_2O emissions is very slight (around +1 Gg CO_2 eq per year).

Air scrubbers
Over recent years, the use of air scrubbers as an abatement technology for reducing ammonia emissions has seen a rapid increase. Until now, the ammonia retained was thought to remain within the animal manure, but the rinsing liquid in actual practice is being used as a chemical fertilizer. The waste stream has therefore been reallocated, which increases N_2O emissions because the corresponding EF is 1.3 instead of 0.9%.

Inspection reports have shown that such air scrubbers were not always used where required. Early investigations conducted in the province of Noord-Brabant indicated a compliance deficiency of 40% in 2009. After measures were taken, deficiency was reported to be down to 16% in 2012 (Handhavingsamenwerking Noord-Brabant, 2010 and 2013). Implementation grades used in the calculations have been adjusted accordingly, i.e. with 40% up to and including 2009, 32% in 2010, 24% in 2011 and 16% in 2012. This has softened the increase in N_2O emissions following the reallocation of the waste stream. But it has also led to higher ammonia emissions and thus indirect N_2O emissions following atmospheric deposition.

Overall, this has resulted in somewhat higher N_2O emissions from 1997 onwards, increasing to about +10 Gg CO_2 eq for 2011.

Manure remaining in storage
Over 2010 and 2011, it appeared as though there was a buildup of stored manure. On closer inspection, however, this was found not to have been the case, as there was sufficient capacity available to dispose of all manure produced. Some (in-)direct emissions have thus been added for these years, amounting to 17 and 13 Gg CO_2 eq, respectively.

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 2013

Emissions:	The emissions data from LULUCF for 2012 are about 4 per cent higher than those from 2011.
Key sources:	Land converted to Cropland (CO_2) 5B2 is now a key source.
Methodologies:	Changes compared with NIR 2013: the availability of new forest statistics (NBI6) covering the period 2000-2012/13, the new Land use map 1-1-2013 allowing the assessment and updating of land-use changes 1-1-2009 to 1-1-2013. The forest statistics include new data for the estimation of the carbon stocks in the forest. The emissions from wildfires in forests have also been recalculated since 2000 on this basis. Additionally, estimates of other wildfires have been included for the whole time series since 1990. This year also, emissions from mineral soils have been included for the first time, which also enabled the calculation of N_2O emissions associated with disturbance from land-use conversions to cropland.

7.1 Overview of sector

This chapter describes the 2012 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 (5 per cent of which 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 2012 to 3.44 Tg CO_2 equivalent. (The recalculated value for 2011 is: 3.31 Tg CO_2) 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 forestland. The LULUCF sector is responsible for 2 per cent of total greenhouse gas emissions in the Netherlands (see Table 7.4). 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).

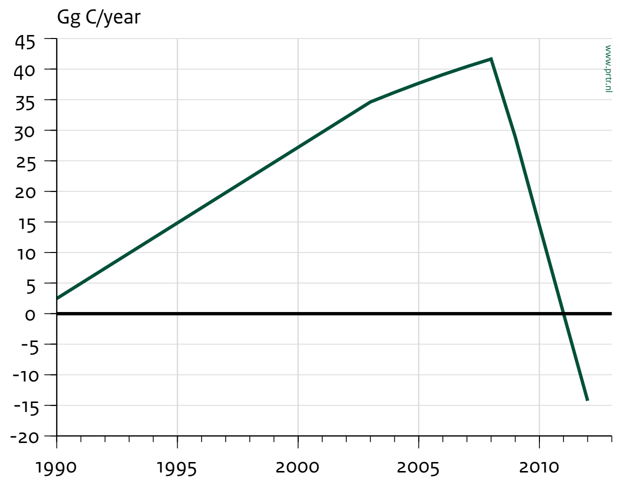
7.2 Methods

The methodology of the Netherlands for assessing 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.
Previously, carbon emissions from mineral soils were conservatively reported as zero at the national scale. In reaction to reviewers' comments, this year an effort was made to quantify the carbon emissions from land-use changes involving mineral soils in the Netherlands. The basis for this is the LSK national sample survey of soil map units (Finke et al., 2001) for about 1,400 locations and at five different depths. The carbon stock in the upper 30 cm was measured (de Groot et al., 2005). The data were classified into 11 soil types and land use (at the time of sampling, Lesschen et al., 2012).
Samples were taken only on grassland, cropland or forest. For conversions of land use involving other land uses, estimates were made using the IPCC 2006 guidelines. The assumptions were

- For conversion to settlements: 50 per cent is paved and has a soil carbon stock of 80 per cent of that of the former land use, 50 per cent consists of grassland or wooded land (TOF) with corresponding soil carbon stock.
- For wetlands and trees outside forest converted to or from forest, no change in carbon stock is assumed.
- For other land, a carbon stock of zero is assumed conservatively.

The IPCC Good Practice Guidance prescribes a transition period of 20 years in which the carbon stock changes take place. It should be borne in mind that such a 20-year transition period for carbon stock changes in mineral soils means that land-use changes in 1970 will still have a small effect on carbon stock changes in mineral soils in 1990. Here we implemented a transition period starting with

Figure7. Aggregated soil carbon stock changes (Gg C/ year) based on all land-use changes and considering a 20 year transition period. Contribution of land-use changes between 1970-1990 are not included.



1990, as we do not have sufficient information on land-use changes before 1990. This means that we have ignored removals and emissions from land-use changes that took place before 1990. The carbon stocks (Gg C per year) in mineral soils aggregated for all land-uses increased from 2.4 Gg C yr^{-1} in 1990 to 41.7 Gg C yr^{-1} in 2008 (see Figure 7.1), which confirms our earlier assumption that mineral soils in the Netherlands were a small sink. After 2008, however, the aggregated changes in carbons stock in mineral soils strongly decreased, mainly as a result of the increased rate of conversion of grassland to cropland between 2009 and 2013, as observed from the new land-use change matrix.

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, 2009 and 2013 (1-1-2013). The first three datasets on land use were especially developed to support temporal and spatial development in land use and policy in the field of nature conservation (MNP, 2008). The 2013 map was specifically developed for the current UNFCCC reporting, but was methodologically similar to the previous maps. For more details see Arets et al., 2014. 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. Subsequently, the land-use change matrices were based on the changes in land use over the period 1990–2004 (Table 7.1a), 2004–2009 (Table 7.1b) and 2009-2013 (Table 7.2). 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 1990–2013. The sum of all land-use categories is constant over time. The new land-use map of 1-1-2013 allows the use of data based on interpolation for 2009-2012 and results in a recalculation for the years 2009-2011, which were previously based on extrapolation of land-use change rates in the period 2004-2009.

The land-use change matrix of Table 7.2 has been based on the most recent statistics, the Land-use data of 1-1-2009 and of 1-1-2013. For more details see Arets et al., 2014.
Table 7.2 will be used as the new reference point for extrapolation of annual land-use changes in the coming years until new statistics become available.

Table 7.3 provides an overview of the completeness of reporting for the Netherlands. To increase completeness, estimates for CO_2, CH_4 and N_2O emissions from wildfires other than forest fires are now also included for the first time (see also section 7.4 Recalculations). This year, new forest statistics based on the recently completed forest inventory were used. Since this inventory was similar to the inventory in (MFV) in 2000, actual carbon stock changes in biomass could be calculated. The improved emission factor for forest-related changes has, for instance, resulted in changes in emissions from conversions from forest land to other land-uses and in small changes in the emissions from wildfires in forests since the year 2000. Emissions from carbon stock change in minerals soils for all land-use categories have been included for the first time this year, and also emissions associated with disturbance from conversions to cropland

Table 7.1a 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 2009-2013 using the Land use data available 1-1-2013.

	BN 2009						
2013	**Forest land**	**Cropland**	**Grassland**	**Wetland**	**Settlement**	**Other land**	***Total***
Forest land	380,255	2,791	9,672	763	3,346	494	*397,320*
Cropland	1,535	793,892	145,410	304	3,198	1	*944,340*
Grassland	7,778	116,002	1,194,126	6,180	20,653	970	*1,345,709*
Wetland	863	1,410	10,849	801,539	4,477	1,825	*820,962*
Settlement	4,907	10,740	30,915	1,311	557,312	328	*605,512*
Other land	235	28	516	1,846	135	34,897	*37,657*
Total	*395,572*	*924,863*	*1,391,488*	*811,941*	*589,121*	*38,515*	*4,151,500*

Note: The areas for 2009 are based on the 2009 land use map, the 2013 (1 January) data are based on the Landuse data 1-1-2013.

have been included for the first time.

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., 2014) and in updates of the two protocols (see the website http://english.rvo.nl/nie):

- Protocol 14-032: CO_2 from Forest land (5A)
- Protocol 14-033: CO_2 from total Land-use categories (5B-G).

Table 7.4 shows the sources and sinks in the LULUCF sector in 1990 and 2012. For 1990 and 2012, the total net emissions are estimated to be approximately 3.0 Tg CO_2 and 3.38 Tg CO_2, respectively. The major source in 2012 is included in 5C1 (Grassland remaining grassland), i.e. CO_2 emissions from the decrease in carbon stored in organic soils and peat lands: 4.2 Tg CO_2, resulting from agricultural and water management. The major sink is the storage of carbon in forests: -3.44 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 about 5 per cent of total national CO_2 emissions in 2012.

Table 7.3 Pools for which emissions are reported in the National System per land use 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	-	-	-

The included pools are mentioned as: BG: Biomass Gain; BL: Biomass Loss; DW: Dead Wood; Litt: Litter.
The land use categories are mentioned as: FL: Forest Land; FAD: Forest According Kyoto Definition; TOF: Trees Outside Forests; CL: Cropland; GL: Grassland; WL: Wetland; Sett: Settlement; OL: Other Land.

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

Sector/category	Gas	Key	Emissions base year Tg CO_2 eq	2011 Tg CO_2 eq	2012 Tg CO_2 eq	Absolute 2012–2011 Tg CO_2 eq	Contribution to total in 2010 (%) by sector	of total gas	of total CO_2 eq
5 LULUCF	CO_2		2.99	3.31	3.44	0.13	100.0	2.0	1.8
5A Forest land	CO_2		-2.35	-3.50	-3.46	0.04	-100.7	-2.1	-1.8
5A1 Forest land remaining forest land	CO_2	L,T	-2.41	-2.90	-2.88	0.02	-83.8	-1.7	-1.5
5A2 Land converted to forest land	CO_2	L2,T	0.05	-0.60	-0.58	0.02	-16.9	-0.3	-0.3
5B. Cropland	CO_2		0.16	1.21	1.25	0.04	36.4	0.7	0.6
5B1 Cropland remaining cropland	CO_2		IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	0.00	0.0	0.0	0.0
5B2 Land converted to cropland	CO_2	L2 T	0.16	1.21	1.25	0.04	36.4	0.7	0.6
5C Grassland	CO_2		4.45	4.18	4.21	0.03	122.4	2.5	2.2
5C1 Grassland remaining grassland	CO_2	L,T	4.25	4.25	4.25	0.00	123.6	2.5	2.2
5C2 Land converted to grassland	CO_2	L,T	0.20	-0.07	-0.04	0.03	-1.2	0.0	0.0
5D Wetlands	CO_2		0.07	0.11	0.11	0.00	3.3	0.1	0.1
5D1 Wetlands remaining wetlands	CO_2		NE	NE	NE	0.00	0.0	0.0	0.0
5D2 Land converted to wetlands	CO_2		0.07	0.11	0.11	0.00	3.3	0.1	0.1
5E Settlements	CO_2		0.46	1.10	1.13	0.02	32.7	0.7	0.6
5E1 Settlements remaining settlements	CO_2		0.00	0.00	0.00	0.00	0.0	0.0	0.0
5E2 Land converted to settlements	CO_2	L,T	0.46	1.10	1.13	0.02	32.7	0.7	0.6
5F Other land	CO_2		0.02	0.13	0.13	0.00	3.7	0.1	0.1
5F1 Other land remaining other land	CO_2		0.00	0.00	0.00	0.00	0.0	0.0	0.0
5F2 Land converted to other land	CO_2		0.02	0.13	0.13	0.00	3.7	0.1	0.1
5G Other	CO_2		0.18	0.07	0.07	0.00	2.1	0.0	0.0
Total national emissions (incl. CO_2 LULUCF)	CO_2		162.23	171.37	168.70	-2.67			
	All		214.86	198.47	195.20	-3.26			

7.4 Recalculations

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

1. Availability of the new land-use map for 1-1-2013, allowing the calculation of the land-use change matrix over the period 2009-2012. Until the NIR 2013, the rate of land-use change was extrapolated from the period 2004-2009.
2. For mineral soils, the CO_2 emissions have been calculated for all land-use categories based on a new Tier2 approach, as described in Arets et al., 2014. The IPCC Good Practice Guidance prescribes a transition period of 20 years in which the carbon stock changes take place. Here we implemented a transition period starting from 1990, as we do not have sufficient information on land-use changes before 1990 that would contribute to emissions or removals in the period until 2009. If no pre 1990 land-use changes are considered in the period 1990-2009, the carbon stock in mineral soil aggregated over all land-use changes gradually increases, supporting our previous assumption that mineral soils in the Netherlands are a small sink. Specific land-use changes, such as conversions from Grassland to other land-use categories, however, act as a strong source that is compensated by other land-use changes. As a result of the implementation of emissions from mineral soils, a 20-year transition was also applied to the reported areas of land-use change. Previously, the Netherlands reported the annual changes in area (except for conversion to forest lands for which a 20-year transition had already been applied) whereas, in the current submission, area is given in the relevant category converted to for 20 years or until the land again changes to another land-use category.
3. For land-use conversions to cropland on soils for which gross CO_2 emissions were calculated under (2, above), nitrous oxide emissions were also calculated using default IPCC GPG methods. See Arets et al, 2014 for more details. Previously, these emissions were not estimated.
4. Over the period 2012-2013, the 6th Dutch Forest Inventory (NBI6) was carried out. Based on this inventory, new forest carbon stock data have become available. Because the methodology was the same one used for the previous forest inventory in 2000 (MFV), the actual carbon stock changes in living biomass between 2000 and 2013 could be determined. Previously, changes in living biomass since 2000 were calculated using a simple forest growth model. For the period 2000-2011, this results in recalculations for carbon stock changes in living biomass for Forest land remaining Forest Land and for conversions from Forest Land to other land-use categories. It also resulted in recalculations of emissions from wildfires on Forest land.
5. Wildfires on Forest land remaining forest land have been included since the NIR 2013. In the NIR 2014, emissions from all other wildfires have also been included. Only historic data on area burned in the period 1980-1992 are available. The actual areas with wild fires for 1990-1992 and an average area of the period 1980-1992 (210 ha) were used to calculate emissions from wildfires for the whole time series. Most wildfires outside forests in the Netherlands are associated with fires on heath and grasslands. So the emissions were included under grassland remaining grassland and calculated using default methods provided in the IPCC GPG (see Arets et al 2014 for more details), resulting in annual emissions of 3.45 Gg CO_2, 0.34 Gg CH_4 and 0.035 Gg N_2O.
6. Emissions from the liming of agricultural soils in 'Other' (5G). Fertilizer data are not available for 2012 and therefore 2012 emissions were set equal to 2011 emissions. Data for 2009 -2011 had a similar time lag and were recalculated in line with the updated statistics.

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 of which are coniferous, 22 per cent broadleaved and the remaining area a mixture of the two. The share of mixed and broadleaved 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 to 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.

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, harmonized and validated digital topographical maps of 1990, 2004, 2009 and 2013 were used (Kramer et al., 2009; Van den Wyngaert et al., 2012, Arets et al., 2014). The result was a national scale land-use and land-use change matrix. The information used concerning the activities and land-use categories covers the entire territorial (land and water) surface area of the Netherlands; see 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 IPCC Guidelines. It also includes systems with vegetation that currently fall below, but are expected to exceed the threshold of the forest land category (IPCC, 2003; 2006).

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

- 'Forest' or 'Forest According to Definition' (FAD) – all forest land which complies with the following (more strict than IPCC) definition chosen by the Netherlands for the Kyoto protocol: forests are patches of land exceeding 0.5 ha with a minimum width of 30 m, with tree crown cover of at least 20% and tree height of at least 5 m or, if this is not the case, these thresholds are likely to be achieved at the particular site. Roads in the forest less than 6 m wide are also considered to be forest. This definition conforms to the FAO reporting and was chosen within the ranges set by the Kyoto protocol. It is also consistent with the definition used for the national forest inventories.
- 'Trees outside Forests' (TOF), that is - wooded areas that comply with the previous forest definition except for their surface area (=< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads and fields. These areas comply with the GPG-LULUCF definition of Forest Land (they have woody vegetation), but not with the strict forest definition that the Netherlands applies.

7.5.4 Methodological issues

7.5.4.1 Forest Land Remaining Forest Land

Removals and emissions of CO_2 from forestry and changes in woody biomass stock are estimated based on country-specific Tier 2 methodology. The approach chosen follows the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The 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 monitoring protocol 14-032 on the website http://english.rvo.nl/nie, as indicated in section 7.3. The Netherlands' National System follows the carbon cycle of a managed forest and wood products system. The pools are distinguished by above-ground biomass, below-ground biomass, litter, dead wood and soil organic carbon. Changes in the carbon stock are calculated for above-ground biomass, below-ground biomass and dead wood and litter in forests. Calculations for the living biomass carbon balance are carried out at plot level for Croplands and scaled to national scale (Van den Wyngaert et al., 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, followed by a calculation of the height and expected volume in the next year. Based on the expected volume for the next year and on the number of trees, the average tree volume for the next year is derived. The next step is the calculation of the average diameter of the tree in the next year. The above-ground and below-ground total biomass is derived using the equations from the COST E21 database. The desired net flux is derived from the difference in tree mass between two years, the basic wood density and the carbon content of the dry mass. This last step is represented in the following equation:

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

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

where:

ΔC_{FF_G} Total net carbon stock change due to biomass increase for Forest land remaining Forest land – FAD in the Netherlands kg C ha^{-1}

A_i Area represented per NFI[1] plot ha

CF Carbon fraction of living biomass 0.5

and

G_{TOTALi} Biomass increase for NFI plot I kg DW[2]

$\overline{B_{it}}$ Average tree biomass of NFI plot i at time t kg DW

B_{it+1} Average tree biomass of NFI plot i at time t+1 kg DW

nt_{it} Living tree density of NFI plot i at time t ha^{-1}

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

In 2012 and 2013, a new National Forest Inventory was carried out (6th National Forest Inventory, see Schelhaas et al., 2014). The methods and set-up of this inventory followed those of the MFV of 2000. Based on these two inventories, the carbon stock change in living biomass between 2000 and 2012 could be directly assessed. The average changes in carbon stocks in tree biomass in the years in between were linearly interpolated. Considering carbon stock losses in living biomass losses from harvesting, the annual biomass gains were calculated to get to the measured net annual carbon stock changes in living biomass. Detailed descriptions of the methods used and EFs can be found in the monitoring protocol 14-032 on the website http://english.rvo.nl/nie, as indicated in section 7.3 and in Arets et al., 2014.

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% $year^{-1}$) and the current stock of dead wood volume is assumed to be 6.6% of the living wood volume (based on data from Timber Production Statistics and Forecast (HOSP) and the MFV). A net build-up may exist, since Dutch forestry only began to pay attention to dead wood a decade ago. The following equations are used to calculate the net carbon flux to dead wood:

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

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

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

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 of living biomass of NFI plot i at time t

f_{mort} Mortality fraction (0.4 percent $year^{-1}$)

V_{SDi} Volume of standing dead wood of NFI plot i

V_{LDi} Volume of lying dead wood of NFI plot i

L_{SDi} Species-specific longevity of standing dead wood

L_{LDi} Species-specific longevity of standing lying wood

D_{DW} Species-specific average wood density of dead wood

$f_{removal}$ Removal fraction of dead wood (was previously set to 0, is now 0.2)

Litter

Analysis of carbon stock changes based on collected data has shown that there is most probably a build-up in litter in Dutch forest land. Data from around 1990, however, are extremely uncertain and, therefore, this highly uncertain sink is not reported in order to be conservative.

7.5.4.2 *Land converted to Forest Land*

Removals and emissions of CO_2 from forestry and changes in woody biomass stock are estimated based on country-specific Tier 2 methodology. The approach chosen follows the IPCC 1996 Revised Guidelines and its updates in the Good Practice Guidance on Land Use, Land Use Change and Forestry (IPCC, 2003). The basis assumption is that the net flux can be derived from converting the change in growing stock volume in the forest into carbon and that young plots (< 20 years) in the national forest inventory are representative for newly reforested/afforested plots. Detailed descriptions of the methods used and EFs can be found in the monitoring protocol 14-032 on the website http://english.rvo.nl/nie, as indicated in section 7.3.

Living biomass

The increase in living biomass in land converted to Forest land is estimated based on the data from the national forest inventories, using the following set of assumptions:

1. At time of regeneration, growth is close to zero.
2. Between regeneration and twenty years of age, the specific growth curve is unknown and is approximated by the simplest function, i.e. a linear curve.
3. The exact height of this linear curve is best approximated by a linear regression on the mean growth rates per age as derived from the NFI. One mean value for each age is taken to avoid confounding effects of the age distribution of the NFI plots (some of which are not afforested but regenerating after a clear-cut).
4. The emission factor is calculated for each annual set of afforested plots separately. Thus, the specific age of the reforested/afforested plots is taken into account and a general mean value is reached only at a constant rate of afforestation for more than twenty years (with varying rates of afforestation, the IEF will vary as well).
5. Between 1990 and 2000, rates were based on the Hosp inventory. From 2000 onwards, rates have been based on the MFV inventory of 2000 and the 6th National Forest Inventory (NBI6) of 2012-2013 (Schelhaas et al., 2014).

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

Dead Organic Matter

The accumulation of dead wood and litter in newly afforested plots is not known, though it is definitely a sink of uncertain magnitude (see section 11). This sink is not reported in order to be conservative.

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

The total emissions from the dead wood component after deforestation is 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, MFV and NBI6).

Forest fires

For wildfires in forests (forest fires), no recent statistics are available on the occurrence and intensity of forest fires in the Netherlands. 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 ha in 1991 and 24 ha in 1992). From 1993 onwards, the average annual area from the period 1980–1992 is used. This is 37.77 ha.

Controlled biomass burning is reported as included elsewhere and not occurring. For the occasional burning as nature management, the area and emissions are included under forest fires. Other controlled burning, like that of harvest residues, is not allowed in the Netherlands (see Article 10.2 of 'Wet Milieubeheer' - the Environmental Protection Act).

7.5.5 Activity data

Activity data on land use and land-use change are derived from the land-use maps (available at the start of the years 1990, 2004, 2009 and 2013) and the land-use change matrix (see section 7.3).
Data on forests are based on forest inventories carried out in 1988–1992 (HOSP data), in 2000–2002 and 2004–2005 (MFV data) and in 2012-2013 (NBI6). As these most accurately describe the state of 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.
With plot level data from the MFV and NBI6 changes in carbon stocks in living biomass in forests were calculated between 2000 and 2012. In addition, changes in activity data were assessed using several databases with tree biomass information, with allometric equations to calculate above-ground and below-ground biomass and with forest litter.
More detailed descriptions of the methods used and EFs can be found in the monitoring protocol 14-032 on the website http://english.rvo.nl/nie, as indicated in section 7.3 and in Arets et al., 2014.

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 2.20 Mg C ha^{-1} in 2012. 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).

Emissions from fertilizer use in forests
N_2O emissions might occur as a result of using fertilizer in forests or drainage. Neither management practice is much applied in forestry in the Netherlands. It is therefore assumed that N_2O emissions from fertilizer 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 reforested/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 was 60.4 Mg C ha^{-1} in 1990 and increased to 95.6 Mg C ha^{-1} in 2012. The EF for litter was 29.0 Mg C ha^{-1} in 1990 and increased to 35.9 Mg C ha^{-1} in 2012 (this value has been constant since 2003) and the EF for dead wood was 0.45 Mg C ha^{-1} in 1990 and increased to 1.86 Mg C ha^{-1} in 2012. 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

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	2004	2009	2011	2012
5A Forest Land	-2,353	-2,488	-2,966	-3,169	-3,426	-3,448	-3,462
5A1 Forest Land remaining Forest Land	-2,411	-2,500	-2,862	-2,855	-2,857	-2,907	-2,881
Live biomass	-3,754	-3,509	-4,108	-3,933	-3,303	-3,704	-3,140
Harvest	1,746	1,257	1,531	1,353	715	1,085	517
Trees outside Forest	-212	-180	-187	-163	-132	-151	-129
Dead Wood (including losses when forests are converted to TOF)	-191	-68	-98	-112	-137	-137	-137
5A2 Land converted to Forest Land	58	12	-104	-314	-569	-541	-581

increment in living biomass is calculated at 13 per cent (rounded off 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 off 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 2,750 Gg CO_2 year^{-1} with a range from 2,400 Gg CO_2 year^{-1} to 2,900 Gg CO_2 year^{-1} over the period 1990–2012 (see Table 7.5). 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 decreased in 2012 probably as a result of fewer building activities. 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 stabilizing when the 20-year transition period has ended. In 2012, the sequestration level reached 554 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 have been used as were used 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 stabilizing when the 20-year transition period has ended (Figure 7.2). In 2012, the sequestration level reached a level of 554 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 2,221Gg CO_2 year^{-1} in 2012. Each new land-use map and resulting land-use change matrix results in a step increase in the annual area of deforested land. The emission factor gradually increases over time.

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.
Map and land-use matrices in Tables 7.1 an 7.2 of the NIR

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	6.13	0.029	0.61	0.00020	0.061	6.80
2001	6.28	0.030	0.62	0.00020	0.063	6.97
2002	6.43	0.030	0.64	0.00021	0.064	7.13
2003	6.59	0.031	0.65	0.00021	0.066	7.30
2004	6.71	0.032	0.66	0.00022	0.067	7.44
2005	6.83	0.032	0.67	0.00022	0.068	7.57
2006	6.95	0.033	0.69	0.00022	0.070	7.71
2007	7.08	0.033	0.70	0.00023	0.071	7.85
2008	7.20	0.034	0.71	0.00023	0.072	7.99
2009	7.33	0.034	0.72	0.00024	0.073	8.12
2010	7.45	0.035	0.74	0.00024	0.075	8.26
2011	7.58	0.036	0.75	0.00025	0.076	8.40
2012	7.72	0.036	0.76	0.00025	0.077	8.56

are dated 1 January, while the areas in the CRF Tables 5 are dated 31 December. So 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 in NIR2013 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.

As a result of the availability of a new National Forest Inventory, the actual change in carbon stocks of living biomass could be calculated over the period 2000-2012. Consequently, carbons stock changes in biomass for land use and land-use changes involving forest land were recalculated for the period 2000-2011. New emission factors also resulted in the recalculation of the emissions from forest fires since 2010. Additionally the new land-use change matrix 2009-2013 resulted in changes in the activity data for the years 2009-2012.

7.5.10 Category-specific planned improvements

A new forest growth and forest management model is under development. This will be implemented and used for the NIR 2015.

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 crop 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 is derived from the land-use maps and the land-use change matrix. For the soil emissions, a 20-year transition period is included, while carbon stock changes in biomass will be instantaneous on conversion. In the current submission, the area associated with the transition period for soil is reported.

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

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

7.6.4 Definitions

The Netherlands has chosen to define croplands as arable lands and nurseries (including tree nurseries). Intensive grasslands are not included in this category and are reported under Grasslands. For part of the agricultural land, rotation between cropland and grassland is frequent, but data on where exactly this is occurring are as yet lacking. Currently, the situation on the topographical map is used as the guideline, 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 digitized 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, 2009 and 2013 are based on observations of land use; the values for the periods in between are obtained through linear interpolations. 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 14-032 and 14-033 on the website http://english.rvo.nl/nie.

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

Nitrous oxide emissions from disturbance associated with land-use conversions to cropland
Nitrous oxide emissions from soils by disturbance associated with land-use conversions 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 (also see emissions from carbon stock change in mineral soils, par 7.2). 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 (IPCC GPG 2003 p. 3.94,). For aggregated soil types where conversion to Cropland led to a net gain of carbon, the nitrous oxide emission was set to zero.

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 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 off 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 to cropland shows an increase from 122 Gg CO_2 in 1990 to 529 Gg CO_2 in 2012.

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

Carbon stock changes in living biomass for conversions from forest land were recalculated for the period 2000-201. See sections 7.4 and 7.5.9.

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 into Grassland'. The source category 5C1 is by far the most important source of CO_2 within the sector LULUCF.

7.7.2 Activity data and (implied) emission factors

The activity data is derived from the land-use maps and the land-use change matrix. The activity data for organic soils is based on soil maps (1:50,000 for the period 1960–1990), recent inventories on organic soils (2001–2003), profile information from LSK and data on field levels in 1990 and 2000.
For the soil emissions, a 20-year transition period is included, while carbon stock changes in biomass will be instantaneous on conversion. In the current submission, the area associated with the transition period for soil is reported.

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 are not considered as croplands. It also includes vegetation that falls below the threshold used in the forest land category and is not expected to exceed, without human intervention, the threshold used in the forest land category. The category also includes all grassland, from wild lands to recreational areas as well as agricultural and silvi-pastoral systems, subdivided into managed and unmanaged, consistent with national definitions (IPCC, 2003). It is stratified in:
- 'Grasslands' – all areas predominantly covered by grass vegetation (whether natural, recreational or cultivated)
- Nature – all natural areas excluding grassland (natural grassland and grassland used for recreation purposes). These mainly consist of heather, peat land, 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 which is predominantly covered by grass vegetation. No distinction is made between agricultural intensively and extensively managed grasslands and natural grasslands. The potential and the need for this, however, are currently under discussion. Apart from pure grasslands, all orchards (with standard fruit trees, dwarf varieties or shrubs) are included in the category grasslands. They do not conform to the forest definition and, although agro-forestry systems are mentioned in the definition of Croplands, this is motivated by the cultivation of soil under trees. But in the Netherlands, the main undergrowth of orchards is grass. We therefore chose to report them as grasslands. As for grasslands, no change in above-ground biomass is reported. The carbon stored in these orchard trees is not reported.

7.7.5 Methodological issues

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 used 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 the soil subsidence of peat land caused by the 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 an average 19.04 tons CO_2/ha is calculated (Kuikman et al., 2005). For the period 1990–2012, 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 in 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. We have therefore 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 14-032 and 14-033 on the website http://english.rvo.nl/nie. In this NIR, emissions from mineral soils are included for the first time. See section 7.7.5 for more details on the methodology.

Wild fires

There are no recent statistics available on the occurrence and intensity of wild fires in The Netherlands. Emissions of CO_2, CH_4 and N_2O from wild 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 wild fires is based on a historical series from 1980–1992, for which the annual number of forest fires and the total area burned are available (Wijdeven et al., 2006). Forest fires are reported under forest land and other wild fires are calculated as the difference between total area burned and the area of forest fires. For the years 1990–1992, the reported areas are used (184 ha in 1990, 381 ha in 1991 and 153 ha in 1992). From 1993 onwards, the average annual area from the period 1980–1992 is used. This is 210 ha. This includes all land-use categories. Most wild fires in the Netherlands, however, are associated with heath and grassland. All other emissions from wild fires, except forest fires, are therefore included under Grasslands remaining Grasslands. Wild fires in other land-use categories are included in this.

CO_2, CH_4 and N_2O emissions from wild fires are based on the default carbon stock in living biomass on grasslands (6.8 ton C ha^{-1}). The default combustion efficiency (fraction of the biomass combusted) for *Calluna* heath was used (0.71, GPG 2003, Table 3A.1.12). For the calculation of non-CO_2 emissions, default emission ratios were used (0.012 for CH4 and 0.007 for N_2O, GPG 2003, Table 3A.1.15).

Controlled biomass burning is reported as included elsewhere (IE) and not occurring (NO). The area and emissions of the occasional burning done as nature management are included under wild fires. Other controlled burning, such as the burning of harvest residues, is not allowed in the Netherlands (see Article 10.2 of 'Wet Milieubeheer' - the Environmental Protection Act).

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 the 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 647 Gg CO_2 in 2012.

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.

7.7.8 Source-specific recalculations

Carbon stock changes in living biomass for conversions from forest land were recalculated for the period 2000-2011. See sections 7.4 and 7.5.9.

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. The submission of the NIR 2015 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 is derived from the land-use maps and the land-use change matrix (see sections 7.2 and 7.3.).

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

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

7.8.4 Definition

The land-use category 'Wetland' includes land that is covered or saturated with water for all or a part of the year and does not fall into the forest land, cropland, grassland or settlements categories. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged sub-divisions (IPCC, 2003). Though the Netherlands is a country with many wet areas by nature, many of these are covered by a grassy vegetation; and those are included under grasslands. Some wetlands are covered by a rougher vegetation of wild grasses or shrubby vegetation, which is reported in the subcategory 'Nature' of Grassland. Forested wetlands such as willow coppice are reported in the subcategories FAD or TOF of Forest Land, depending on their surface area.

In the Netherlands, only reed marshes and open water bodies are included in the Wetland land-use category. This includes natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes. It includes bare areas which are under water only part of the time, as a result of tidal influences, and very wet areas without vegetation. It also includes 'wet' infrastructure for boats, i.e., waterways as well as the water in harbours and docks.

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 the monitoring protocols 14-032 and 14-033 on the website http://english.rvo.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 232 Gg CO_2 in 2012.

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.

7.8.8 Source-specific recalculations

Carbon stock changes in living biomass for conversions from forest land were recalculated for the period 2000-2011. See sections 7.4 and 7.5.9.

7.8.9 Category-specific planned improvements

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

7.9 Settlement [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 transport 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 transport 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. It therefore includes houses, blocks of houses and apartments, office buildings, shops and warehouses, as well as filling stations and greenhouses. Urban areas and transport 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 latter classes are covered by grass, the distinction cannot be made from a study of maps. Because 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 monitoring protocols 14-032 and 14-033 on the website http://english.rvo.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 1050 Gg CO_2 in 2012.

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.

7.9.8 Source-specific recalculations

Carbon stock changes in living biomass for conversions from forest land were recalculated for the period 2000-2011. See sections 7.4 and 7.5.9.

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 used 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 another 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 the monitoring protocols 14-032 and 14-033 on the website http://english.rvo.nl/nie, as indicated in section 7.4.

7.10.6 Uncertainty and time series consistency

Uncertainties
For information on the uncertainty estimate, 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 41 Gg CO_2 in 2012.

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.

7.10.8 Source-specific recalculations

Carbon stock changes in living biomass for conversions from forest land were recalculated for the period 2000-2011. See sections 7.4 and 7.5.9.

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 (calcium carbonate) and dolomite (calcium-magnesium carbonate). Limestone and dolomite are used in the Agriculture sector 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 fertilizers (period 1990–2012). 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 statistics, updated annually, on fertilizer 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 14-033). 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

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

	1990	1995	2000	2005	2010	2011	2012
5G Other (liming of agricultural soils)	183	98	98	75	60	73	73

14-032 and 14-033 on the website http://english.rvo.nl/nie, as indicated in section 7.4.

7.11.4 Uncertainty and time series consistency

Uncertainties
The Tier 1 analysis in Annex 7, shown in Table A7.1, provides estimates of uncertainties 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 1990–2012 is consistent over time. These fertilizers make up 40 per cent to 60 per cent of the calcium containing fertilizers used in agriculture. The remaining percentage consists mainly (about 30 per cent to 55 per cent of the total) of sugar beet factory lime. The CO_2 emission related to the latter fertilizer is balanced by the CO_2 sink in the sugar production and not brought into the account. The total use of fertilizer containing calcium carbonate in the Netherlands decreased from 265 million kg in 1990 to 134 million kg in 2011 (on the basis of CaO). Over that period, the amounts of limestone remained approximately equal and the amounts of dolomite gradually decreased to about one third of the amount applied in 1990. The CO_2 emissions related to limestone and dolomite are shown in Table 7.7. For the years 2011 and earlier, observed values are available (except for 2009). Due to the current lack of fertilizer statistics for 2012, the related 2012 emissions have been set equal to those of 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 the fertilizer data for 2010 have become available.

7.11.7 Category-specific planned improvements

A recalculation over 2012 will be carried out when fertilizer data become available.

8
Waste [CRF Sector 6]

Major changes in the Waste sector compared with the National Inventory Report 2013

Emissions:	In 2012, total greenhouse gas emissions in this sector decreased further.
Key sources:	No changes in key sources in this category.
Methodologies:	No methodology changes

8.1 Overview of sector

The national inventory of the Netherlands comprises four source categories in the Waste sector:
- 6A (Solid waste disposal): CH_4 (methane) emissions;
- 6B (Wastewater handling): CH_4 and N_2O emissions;
- 6C (Waste incineration): CO_2 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; these emissions are therefore 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 http://english.rvo.nl/nie, describe the methodologies applied for estimating CO_2, CH_4 and N_2O emissions from the Waste sector in the Netherlands (see Annex 6):
- Protocol 14-034: CH_4 from Waste disposal (6A1);
- Protocol 14-035: CH_4, N_2O from Wastewater treatment (6B);
- Protocol 14-036: CH_4, N_2O from Industrial composting (6D);
- Protocol 14-038: CO_2 CH_4 N_2O from Biomass (1A).

The Waste sector accounted for 2 per cent of total national emissions (without LULUCF) in 2012, 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 (93 per cent) originates from Landfills (6A) – accounted for 20 per cent of total national CH_4 emissions in 2012. 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 71 per cent between 1990 and 2012 (see Figure 8.1), mainly due to a 74 per cent reduction in CH_4 from Landfills (6A1 Managed waste disposal on land). Between 2011 and 2012, CH_4 emissions from landfills decreased by approximately 6 per cent. Decreased methane emissions from landfills since 1990 are the result of:
- Increased 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;
- Increased methane recovery from the landfills (from 5 per cent in 1990 to 15 per cent in 2012).

Figure 8.1 shows the trend and emission levels of the Waste sector in the period 1990-2012. 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 3.9 Tg CO_2 eq in 2012.

CH_4 emissions from landfills contribute the largest proportion of greenhouse gas emissions in 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 2012 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 the 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. At 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 (oxidized) 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 temperature, among others. The major factors determining the decreased net CH_4 emissions are lower quantities of organic carbon deposited into landfills

Figure 8. Sector 6 'Waste': trend and emission levels of source categories, 1990-2012.

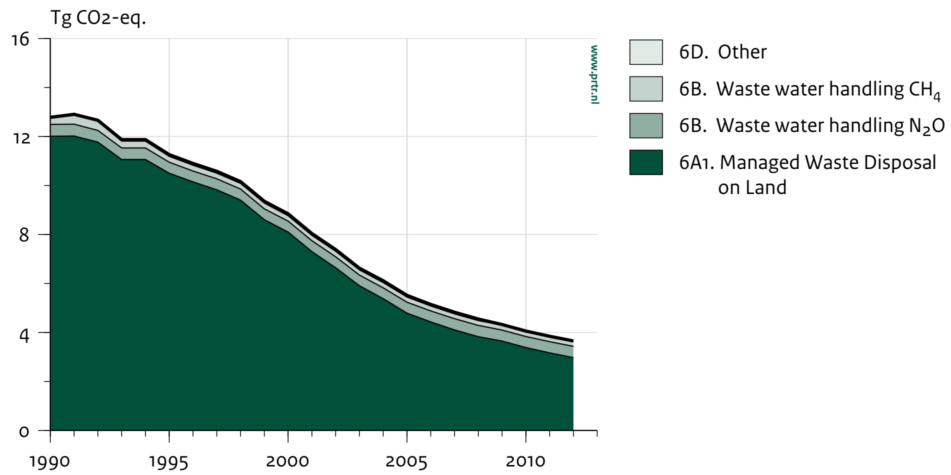


Table 8.1 Contribution of main categories and key sources in Sector 6 Waste.

Sector/category	Gas	Key	Emissions base year Gg	Emissions base year Tg CO_2 eq	Emissions 2011 Gg	Emissions 2011 Tg CO_2 eq	Emissions 2012 Gg	Emissions 2012 Tg CO_2 eq	Change 2012 - 2011 Gg	Contribution to total in 2012 (%) by sector	of total gas	of total CO_2 eq
6 Waste	CH_4		585.8	12.3	161.3	3.4	152.18	3.2	-0.2	87	21	2
	N_2O		1.6	0.5	1.6	0.5	1.6	0.5	0.0	13	5	0.3
	All			12.8		3.9		3.7	-0.2	100		2
6A Solid Waste disposal on Land	CH_4		572.0	12.0	150.8	3.2	141.6	3.0	-0.2	81	20	2
6A1 Managed Waste disposal on Land	CH_4	L.T	572.0	12.0	150.8	3.2	141.6	3.0	-0.2	81	20	2
6B Waste water handling	N_2O	L2	1.6	0.5	1.5	0.5	1.5	0.5	0.0	12	5	0.2
	CH_4		13.8	0.3	9.5	0.2	9.5	0.2	0.0	5	1.3	0.1
	All			0.8		0.7		0.7	0.0	18		0.3
6D Other	CH_4		0.06	0.00	1.0	0.0	1.1	0.0	0.0	0.6	0.2	0.01
	N_2O		0.00	0.00	0.11	0.00	0.11	0.00	0.0	0.1	0.0	0.00
	All			0.00		0.1		0.1	0.0	1.6		0.03
National Total GHG emissions (excl. CO_2 LULUCF)	CH_4		1.224.4	25.7	727.2	15.3	712.0	14.9	-0.3			
	N_2O		64.5	20.0	30.2	9.4	29.5	9.1	-0.2			
	All			213.2		195.1		191.7	-3.4			

(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 2012 – a decrease of 74 per cent. This decrease is partly due to the increase in recovered CH_4 – from about 5 per cent in 1990 to 15 per cent in 2012 – but also to the decrease in methane produced at 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 2012, solid waste disposal on land accounted for 81 per cent of total emissions from the Waste sector and 2 per cent of total national CO_2-equivalent emissions (see Table 8.1).

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	2012
Waste generation rate (kg/cap/day)	1.52	1.50	1.69	1.75	1.66	1.67	1.61
Fraction MSW disposed to SWDS	0.38	0.29	0.09	0.01	0.00	0.01	0.01
Fraction DOC in MSW	0.13	0.13	0.11	0.06	0.03	0.03	0.03
CH_4 generation rate constant (k)	0.09	0.07	0.07	0.05	0.05	0.05	0.05
Number of SWDS recovering CH_4	45	50	55	50	53	53	53
Fraction CH_4 in landfill gas	0.6	0.6	0.6	0.53	0.51	0.50	0.50

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 landfilling; for example, the organic fraction of household waste. Another method implemented to reduce landfilling 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 3 million tons in 2012, 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 14-034 on the website http://english.rvo.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 http://english.rvo.nl/nie and are documented in Rijkswaterstaat (2013a). 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. As stated above, however, 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 landfilled 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 landfilled 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 to 2004 to 0.05 (IPCC parameter) and remaining 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 until 2000 (see also Oonk et al. 1994); from 2000 to 2004, decreasing to 0.5 (IPCC parameter) and remaining constant thereafter;
- CH_4 conversion factor (IPCC parameter): 1.0;
- The fraction of methane in landfill gas recovered has been determined yearly from 2002 onwards based on the composition of landfill gas at all sites with CH_4 recovery. For the years up until 2001, the fraction of methane in landfill gas has been 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 was due to such factors as the prohibition on depositing combustible waste in landfills, whereas the change in k-values (CH_4 generation rate constant) was 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 deposited in landfills, due to overcapacity at incineration plants. The integration time for the emissions calculation is defined as the period starting 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 23 per cent in annual emissions. The uncertainty in the activity data and the EF are estimated to be less than 0.5 per cent and 23 per cent, respectively. For a more detailed analysis of these uncertainties (see Rijkswaterstaat, 2014).

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 it 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

Compared with the previous submission, no recalculations took place for this submission.

8.2.5 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 was conducted in 2013. Based on the results of this study in 2014, the possible improvements will be investigated.

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.

In 2012, the mixture of domestic, commercial and industrial wastewaters was treated aerobically in 343 public wastewater treatment plants (WWTP). The treatment of the resulting wastewater sludge was accomplished mainly by using anaerobic processes. During wastewater 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, as well as other direct discharges, 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 a total of 53 anaerobic industrial wastewater treatment plants (IWWTP). Moreover, as 0.6% of the resident population is still connected to a septic tank, CH_4 and N_2O emissions from septic tanks are also calculated, but these are small compared with those from public WWTP.

N_2O emissions from wastewater treatment (see Table 8.1) accounted for approximately 5 per cent of total N_2O emissions in 2012 and 0.3 per cent in total CO_2-equivalent. N_2O emissions from wastewater handling and effluents decreased by 5 per cent during the 1990–2012 period. This small decrease was 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. Improved nitrogen removal and lower untreated discharges, however, 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 2012 was 1.3 per cent. Since 1994, CH_4 emissions from public WWTPs have decreased, due to the introduction of a new sludge stabilization system in one of the largest wastewater treatment plants in 1990. Because the operation of the plant took a few years to optimize, venting emissions were higher during the introductory period (1991–1994) than they were under normal operating conditions. CH_4 emissions from wastewater handling decreased by 31 per cent during the period 1990–2012. The amount of wastewater and sludge being treated does not change much over time. The interannual changes in methane emissions, therefore, can be explained by varying fractions of methane being vented incidentally, instead of flared 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.

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

Parameter	1990	1995	2000	2005	2010	2012
CH_4 industrial wastewater	0.25	0.33	0.34	0.36	0.34	0.34
CH_4 domestic & commercial wastewater	9.07	7.90	7.96	8.20	8.60	8.36
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	47.5
Recovery/flared (% gross emission)	70.5	77.4	79.4	80.7	82.3	83.4
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	1.55	1.45	1.44	1.44	1.45	1.47

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	2012
Wastewater DOC[1)] WWTP	Gg/year	933	921	921	943	953	965	972
Sludge DOC[1)] WWTP	Gg/year	254	269	281	298	320	325	347
Nitrogen removed in public WWTP	Gg/year	42.0	47.7	55.8	63.1	71.3	74.0	73.8
Treated volume WWTP	Mm^3/y	1,711	1,908	2,034	1,841	1,934	1,917	1,989
Wastewater DOC[2)] IWWTP	Gg/year	181	233	244	261	239.7	238.3	245.0
Nitrogen in effluents[3)]	Gg/year	53.8	41.5	33.8	27.8	20.5	19.4	19.3
Resident population	1,000	14,952	15,459	15,926	16,320	16,615	16,694	16,756
% Inhabitants with septic tanks	%	4.0	2.8	1.9	1.2	0.62	0.62	0.62
Annual per capita protein uptake	kg	34.86	39.97	38.69	38.03	38.62	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 COD.
3) Total of industrial. domestic and commercial effluents

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 14-035 on the website http://english.rvo.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 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. The interannual changes in CH_4 emissions, therefore, 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 14-035 (see the website http://english.rvo.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 (category 6B.1.a)

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 on the DOC in the influents of anaerobic WWTP are not available, the DOC is calculated on basis of the design capacity and a utilization rate of 80 per cent (Oonk et al., 2004). The design capacity is available in terms of Pollution Equivalents (PE also referred to as Inhabitant Equivalents, see protocol 14-135), with 1 PE 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. While anaerobic reactors produce very little excess sludge, the EF includes emissions from the simultaneous digestion of excess sludge in the anaerobic reactors.

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 2012, 65 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 (15 per cent), chemical industry (16 per cent) and paper and cardboard industry (4 per cent).

CH_4 emissions from industrial sludge treatment (category 6B.1.b)

- Data from the survey among IWWTPs, conducted 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.
- Anaerobic sludge, which builds up in the industrial anaerobic wastewater treatment systems, is digested simultaneously with the wastewater. The emissions are thus included (IE) within category 6B.1.a (see description of 6B.1.a here above).
- The majority of the industrial companies discharge the wastewater into the sewer system, subsequently connected to public WWTP. Emissions from these companies are thus included elsewhere (IE), namely within the category 'Domestic and commercial wastewater handling' (6B.2.a).

CH_4 emissions from domestic and commercial wastewater treatment (categories 6B.2.a and 6B.2.b)

Although public WWTP's in the Netherlands exclusively make use of aerobic treatment methods, the Netherlands estimates CH_4 emissions for this type of plant. CH_4 emissions can occur in several parts of the WWTP, for instance from the influent cellars, in anaerobic zones for biological desphosphotation, or anaerobic pockets in zones with poor aeration. Moreover, anaerobic circumstances can occur in sludge thickeners. Sometimes biogas is incidentally vented from anaerobic sludge digesters.

For public WWTPs and related anaerobic sludge handling, the combined EF is defined as 0.0085 tons CH_4 per ton $DOC_{influent}$. The 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 2012, the amount of CH_4 emitted by the venting of biogas was 0.01 Gg CH_4, equaling 1.2 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, which means that the venting of biogas in 2012 was very low.

CH_4 emissions from septic tanks (category 6B.3)

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. For this submission, no new data on the percentage of the population connected to septic tanks became available, so the value of 2012 has been kept equal to the value of 2011. It is expected that an update of the figure on % of population connected to septic tanks will be published in 2014.

N_2O emissions: default EF

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). Although N_2O emissions from wastewater handling are identified as a key source, we can only use Tier 1, as no country-specific emission factors are available.

N_2O emissions from domestic and commercial wastewater treatment (category 6B.2)

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 Table 8.4). The Netherlands does not use the standard IPCC method based on the per capita protein consumption. 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).

N_2O emissions from septic tanks (category 6B.3)

Despite the fact that septic tanks are an unlikely source of significant N_2O emissions because of the lack of oxygen needed to convert reduced Nitrogen, these emissions 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. As the time series of these statistics are not up to date, the value for 2012 has been kept equal to the value of 2011. For data on the percentage of the population connected to septic tanks, the same time series is used as in the calculation of CH_4 emissions from septic tanks.

Indirect N_2O emission from surface waters as a result of the discharge of domestic and industrial effluents

Country-specific activity data for the calculation of these emissions (CRF category "N2O emissions from human sewage") are derived from the Dutch Emission Inventory database. Data on the total loads of nitrogen released to surface waters via the discharge of industrial, domestic and commercial effluents are available from this database. The data are calculated on basis of several sources such as statistical surveys, environmental reporting and models.
The values of 2010 and 2011 have been recalculated because of more up-to-date information on the N discharges to surface waters for these years (see 8.3.5).

N_2O emissions from industrial wastewater treatment (category 6B.1)

Because of their insignificance compared with public wastewater treatment, no N_2O emissions were estimated for separate industrial wastewater treatment. The first reason for this is that most industries discharge their wastewater into the sewer system/WWTP (emissions included in 6B.2.). The second reason is that the nitrogen content in most IWWTP is often lower and related conversions of nitrogen are also small.

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, which is a maximum estimate. The yearly loads of $DOC_{influent}$, $N_{influent}$ as well as $N_{effluent}$, are calculated on the basis of wastewater sampling and analysis, as well as flow measurements at 343 WWTP's; all of these measurements can be a source of uncertainty.
The uncertainty in EFs for CH_4 and N_2O is estimated to be 25 per cent and 50 per cent, respectively (Olivier et al., 2009).
A recent international study (GWRC, 2011), in which the Dutch public wastewater sector also participated, showed that N_2O EFs, in particular, are highly variable among different WWTPs and at the same WWTP during different seasons or even throughout the day. The same study even concludes that the use of a generic emission factor (such as the IPCC default) to estimate N_2O emissions from an individual WWTP is inadequate; but at the same time the study provides no alternative method, except the recommendation that the GHG emission from an individual WWTP can only be determined based on online measurements over the operational range of the WWTP (GWRC, 2011). The results of this study, therefore, provide no starting point to improve the method for estimating CH_4 and N_2O emissions and the related uncertainty.

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. Moreover, statistical data are covered by the specific QA/QC procedures of Statistics Netherlands.
For annual CH_4 and N_2O emissions from domestic and commercial wastewater treatment, the results of a recent study cannot confirm nor reject the current methods used (GWRC, 2011, see also 8.3.3). The Dutch wastewater sector will continue research to further determine the factors and circumstances that are of importance for the formation of CH_4 and N_2O in public WWTP.
Unlike the Netherlands, most other Western European countries do not estimate CH_4 emissions from public wastewater treatment plants. The argument to support this is that aerobic WWTP's are not considered to be a source of CH_4 emissions.
In cases of N_2O emissions from WWTP and indirect N_2O emissions from discharges of effluents, the methods used in surrounding countries are the same, with some differences in activity data. As for N_2O emissions from septic tanks, it can be observed that no other Western European country calculates these emissions, despite the widespread presence of septic tanks in these countries. Indeed, there is no scientific basis for N_2O formation in septic tanks, since significant N_2O formation can only occur in the presence of oxygen. In this light, it is remarkable that the Netherlands had to include these emissions after the in-country review in 2011.

8.3.5 Source-specific recalculations

The value for indirect N_2O emissions from surface water as a result of domestic and industrial effluents (CRF category "N_2O emissions from human sewage") have been recalculated for 2010 and 2011 because of new up-to-date activity data on total N discharged to surface water. The value of 2010 was adjusted from 0.321 Gg N_2O to 0.323 Gg, an increase of 0.3 per cent. The value of 2011 was adjusted from 0.303 Gg to 0.305 Gg N_2O, which is an increase of 0.88 per cent.

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).

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 http://english.rvo.nl/nie and in a background document (Rijkswaterstaat. 2013a.).
A more detailed description of the method used and the EFs can be found in the protocol 14-038 on the website http://english.rvo.nl/nie, as indicated in section 8.1. and in a background document (Rijkswaterstaat, 2013b).

Total CO_2 emissions – i.e. the sum of organic and fossil carbon – from waste incineration are reported for each 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 for each waste stream (e.g. business 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. For some waste streams, the composition is updated on a yearly basis, based on sorting analyses of household residual waste. 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 Rijkswaterstaat (2013b) 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 of SCR increased from 6 per cent in 1990 to 36 per cent in 2012.

In 2013, a new waste stream was introduced with its own calculation for the composition. This is imported waste. The reason for this change was the substantially increased amount of imported waste that is being processed in waste incinerators in the Netherlands. In 2012, 14 per cent of the incinerated waste was imported from other

Table 8.5 Composition of incinerated waste.

	1990	1995	2000	2005	2010	2011	2012
Total waste incinerated (Gg)	2,780	2,913	4,896	5,503	6,459	7,207	7,480
- of which household waste (Gg)							
- of which	2,310	2,083	3,115	4,413	3,727	2,613	3,222
paper/cardboard (weight %)							
wood (weight %)	26%	33%	32%	25%	21%	20%	20%
other organic (weight %)	1%	2%	2%	3%	4%	3%	3%
plastics (weight %)	51%	37%	35%	35%	33%	35%	38%
other combustible (weight %)	8%	11%	13%	19%	18%	16%	14%
non-combustible (weight %)	3%	5%	5%	6%	10%	10%	10%
	11%	13%	13%	13%	14%	15%	15%
Total waste incinerated (TJ)	22,746	27,903	51,904	55,058	63,818	68,995	71,209
Energy content (MJ/kg)	8.2	9.6	10.6	10.0	9.9	9.6	9.5
Fraction organic (energy %)	58.2%	55.2%	50.4%	47.8%	53.1%	53.7%	55.6%
Amount of fossil carbon (Gg)	164	221	433	561	675	701	708
Amount of organic carbon (Gg)	544	561	938	909	1,172	1,298	1,363

countries. This change is also described in detail in Rijkswaterstaat (2013b).

A survey of emission factors for CH_4 used in other countries and analysis of emissions from waste incinerators in the Netherlands made it clear that the CH_4 concentration in the flue gases from waste incinerators is below the background CH_4 concentration in ambient air. The Netherlands therefore uses an EF of 0 g/GJ and reports no methane. When it is unable to handle problems of such a value, the code 'NO' is used. More information can be found in Rijkswaterstaat (2013b).

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 5%. 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 3% and 5%, respectively.
The uncertainty in annual N_2O emissions from waste incineration is estimated at 73%. The uncertainty in the AD and the uncertainty in the corresponding EF for N_2O are estimated to be less than 0.5% and 73%, respectively.

For a more detailed analysis of these uncertainties (see Rijkswaterstaat, 2014).

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 the 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 was conducted in 2013. Based on the results of this study, the possible improvements will be investigated in 2014.

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 the composting and digesting of separately collected organic waste from households, is not considered to be a key source. Emissions from the 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 2012. In 2012, there were 24 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 14-036 on the website http://english.rvo.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 http://english.rvo.nl/nie and in a background document (Rijkswaterstaat. 2013a.). 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 14-036 on the website http://english.rvo.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. The uncertainty in annual CH_4 and N_2O emissions are both estimated at 29% and 24%, with an uncertainty in the AD of less than 0.5% and in the EF of 29% and 24%.

For a more detailed analysis of these uncertainties (see Rijkswaterstaat, 2014)

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).
In general, the QA/QC procedures within the waste sector are:
- Check of AD with other sources within the monitoring of waste
- Check on trends in the resulting emissions
- Check of the EFs once every 4 to 5 years with EFs in other European countries.

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 'Other waste handling', an assessment of the uncertainties was conducted in 2013. Based on the results of this study, the possible improvements will be investigated in 2014.

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 with the National Inventory Report 2013

For the NIR 2014, the data for the most recent year (2012) were added to the corresponding Common Reporting Format (CRF).

During the compilation of this NIR some errors from previous submissions were detected and corrected. These have resulted in minor changes in emissions over the entire 1990–2011 period.

Furthermore, some recalculations were performed based on new, improved activity data and/or improved emission factors.

For more details on the effects of and justification for the recalculations, see Chapters 3-8.

10.1 Explanation of and justification for the recalculations

10.1.1 GHG inventory

For this submission (NIR 2014), the Netherlands uses the CRF Reporter 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 2013. These improved methodologies are also described in the (updated) monitoring protocols 2014 (see Annex 6).

This chapter summarizes the relevant changes in emission figures compared with the NIR 2013.
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 increased by 13.6 Gg CO_2 eq compared with the previous submission. For 1995, the corrections led to a decrease in emissions of 44.1 Gg CO_2 eq. For 2005, a decrease in emissions amounting to 759.9 Gg CO_2 eq was calculated (all figures including LULUCF).

All relevant changes in previous data (methodological, allocation and error corrections) 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 made.

Recalculations in this submission (compared with the previous NIR and the additional resubmission of the CRF tables in October 2013 (including emissions from mules and asses) are:

- Changed CH_4 and N_2O emissions from transport for the years 1995 to 2011, due to implementation of improved data on kilometres driven by motor cycles and mopeds (1A4a);
- Update of fuel use for inland navigation (2005-2011) (1A3d);
- Improved activity data for mobile machinery in category 1A2a (2008-2011);
- Improvement of the estimates for the oil and gas sector combustion emissions (1A1c) based on improved environmental reports and inclusion of a missing plant (2009-2011);
- Improved AD for gas transmission 1B2b (2011);
- Improved emission data from individual companies 1B2b (2009 to 2011);
- Improved activity data for LPG, natural gas and charcoal use in category 1A4 (2008-2011).

The above-mentioned improvements resulted in relatively small changes in emission totals from the energy sector (8.6 Gg CO_2 eq in 1995 and 535 Gg CO_2 eq in 2011).

- Error correction in the calculation of the CO_2 emission from Biomethanol production 2B5 emission (2011, 30 Gg CO_2 eq);
- Changed HFC emissions for the years 2000 to 2011 due to improved activity data in cooling (2F1);
  (-0.9 Gg CO_2 eq in 2000 and -0.7 Gg CO_2 eq in 2011);
- Improved activity data for N_2O in aerosols (3D for 1990-2012)
  (6 Gg CO_2 eq in 1990 and 60 Gg CO_2 eq in 2011).

The above-mentioned improvements resulted in relatively small changes in emission totals from industrial processes and product use (6 Gg CO_2 eq in 1990 and 43 Gg CO_2 eq in 2011).

- Improved activity data influencing the nitrogen flows in agriculture and therefore the N_2O emissions (4A and 4D for 2000-2011);
- Improved regional activity data for enteric fermentation (CH_4 emissions in 4A for 1990-2011);
- Error correction in activity data for manure management (CH_4 emissions in 4B for 1995-2005).

The above-mentioned improvements resulted in relatively small changes in emission totals from agriculture (-5.6 Gg CO_2 eq in 1990 and 105 Gg CO_2 eq in 2011).

- Improved calculation method for LULUCF based on new actual land-use change matrix (5A to 5G for 2009-2012);
- Improved carbon stock changes in LULUCF based on new forest inventory for the years 2012-2013 (5A in 2000-2012);
- New method to calculate emissions from mineral soils (5A to 5F in1990-2012). Previously, emissions from mineral soils were assumed to be small sinks of unknown magnitude that were reported as NE.

Table 10.1 Summary of the recalculations for the period 1990–2011 (Gg CO_2 eq)

		1990	1995	2000	2005	2009	2010	2011
	Resubmission October 2013, v1.4	**214849**	**226046**	**215931**	**212489**	**200708**	**212169**	**197645**
	Submission 2014	**214863**	**226002**	**215395**	**211729**	**201002**	**212593**	**198468**
Difference								
CO_2 CH_4 N_2O	1A1 Energy industries					-0.1	-27.1	362.5
CO_2 CH_4 N_2O	1A2 Manufacturing industry		-0.1					167.3
CO_2 CH_4 N_2O	1A3 Transport	0.0	8.7	14.1	5.7	7.6	6.4	5.6
CO_2 CH_4	1A4 Other sectors					0.0	0.0	0.0
CO_2 CH_4	1B2 Fugitive Emissions from Fuels					-85.1	51.5	0.0
CO_2 CH_4 N_2O	2B Industrial processes							-16.5
HFCs	2F Consumption of Halocarbons			-0.9	-1.3	-2.0	-3.1	-0.7
CO_2	3 N_2O from aerosols	5.9	10.0	9.2	13.6	17.1	31.2	60.3
CH_4	4A Enteric fermentation	-5.6	-52.7	-4.4	-44.7	-20.5	-19.9	-3.0
CH_4	4B Manure management			-0.3	-0.4	0.0		
N_2O	4D Agricultural soils	0.0		-0.2	1.1	4.7	70.2	108.0
N_2O	6B Waste water Handling						0.3	0.8
CO_2 CH_4 N_2O	5 LULUCUF	13.3	-9.9	-553.5	-733.8	371.5	314.1	138.6
Total Difference		**13.6**	**-44.1**	**-536.1**	**-759.9**	**293.1**	**423.7**	**823.0**

- N_2O emissions associated with disturbance from conversion to cropland were included for the first time (5A in 1990-2012).

The above-mentioned improvements resulted in changes to emissions from LULUCF (13,3 Gg CO_2 eq in 1990 and 138.6 Gg CO_2 eq in 2011).

- Recalculation of N_2O emissions from human sewage for 2010 and 2011 based on improved activity levels.

Table 10.1 summarizes the recalculations described above.

As a result of some of the above-mentioned changes (and others), figures for emissions from precursor gases changed over the entire time series. The explanation of the recalculations can be found in the IIR report (2014).

Source allocation

Based on new fuel data for the agricultural sector, emissions were reallocated from 1A4a and 1A4c for the years 2008-2011.

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

Error correction

In general, the 2011 figures have been updated whenever improved statistical data have become available since the 2013 submission. Furthermore, as a result of internal QA/QC procedures, minor errors (in activity data and emission figures) were detected and corrected. The individual small error corrections amount to a max of ±0.1 Gg CO_2 eq per source category and are therefore not explained individually. They are included in the figures as presented in the tables appearing in this section.

10.1.2 KP-LULUCF inventory

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

For the end of period reporting of KP-LULUCF, an effort was made to have a new land-use map dated 1-1-2013 to allow inclusion of actual land-use changes up to 2012. Previously, the rate of land-use change observed between 2004 and 2009 was extrapolated up to 2011.

The availability of a new national forest inventory (NBI6) that was carried out in 2012 and 2013 enabled the calculation of actual carbon stock changes between 2000 (previous national forest inventory, MFV) and 2012. These changes were linearly interpolated for the years in between these two dates.

Emissions from wild fires on land that is subject to deforestation were included.

Table 10.2 Differences between NIR 2013 and the NIR 2014 for the period 1990–2011 due to recalculations (Units: Tg CO2 eq; for F-gases: Gg CO_2 eq)

Gas	Source	1990	1995	2000	2005	2009	2010	2011
CO_2 (Tg)	NIR 2014	**162.2**	173.5	172.2	178.1	173.0	184.6	171.4
Incl. LULUCF	NIR 2013	**162.2**	173.6	172.8	178.9	172.7	184.4	170.8
	Difference	*0.0%*	*0.0%*	*-0.4%*	*-0.5%*	*0.2%*	*0.1%*	*0.3%*
CO_2 (Tg)	NIR 2014	**159.2**	170.7	169.9	175.9	169.9	181.4	168.1
Excl. LULUCF	NIR 2013	**159.2**	170.7	169.9	175.9	169.9	181.4	167.6
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.3%*
CH_4 (Tg)	NIR 2014	**25.7**	24.3	19.9	16.1	16.0	15.9	15.3
	NIR 2013	**25.7**	24.3	19.9	16.1	16.1	15.9	15.3
	Difference	*0.0%*	*-0.2%*	*0.1%*	*-0.2%*	*-0.6%*	*0.1%*	*0.1%*
N_2O (Tg)	NIR 2014	**20.0**	19.9	17.4	15.5	9.5	9.3	9.3
	NIR 2013	**20.0**	19.9	17.4	15.4	9.4	9.2	9.1
	Difference	*0.0%*	*0.1%*	*0.4%*	*0.6%*	*1.1%*	*2.4%*	*1.9%*
PFCs (Gg)	NIR 2014	2264	**1938**	1581	265	168	209	183
	NIR 2013	2264	**1938**	1581	265	168	209	183
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
HFCs (Gg)	NIR 2014	4432	**6019**	3891	1511	2070	2257	2132
	NIR 2013	4432	**6019**	3892	1512	2072	2260	2133
	Difference	*0.0%*	*0.0%*	*0.0%*	*-0.1%*	*-0.1%*	*-0.1%*	*0.0%*
SF_6 (Gg)	NIR 2014	218	**287**	295	240	170	184	147
	NIR 2013	218	**287**	295	240	170	184	147
	Difference	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Total	NIR 2014	214.9	226.0	215.4	211.7	201.1	212.6	198.5
(Tg CO_2 eq.)	NIR 2013	214.8	226.0	215.9	212.5	200.7	212.2	197.6
Incl. LULUCF	*Difference*	*0.0%*	*0.0%*	*-0.2%*	*-0.4%*	*0.1%*	*0.2%*	*0.4%*
Total	NIR 2014	211.8	223.2	213.0	209.4	197.8	209.3	195.1
[Tg CO_2 eq.]	NIR 2013	211.8	223.2	213.0	209.5	197.9	209.2	194.4
Excl. LULUCF	*Difference*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*0.4%*

Note: Base year values are indicated in bold.

Combined, these changes amount to:
-13.0 Gg CO_2 eq in 2008
201.9 Gg CO_2 eq in 2009
9.1 Gg CO_2 eq in 2010
11.1 Gg CO_2 eq in 2011

10.2 Implications for emission levels GHG inventory

10.2.1 GHG inventory

This chapter outlines and summarizes the implications of the changes described in section 10.1 for emission 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.

Table 10.2 shows the changes made due to the recalculations for the 1990, 1995, 2000, 2005, 2010 and 2011 (compared with the NIR 2013). From the table, it can be seen that the recalculations changed national emissions only to a small extent. The year 2011 holds the largest recalculation (823 Gg CO_2 eq).

10.2.2 KP-LULUCF inventory

The rates of deforestation, afforestation and reforestation between 2009 and 2012 changed as a result of the use of the new land-use change matrix that was based on observed land-use changes between 1-1-2009 and 1-1-2013.

Table 10.3 Differences between NIR 2013 and NIR 2014 with respect to emission trends during the period 1990–2011 (Units: Gg CO_2 eq. rounded)

Gas	Trend (absolute)			Trend (percentage)		
CO_2 eq (Gg) [1)]	NIR 2014	NIR 2013	Difference	NIR 2014	NIR 2013	Difference
CO_2	8,822	8,314	508	5.5%	5.2%	0.3%
CH_4	-10,443	-10,451	7	-40.6%	-40.6%	0.0%
N_2O	-10,639	-10,881	242	-53.2%	-54.4%	1.3%
HFCs	-2,300	-2,299	1	-51.9%	-51.9%	0.0%
PFCs	-2,082	-2,082	0	-91.9%	-91.9%	0.0%
SF_6	-72	-72	0	-32.8%	-32.8%	0.0%
Total	-16,713	-17,470	757	-7.9%	-8.2%	0.4%

[1)] Excluding LULUCF.

The use of improved carbon stock change data for forest land resulted in changes in the emission factor for biomass. Compared with the previous estimates, the carbon stocks in living biomass on forest land were 0.2 tons per ha higher in 2008, increasing to 1.4 tons per ha higher in 2011. Consequently, emissions from deforestation per unit of area increased compared with previous submissions. This improved information on carbon stock changes also has an effect on the emission factor used for forest fires.

10.3 Implications for emission trends, including time series consistency

10.3.1 GHG inventory

In general, the recalculations improve both the accuracy and time series consistency of the estimated emissions. Table 10.3 presents the changed trends in the greenhouse gas emissions during this period due to the recalculations carried out.

10.3.2 KP-LULUCF inventory

In the land-use change matrices that are used for the different time periods (i.e. 1990-2004, 2004-2009 and 2009-2012), the changes are linearly interpolated, thus assuming the same change rate each year within the period. At the transition from one matrix to the next, a step in the calculated annual change rates may occur. This is also the case for the transition from the matrix 2004-2009 to 2009-2012.

10.4 Recalculations, response to the review process and planned improvements

10.4.1 GHG inventory

10.4.1.1 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. During the public review on the draft NIR of January 2014, two questions on allocation of emissions were raised. The peer review includes a general check on all chapters. In addition, special attention has been given to a specific sector or topic each year. This year, a separate study (CE Delft, 2014) focused on the chapter Energy (excluding transport). 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 generally high. Recommendations were made, for example, in the field of improving inconsistencies and adding more extensive explanations on recent trends and complex tables. Finally, suggestions were made to improve the transparency and readability of the Energy chapter. Peer reviews in past years have focused on the following sectors and categories: Industrial process emissions (Royal HaskoningDHV, 2013), 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 has been that the Dutch NIR adequately describes the way that the Netherlands calculates the emissions of greenhouse gases. The major recommendations refer to the readability and transparency of the NIR and suggestions for textual improvement.

UNFCCC reviews

In September 2013, a centralized review of the NIR 2013 took place. An intensive process of questions and answers was part of this process. The review resulted in a Saturday paper, in which emissions of mules and asses were included. As a response to the review, the Netherlands resubmitted the CRF files in October 2013. The Netherlands used the recommendations in the ERT reports of the 2012 review (published in August 2013) and the 2013 review (published in January 2014) for further improvements to this NIR.

Table 10.4 Improvements made in response to the latest UNFCCC reviews of 2012 and 2013.

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-9	Cross cutting	Obtain the data, calculate potential emissions of F-gases, CO_2, CH_4 and N_2O emissions from biomass burning for all sub-categories, except for land converted to forest land and cropland remaining cropland, and N_2O emissions from disturbance associated with land-use conversion to cropland and include them.	For F-gasses, See 2012-55 and **2013-43** For LULUCF related issues, see 2012-84 to 87 and **2013-61 to 62**	4.7.1 7.2 and 7.7.5
2012-10	Cross cutting	Fully complete CRF Summary Table 3 for the entire time series.	All notation keys on AD , EFs and Methods were checked and improved	Updated sectoral tables in CRF for all years
2012-12	Cross cutting	Explain the allocation of emission estimates reported as "IE" in the NIR and the CRF tables.	See 2012-10	2012-10
2012-13	Cross cutting	Include in the NIR, the descriptions of the methods and parameters used, particularly for higher-tier methods and country-specific parameters.	Based on sectoral review, comments improvements were made	Improved NIR sections f.i. 3.2.6 methodo-logical issues
2012-16	Cross cutting	Include missing information on the role of different entities in the inventory development and improve the transparency of the information on the national system.	We updated text and figures in section 1.3 and added items in 1.6	Improved sections 1.3.1, 1.3.2, 1.6
2012-17	Cross cutting	Further enhance the functionality of the national system and report emissions from all categories for which IPCC methodologies and EFs are available.	Inclusion of emissions of Mules and Asses	6.2
2012-18	Cross cutting	Ensure that sufficient resources and planning are put in place to ensure that the new land-use map is produced on time.	A new land-use map with date 1-1-2013 is produced and used to assess land-use changes for 2008-2012. These data are used to update the activity data between 2008 and 2012.	7.3
2012-21	Cross cutting	Describe in the NIR how the results of the key category analysis have been used for the improvement of the inventory.	We included a bullet point on Annual Inventory Improvement in section 1.6.1.	1.6.1.

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-22	Cross cutting	Explain the difference in the uncertainty estimates for the consecutive annual submissions.	There is now an annual cycle put in place to process changes in uncertainty estimates for each source.	Annex 7
2013-22	Cross cutting	Document how the results of the uncertainty analysis have been used for the improvement of the inventory.	We included a bullet point on Annual Inventory Improvement in section 1.6.1.	1.6.1.
2012-24	Cross cutting	Improve the QC checks applied to plant-specific data and describe them.	Improved text and see 2012-31. We used ETS data and data from AERs to check and improve the emissions as derived from the National Energy statistics.	3.2.6, 3.2.7, 3.2.9 and 4.3.3 to 4.3.5
2012-25 & 2012-38	Cross cutting	Strengthen the arrangements under the national system in order to ensure the descriptions of the methods used to calculate the emissions in the NIR and in the Monitoring Protocols are complete, updated and transparent.	Special attention is paid to the description of methods between Protocols, NIR and CRF and in this submission. See also 2012-13.	Sectoral sections of NIR and improved CRF tables
2012-26	Cross cutting	Elaborate on alternative ways for reporting on data, methods, and parameters used for emission estimation in line with the UNFCCC reporting guidelines and without violating existing country-specific rules on confidentiality.	Improved text. Some of the data used in the compilation of the inventory are confidential and cannot be published in print or electronic format. All confidential data, nevertheless, can be made available to the official review process of the UNFCCC.	1.6.3, 3.3.1.
2012-39	Cross cutting	Address the recommendations of the previous review reports that have not yet been addressed.	See 2012-44, 2012-48 and 2012-43	This table
2013-17	Cross cutting	Improve transparency of archiving procedures.	The RIVM database holds, as of the 2012 submission, storage space where the Task Forces can store the crucial data for their emission calculations. The use of this feature is voluntary, as storage of essential data is also guaranteed by the quality systems at the outside agencies.	1.6.1
2012-49 & **2013-23**	Cross Cutting	Improve QC (CRF versus NIR) and NIR versus protocolls.	Improvements were made in the consistency between methods described in NIR and CRF and Protocols.	Sectoral sections in the NIR and sectoral CRF tables
Energy				
2012-36 & **2013-40**	Energy	Improve transparency of reporting by providing documentation on all recalculations in the NIR and in the CRF tables, including any changes to the AD, EFs or methods applied.	Detailed descriptions of all recalculations have been included in the recalculation paragraphs.	3.2.6, 3.2.7, 3.2.8 and 3.2.9, section 4 and 10 of NIR and CRF tables

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-31 & 2012-41	Energy	Review the appropriateness of the IPCC default EFs used, with the aim of calculating more country-specific emission factors, particularly for fuels associated with a large proportion of emissions from fuel combustion, for example diesel oil.	A description of country-specific and company-specific emission factors is given, including the percentage of the emissions which is calculated using country-specific or company-specific emission factors.	Methodical issues as described in 3.2.6., 3.2.7 and 3.2.9
2012-42 & **2013-25**	Energy	Continue to perform the verification activity based on the EU ETS data at regular intervals.	This has been an annual activity since emission year 2006.	see publication: De Ligt, 2014
2012-43 & **2013-26**	Energy	Improve the transparency of reporting by including, in the NIR of the next annual submission, a more transparent description of the QC procedures performed for the plant-specific data.	Improved text in 3.2.6 (with reference to the general QC for plant-specific data and graphs) by adding the CO_2 emissions from the iron and steel industry.	3.2.6.2, 3.2.7, 3.2.9 and 4.3.3 to 4.3.5 Figures 3.7 and 3.8
2012-44	Reference and sectoral approach	Report on the apparent energy consumption in CRF table 1.A(c).	Now included	CRF 1.A(c)
2012-47 & **2013-24** & **2013-31**	Stationary combustion: solid, liquid and gaseous fuels – CO_2, CH_4 and N_2O	Provide a more transparent description, including additional implied emission factors information on the AD and EFs, to justify the low value of the implied emission factors.	A more detailed description of the methodology has been included. Due to confidentiality, detailed data on fuel consumption and emission factors per CRF category and fuel are not presented in the NIR, but are available for the reviewers upon request. Also see 41.	Methodical issues as described in NIR 3.2.6, 3.2.7 and 3.2.9
2012-48 & **2013-32** **&** **2013-34**		Correctly allocate CO_2, CH_4 and N_2O emissions from fuel combustion from on-site coke production in iron and steel plants.	The trend in CO_2 emissions from the iron and steel plant is presented in a graph in the energy chapter, including emissions of fuel combustion from on-site coke production.	3.2.7 And Figures 3.7 and 3.8 Improved CRF tables (Table2(I).A-Gs2)
2012-49 **&** **2013-33**	Road transport: liquid fuels – CO_2 and N2O	Report on the progress made with regard to the study to update N_2O and CO_2 EFs for diesel oil and petrol (gasoline). Ensure the consistency in reporting between the NIR and other inventory documentation.	The new N_2O EFs have been used and documented in the NIR2013. Progress on the CO_2 EFs is documented in paragraph 3.2.8. Consistency between the methodologies and emission factors in the NIR2014 and the underlying documentation on methodologies used in Klein et al. (2014) has been ensured.	3.2.8
2012-50	Natural gas - other leakage- CO_2	Review the use of the notation keys and correct the identified error, and improve the QA/QC processes related to the information provided in the CRF and NIR.	See 2012-10	Improved CRF tables (Table1.B.2)

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2013-35	Oil and natural gas	Improve reported activity data for oil refining and storage.	Work is ongoing to be more transparent in the reporting for this sector. The sector is improving their data gathering and verification and improved activity data are expected in next submission.	
2013-36 & 2013-37	Oil and natural gas	Other transport notation keys	We replaced NE by IE for other leakage.	Improved CRF tables (Table1.B.2)
Industrial processes and solvent and other product uses				
2012-55 & **2013-43**	Industrial processes and solvent and other product uses	Estimate the potential HFC, PFC and SF6 emissions under consumption of halocarbons and SF6.	From the 2012 submission onwards, the potential emissions for the period 1990–2012 are included in the CRF reporter. Because the consumption data of PFCs and SF6 are confidential, only the HFC emissions (2F1 and 2F9) are reported.	4.7.1 Please note that the potential emissions are not shown in the CRF Table 2 (II) s2 due to a program bug. They are, however, included in the CRF reporter database.
2012-56	Industrial processes and solvent and other product uses	Find alternative ways, without violating the existing country-specific rules on the confidentiality, and report the AD and EF for ammonia, nitric acid, silicon carbide, ethylene and caprolactam production and the emissions of the HFCs from aerosols and foam blowing and SF6 from semiconductor manufacture and electrical equipment.	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 with respect to the public. The Dutch emission inventory team has access to most of these confidential data. If reviewers sign a confidentiality clause, the Netherlands can provide the confidential information to which the Dutch emission inventory team has access. Some of the confidential information can be viewed by the Dutch emission inventory team and reviewers only at the companies' premises.	4.1

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-58	Nitric acid production–N_2O	Retrieve the results of the measurements taken in 1998 and 1999 in order to demonstrate time series consistency, archive all measurement results properly, and make that information available for review by the ERT.	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. The results of these measurements are confidential information and can be viewed at the company's premises. 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.	4.3.3, Nitric acid production [2B2]
2012-59	Iron and steel production–CO_2	Include information on the carbon mass balance for iron and steel production.	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 to the UNFCCC review.	3.2.7 and 4.4.1
2012-57 & 2012-60 & **2013-41**	Production of halocarbons and SF_6– HFCs	Enhance category-specific QA/QC procedures to verify the plant-specific information provided by the companies, in accordance with the IPCC good practice guidance, and provide the results in the NIR.	As mentioned in the protocol, the confidential information ("HFC 23 load in the untreated flow" and "the removal efficiency of the TC") is available at the company's premises. During the annual verification of the AER, the competent authorities check this information. Furthermore, the industrial expert of the Dutch emission inventory team checks the confidential information. Up to now, all controlled confidential data have been reliable.	4.6.7
2012-62	Consumption of halocarbons and SF6– HFCs	Report the emissions of F-gases across all categories, as appropriate, in order to enhance the transparency of the reporting.	In the Netherlands, many processes related to the use of HFCs and SF6 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 SF6 emissions of 2F7 and 2F8 is reported (included in 2F9).	4.7.1

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-64 & **2013-44**	Soda ash production and use – CO_2	Verify the plant-specific data on the non-energy use of coke, in order to ensure that double counting is avoided, and clearly indicate this in the NIR and use the correct notation keys in the CRF tables.	To avoid double counting, the plant-specific data on the non-energy use of coke were subtracted from the non-energy use of coke and earmarked as feedstock in the National Energy Statistics. Furthermore, the Netherlands has included the information on the closure of the soda ash production plant and the notation key NO in the CRF Tables (from 2010 onwards) in this submission.	4.2.4.
2012-64 & **2013-40 & 2013-42 & 2013-45**		Use the correct notation keys and recalculation descriptions in the CRF tables.	Did so, where possible, and we improved the use of the correct notation keys.	Improved sectoral CRF tables and Table8(b)
Agriculture				
2012-71	Agriculture	Revise and correct the notation keys in order to improve the consistency and transparency of the reporting.	The notation keys were reviewed and corrected.	Improved CRF tables
2012-72	Enteric fermentation– CH_4	Improve the transparency of the reporting by providing information on the method used to determine the value of the methane conversion factor for cattle in English.	The model calculates the gross energy (GE) intake, CH4 EF (in kg CH4/cow/year) and the methane conversion factor (Ym; % of GE intake converted into CH4) 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, organic acids and ash) and the intrinsic degradation characteristics of starch, NDF and crude protein in the rumen.	6.2.3
2012-73	Enteric fermentation– CH_4	Improve the accuracy of the reporting by filling in CRF Table 4.A correctly.	We completed the table to the extent possible within the Dutch methodology.	Improved CRF table 4A
2012-74	Manure management – CH_4 and N_2O	Include clear and detailed information on the methods and EFs used for the estimation of emissions from rabbits and fur-bearing animals.	'Other animals' is comprised of rabbits and fur-bearing animals, producing solid and liquid manure, respectively. Resulting IEF for this category is therefore very dependent on the ratio between both species in a given year.	6.3.3
2012-75 & **2013-51** & **2013-55**		Maintain consistency in the notation keys used to report emissions from buffalo, and mules and asses.	Emissions from mules are now included.	6.1 and improved CRF tables

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-76	Agricultural soils – N_2O	Include detailed information justifying the changes in the nitrogen flows related to agriculture in order to increase the transparency of the reporting.	Improved text and explanatory Tables 6.7 and 6.8.	6.4.4 and 6.4.8
2012-77		Correct the comment in CRF Table 4, clearly stating that the notation key "NE" has been used due to the fact that there are no IPCC estimation methods available.	"NE" has been used due to the fact that there are no IPCC estimation methods available.	Improved CRF table 4
2012-77		Provide a reference or include the data on the use of sludge in agriculture in the NIR.	Reference included. Van der Hoek et al., 2007	6.4.4
2012-78		Include sufficiently transparent documentation on the changes in the definitions of farm size and their possible effects on emissions from the agriculture sector.	In order to comply with the requirements set by the Farm Accountancy Data Network (FADN) of the European Union, a new definition for farms has been used from 2010 on. Previously, the criterion for inclusion in the agricultural census was three Dutch size units (nge); this has been changed to 3,000 Standard Output (SO). The influence on measured population has been minimalized by setting the new criterion to a value that matches 3 nge.	6.2.5, 6.3.5 and 6.4.6
2013-48		More information on models and gross energy intake.	Reference included (www.cbs.nl) and improved text.	6.2.3, 6.4.4 and 6.4.8
2013-49		Transparency of methods and parameters.	Reference (Bannink, 2010) included.	6.2.3
2013-50 & 2013-54		Buffalo's Notation keys	We now use NO instead of NE.	Improved CRF tables 4s1 and 4A
52	Manure management	Consistency between N_2O and CH_4	Has been identified as area for possible improvement.	
57	Pasture, range etc	Give more detail on cattle outdoors.	The decrease in N_2O emissions from animal manure produced on pasture land is also entirely reflected in the decrease in N input to soil by this source.	6.4.4
LULUCF				

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-81 & **2013-59**	LULUCF	Obtain the data and make the estimates for those categories reported as "NE", in which the IPCC methodology and the default EFs exist in the IPCC good practice guidance for LULUCF.	* Carbon stock changes in mineral soils have been assessed and are now included. * N2O emissions resulting from conversions from land to cropland have been included. * Estimates have been included for emissions from wildfires, other than forest fires. Forest Fires were included already in the NIR 2013. Additional wildfires (area and emissions) have been included under 'grassland remaining grassland', as this is likely the most prominent source for wildfires outside forests. Notation keys have been updated.	7.2 and 7.7.5
2012-82	LULUCF	Use the appropriate notation key (i.e. "NE" and "NO") to report those pools where no emissions have been assumed.	We improved the notation keys according the remarks from the review.	Improved LULUCF CRF tables
2012-82	LULUCF	Provide the verifiable justification for the assumptions made for those categories in which the "NO" and "NE" notation keys have been used.	See Arets et al., 2014 In the NIR, we included the explanation (in CRF as cell comments).	7.1, 7.6.1. 7.8.5.
2012-83 & **2013-60**	Grassland remaining grassland – CO_2	Obtain the data, make the estimates and report on carbon stock changes in living biomass for the 'grassland remaining grassland' category and justify the fact that the mineral soils under this category are not an emission source.	* Carbon stock changes from mineral soils for grasslands remaining grasslands have been explicitly included. * Carbon stock changes in living biomass for grasslands remaining grasslands could not yet be included, but will be considered for future reporting. Potential data sources have been investigated.	7.2
2012-84	Land converted to grassland– CO_2	Obtain the data and make the estimates of carbon stock changes in soil pools under land converted to grassland, otherwise justify that non-estimated mineral and organic soil pools are not an emission source.	Carbon stock changes in mineral soils for land converted to grassland have been included in the NIR 2014. See Arets et al., 2014	7.4
2012-85 & **2013-61**	N2O emissions from disturbance associated with land-use conversion to cropland– N_2O	Obtain the data and estimate N2O emissions from disturbance associated with land-use conversion to cropland.	N_2O emissions from disturbance associated with conversions to cropland have been included in the NIR 2014, covering the time series since 1990.	7.2

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-86 & 2012-87 & **2013-62**	Biomass burning – CO_2	Provide a description of the legislation on controlled burning. Reconcile the use of the notation keys for specific land-use categories in accordance with existing legislation. Obtain the data on the areas of wildfires, estimate CO_2 and non-CO_2 emissions for the entire time series and include them.	Notation keys have been updated to reflect the new reporting of wildfires. The notation key for controlled burning was set to IE, NO because the area included under wildfires partly includes the occasional burning that is done under nature management. Controlled burning of harvest residues is not allowed in the Netherlands (Article 10.2 of 'Wet Milieubeheer' - the Environment Law in the Netherlands). Wildfires on Forest land remaining forest land have been included since the NIR 2013. In the NIR 2014, emissions from all other wildfires have also been included. Only historic data on area burned in the period 1980-1992 are available. The average area of this period (210 ha) was used to calculate emissions from wildfires. Most wildfires outside forests in the Netherlands are associated with heath and grassland. The emissions were therefore included under grassland remaining grassland and calculated using default methods provided in the IPCC GPG. The notation key of wildfires on other land-use categories was set to IE.	7.7.5.
KP				
2012-100 & **2013-70**	Supplementary information required under Article 7, paragraph 1 of the Kyoto Protocol.	Justify the fact that the conversions between the TOF and FAD categories are direct and human-induced activities, and that they correspond to the definitions of afforestation, reforestation and deforestation outlined in the annex to decision 16/CMP.1	Further explanation has been included in the NIR.	11.1.1 and 11.3.1
2012-100	Supplementary information required under Article 7, paragraph 1 of the Kyoto Protocol.	Justify the fact that the afforestation, reforestation and deforestation activities under the Kyoto Protocol on the units of lands have started since 1 January 1990, and these units of land are tracked over time separately from the other forest lands.	Further explanation has been included in the NIR.	11.1.1 and 11.3.1

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-103		Collect the wildfire statistics in order to provide the emission estimates from afforestation and reforestation.	Emissions from wildfire on forest land (AR) have been included since the NIR 2013. In the NIR 2014 also, emissions from wildfires on D land have been included. These are calculated based on a historic time series and are a fraction from the total area of wildfires.	7.4
2012-104 & **2013-72**	Afforestation and reforestation– CO_2	Provide the verifiable information that demonstrates that the pools unaccounted for under the conversions between TOF and FAD are not the net sources of emissions, as required by the annex to the decision 15/CMP.1.	Further explanation has been included in the NIR.	11.1.1 and 11.3.1.1
2012-105	Deforestation– CO_2	Justify the fact that the assessment of the emissions and removals from the changes in carbon stocks owing to deforestation activities under the Article 3, paragraph 3, of the Kyoto Protocol has been performed in accordance with the methodology of the IPCC Good Practice Guidance for the LULUCF.	Further explanation has been included in the NIR.	11.1.1 and 11.3.1.1
2012-111	Changes in the national system	Further strengthen the entire functionality of the national system in order to address the recommendations contained in the current and previous review reports.	The Netherlands has continuously worked on improving the National System, but the budget is not unlimited.	
Waste				
2012-91 & **2013-65**	Waste	Include information on the results of the category-specific QA/QC checks in the relevant sector chapter of the NIR in order to enhance the transparency of the reporting.	In general, the QA/QC procedures within the waste sector are: •Check of AD with other sources within the monitoring of waste; •Check on trends in the resulting emissions; •Check of the EFs once every 4 to 5 years with EFs in other European countries.	8.3.4 and 8.5.4
2012-92 & **2013-66**	Waste	Use the uncertainty analysis as a tool to identify the priorities for the sectoral improvements and provide an explanation on expert judgements used in the uncertainty assessment in the waste sector.	Improved text i.a..A recent international study (GWRC, 2011), in which the Dutch public wastewater sector also participated, showed that N2O EFs, in particular, are highly variable among different WWTPs and at the same WWTP during different seasons or even throughout the day.	8.3.3. and 8.5.6

ARR 2012 & 2013 Paragraph *	Category	ERT comments	Netherlands' Response	Reference (Section of NIR)
2012-94	Solid waste disposal on land – CH_4	Keep track of updates or revisions of the Monitoring Protocol in the waste sector in order to enhance the transparency of the information on the activity data collection system and methodology used for CH4 emission estimation.	The NIR text is now in line with the most recent protocol.	
2013-67		Remove inconsistencies between NIR and CRF.	Done.	8.2.1 and Improved CRF tables (Table 6A,C)
2012-96	Wastewater handling – CH_4 and N_2O	Correct the notation key used to "IE", in accordance with the explanation provided in the NIR and in the Monitoring Protocols.	Improved text: i.a. Anaerobic sludge, which builds up in the industrial anaerobic wastewater treatment systems, is digested simultaneously with the wastewater. The emissions are therefore included (IE) within category 6B.1.a.	8.3.2 and Improved CRF tables (Table 6Bs1)
2013-68	Wastewater handling – CH_4 and N_2O	Improve description and rationale in NIR and CRF.	Improved text for the 8.3.2. section.	8.3.2
2013-80	National Registry	Include all additional information in the NIR related to the reporting of test results, in accordance with decision 15/CMP.1, annex, Chapter I.G.	Changes introduced in releases 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to the release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is included in Annex B (confidential information, separately submitted to the UNFCCC).	Chapter 14

10.4.1.2 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.

10.4.1.3 Completeness of CRF files

For the years 1991–1994, energy data are less detailed for all industrial source categories than in both of the preceding and following years, but they adequately cover all sectors and source categories. All emissions are specified by 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).

10.4.1.4 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, 2013).

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 drawn was that annual fluctuations in intermediate years were very minor. It was therefore decided not to carry out a 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 and 2012 was 56.5 (see Annex 2; Zijlema, 2011; Zijlema, 2012).

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 http://english.rvo.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).The Netherlands included this recommendation in its QA/QC programme for 2009 to improve the 'balance' between NIR, protocols and background reports. This process started in 2009 and was finalized in 2010.

The QA/QC programme for this year (NL Agency, 2013) continues the assessment of improvement options in the longer term based on the consequences of the 2006 IPCC Guidelines for reporting from 2015 onwards. Improvement actions for new methodologies and changes of emission factor will be performed in 2014.
Another issue for the ERT was the recommendation to further centralize 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 estimates will be continued in 2014.

10.4.2 KP-LULUCF inventory

No major planned improvements are foreseen.

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

In its Initial Report, the Netherlands identified 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.

Wooded areas that comply with the previous forest definition, except for their surface area (=< 0.5 ha or less than 30 m width), are included in a forest land category 'Trees outside Forests' (TOF). 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 with the strict forest definition that the Netherlands applies for the Kyoto Protocol.

11.1.2 Elected activities under Article 3, paragraph 4 of the Kyoto Protocol

The Netherlands has not elected any activities to include under Article 3, paragraph 4 of the Kyoto Protocol.

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

Units of land subject to Article 3.3 (Afforestation and reforestation) are reported jointly and are defined as units of land that did not comply with the Forest definition on 1 January 1990 and then do comply at any time (that can be measured) before 1 January 2013. Land is classified as reforested/afforested (AR land) as long as it complies with the Forest definition. Units of AR land that are deforested again later will be reported under Article 3.3. Deforestation from that point in time onwards.

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, an overlay of land-use maps shows 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 it 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 determining the area of the units of land under Article 3.3

The Netherlands has complete and spatially explicit land-use mapping that allows for geographical stratification at 25 m x 25 m (0.0625 ha) pixel resolution (Kramer et al., 2009). This corresponds with the wall-to-wall approach used for reporting under the Convention (Approach 3 in GPG-LULUCF, Chapter 2) and is described as Reporting Method 2 in GPG-LULUCF for Kyoto (par. 4.2.2.2). 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 reforestation/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 its 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. Therefore, 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), 1 January 2009 (Van den Wyngaert et al., 2012) and 1 January 2013 (Arets et al 2014). An overlay was made between those four 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 1 January 1990 and 1 January 2004, a second matrix covering the period 1 January 2004 and 1 January 2009 and a third matrix covering the period January 2009-1 January 2013 . Together, the 3 matrices thus cover the full period 1 January 1990 - 1 January 2013, ensuring that we are able to capture all land-use changes, including 2012 (IPCC, 2003). Mean annual rates of change for all land-use transitions in between the years with maps were calculated by linear interpolation. In the previous submissions, the land-use change rates between 2009 and 2011 were estimated by extrapolation of the 2004–2009 changes. The use of the actual land-use changes for this period has resulted in the recalculation of land-use change rates and associated

Table 11.1 Results of the calculations of the area change (in kha) of re/afforestation (AR) and deforestation (D) in the period 1990-2012.

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	41.52	2.51	0.86	37.84	1.64	4,067.08	84.37
2009	42.69	2.91	1.34	40.34	1.87	4,062.30	89.15
2010	44.26	2.91	1.34	43.55	1.88	4,057.51	93.95
2011	45.84	2.91	1.34	46.77	1.87	4,052.71	98.73
2012	47.42	2.91	1.34	49.98	1.88	4,047.93	103.52

emission for the years 2009-2011 in this submission.

A land-use map with a map date of 1 January 2008 would have allowed exact land-use changes during the CP, but this was not feasible, practically speaking. Because emissions from all AR and D land in between 1990 and 2012 need to be reported under the Kyoto Protocol, this was not considered a major problem.

Table 11.1 gives the annual values from 1990 on for the Article 3.3-related cells in Table NIR-2.
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 up to 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.

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 land-use maps for monitoring nature development in the Netherlands, 'Basiskaart Natuur' (BN) for 1990, 2004 and 2009 plus an additional map for 1 January 2013 that was developed specifically for KP-LULUCF reporting+ following the same methodologies used for the previous three land-use maps.
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

Table 11.2 Characteristics of BN 1990, BN 2004, BN 2009 and BN2013.

Characteristics	BN 1990	BN 2004	BN 2009	BN 2013
Name	Historical Land Use Netherlands 1990	Base Map Nature 2004	Base Map Nature 2009	Base Map Nature 2013
Aim	Historical land use map for 1990	Base map for monitoring nature development	Base map for monitoring nature development	Specifically developed for KP end of period reporting following the methodology of BN2009
Resolution	25 m	25 m	25 m	25 m
Coverage	Netherlands	Netherlands	Netherlands	Netherlands
Map date	1 January 1990	1 January 2004	1 January 2009	1 January 2013
Base year source data	1986–1994	1999–2003	2004–2008	2009-2011
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	Digital topographical maps at 1:10,000 and additional sources to distinguish specific nature types
Number of classes	10	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, Nature grassland, Arable land, Heath land, Forest, Built-up area and infrastructure, Water, Reed marsh, Drifting sands, Dunes and beaches	Grassland, Nature grassland, Arable land, Heath land, Forest, Built-up areaand infrastructure, Water, Reed marsh, Drifting sands, Dunes and beaches

with exploration years in the period 1986–1994 were used. The source material for BN 2004 consists of the digital topographical map 1:10,000 (Top10Vector). For BN 2004, as well as BN 2009 and the 2013 map, information from the Top 10 vector is combined with four other sources, i.e. two subsidy regulations (information from 2004 and 2009, respectively), 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 summarizes the characteristics of the 1990, 2004, 2009 and 2013 maps (taken from Kramer et al., 2009). The 2009 and 2013 maps have basically the same properties as the 2004 map.
In 2008, a series of improvements were made to the methodology for the digitalization, 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 the 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 digitized 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, harmonization between the different source materials was applied to allow a sufficiently reliable overlay. Harmonization 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 digitizing and classifying processes.

To distinguish between mineral soils and peat soils, an overlay was made between the land-use maps and the Dutch Soil Map (De Vries et al., 2003) resulting in land-use information with national coverage. For each pixel, it identifies whether it was subject to AR or D between 1990 and 2004, 2004 and 2009, and 2009 and 2012, and whether it is located on a mineral or an organic soil.

Following this procedure, the status of a reforested/afforested area or deforested area is confirmed for each of the individual locations on the map that were subject to ARD between 1-1-1990 and 1-1-2013. However, it is unknown for each individual location when exactly ARD occurred in each of the intervals between new land-use maps. A mean annual rate for the Netherlands as a whole is derived from the aforementioned analysis by interpolation.

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-ground or 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-ground 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 from 1990 on 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 were differentiated in above-ground or below-ground biomass using data available from the simple bookkeeping model used (Arets et al., 2014). Data from the newly available 6th Dutch Forest Inventory 2012-2013 in combination with the data from the previous National Forest Inventory (MFV) in 2000, allowed the calculation of actual carbon stock changes between in 2000 and 2012. Therefore emission factors involving living tree biomass were recalculated. As a consequence, emissions from Deforestation and from wildfires in forests needed to be recalculated for 2008-2011.

In the Netherlands, the definition of forest that was chosen for the Kyoto Protocol (Forest According the Kyoto Definition, FAD) does not include all land with woody cover. Wooded areas that comply with the FAD definition, except for their surface area (=< 0.5 ha or less than 30 m width), are included in a forest land category 'Trees outside Forests' (TOF). In terms of biomass and carbon stocks, these areas are similar to the forests that meet the Kyoto definition.
For both AR and D, therefore, a distinction is made between land-use conversions that imply a discontinuity in woody cover (i.e. conversions to cropland, grassland, wetland, settlement and other land uses, see above) and conversions that imply a discontinuity in land use but not in land cover (conversion to and from trees outside forest).

FAD land may be converted to TOF if, for instance, part of a larger FAD area is converted to other non-woody land-uses. After such conversions, small units of lands with their original woody cover intact may remain separated from the larger area. If these areas don't meet the area requirements for FAD any longer, then they are converted to TOF. Similarly, the previously larger FAD area may stop meeting the area requirements for FAD. It is part of its area and is converted to non-woody land uses.

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	89.84	33.83	NE	NE	11.18	-21.45
2009	95.65	34.24	NE	NE	11.05	-21.87
2010	164.00	20.96	NE	NE	10.32	-22.30
2011	167.60	21.72	NE	NE	9.61	-22.72
2012	171.04	22.53	NE	NE	8.90	-23.10

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	-117.32	-20.19	-52.72	-2.40	-0.31	-14.05
2009	-143.63	-23.12	-81.57	-3.84	-0.26	-15.27
2010	-147.00	-24.54	-81.57	-3.97	-0.23	-16.49
2011	-152.97	-25.37	-81.57	-4.10	-0.22	-17.71
2012	-158.96	-33.28	-81.57	-4.23	-0.23	-18.93

CSC : carbon stock change
AR : afforestation and reforestation
AG : above ground
D : deforestation
BG : below ground

This does not involve a discontinuity in land cover (i.e. living biomass) over time for the units of land with woody cover, though the loss of connection to a larger unit does involve a change in land use from Kyoto forests to Trees outside forest, which is reported under deforestation. Since the trees on these units of land still grow, this is reported as a carbon stock increase in biomass. Carbon stock losses on the units of land of the originally larger FAD area that were converted to non-woody land uses are reported under Deforestation of FAD to those land-use categories.

Carbon stock change due to changes in above-ground 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 reforested/afforested land involved an emission of all carbon stocks that had been calculated to have accumulated following the methodologies for reforestation/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 taken 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 approximately 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 comprises sandy beaches and inland (drifting) sandy areas).

The estimated annual C flux associated with reforestation/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 or 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), and net sink of 59.5 (2009), 159.4 (2010), 257.4 (2011) and 353.9 (2012) kton CO_2 per year for deforestation and a net sink of 27.9 (2008), 29.4 (2009), 27.14 (2010), 24.9 (2011) and 22.7 (2012) kton CO_2 per year for reforestation/afforestation. The net sink for deforestation after 2008 is the result of the conversion of a relatively large area of forest to grassland between 1 January 2009 and 1 January 2013.

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 AR land on organic soils was 49 ha in 2012 (0.1% of total AR area) and of deforested land on organic soils was 2,905 ha (5.4% of deforested area) in 2012. The majority of this change (79% for AR and 60% for Deforestation in 2012) was a conversion between Kyoto Forest and agricultural land (Cropland or Grassland). Drainage of organic soils to sustain forestry is not part of the land management nor is it actively done. However, organic soils under forests 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 reforestation/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 reforestation/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 reforestation/afforestation.

The result of the overlay of the subsidence map of peat soils with the locations of reforestation/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 reforestation/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

Table 11.5 Estimates area and GHG emissions from wildfires on AR land and D land. Fraction of total area gives the proportion AR to total forest area for AR land and the proportion of area of FAD converted to Grassland to total grassland area for Deforestation.

Year	fraction of total area	area burned (ha)	CO_2 (Gg)	CH4 (Gg)	N_2O (Gg)
AR					
2008	0.112	4.24	0.809	0.004	0.00003
2009	0.130	4.92	0.954	0.004	0.00003
2010	0.139	5.24	1.034	0.005	0.00003
2011	0.147	5.56	1.115	0.005	0.00004
2012	0.156	5.87	1.200	0.006	0.00004
D					
2008	0.014	2.99	0.049	0.00023	0.000002
2009	0.015	3.16	0.052	0.00024	0.000002
2010	0.016	3.40	0.056	0.00026	0.000002
2011	0.017	3.64	0.060	0.00028	0.000002
2012	0.019	3.89	0.064	0.00030	0.000002

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

The 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 therefore 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.

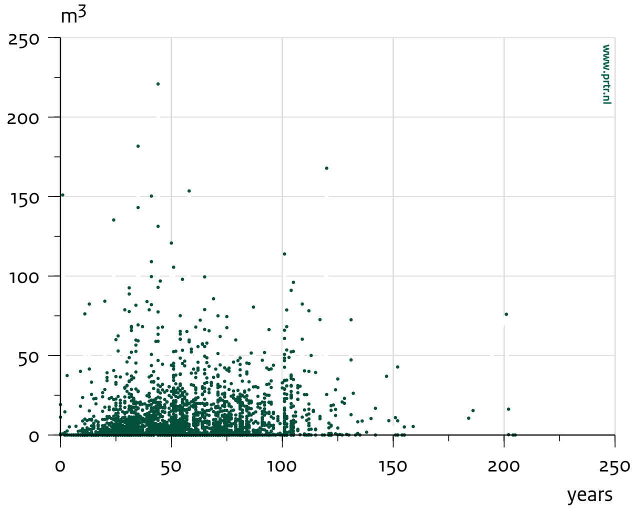
Due to changes in the implementation of the new land-use matrix 2008-2012, the area of Grassland and Cropland reported under Article 3.3 deforestation changed. The emissions from lime application were recalculated to reflect this change.
Statistics on lime application lag behind by one year. The 2012 emissions from lime application were therefore estimated using the 2011 quantities of lime applied, resulting in an emission of 0.89 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; they are therefore reported as not occurring (NO). No recent statistics on wildfires are available (only 1980–1992, see Wijdeven et al., 2006). Greenhouse gas emissions (CO_2, CH_4 and N_2O) from wild fires on ARD land are therefore estimated using the Tier 1 method. Average annual area AR land burned was estimated from the historical series of total forest area burned between 1980 and 1992 (on average 37.8 ha, approximately 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%–16%; 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 and are subject to recalculation compared with the NIR 2013, due to the new land-use change matrix 2009-2012, resulting in a change in the proportion of AR to total forest area and the availability of new average annual carbon stock in living biomass data from the NBI6.

Average annual area D land burned was estimated from the same historical series of area burned between 1980 and 1992 (difference between total area and area of forest fire, on average 210 ha; Wijdeven et al., 2006) scaled to the proportion of FAD converted to grassland to total area Grassland (approximately 1.4%–1.9%; see Table 11.5) and average annual carbon stock in living biomass (6.7 t ha^{-1}) in Grassland.

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



The estimated GHG emissions for wildfires have a high 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, which was used to estimate an average area.

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

In the Netherlands, wild fires seldom lead to total loss of forest cover and therefore do not lead to Deforestation.

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. Therefore, age does not necessarily represent the time since reforestation/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). The conversion of non-forest to forest, therefore, always involves a build-up of carbon in litter. But because good data are lacking to quantify this sink, we report the accumulation of carbon in litter for reforestation/afforestation conservatively as zero.

Similarly, no other land use has carbon in dead wood. The conversion of non-forest to forest, therefore, involves a build-up of carbon in dead wood. But 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 reforested/afforested plots is most likely a very tiny sink that is too uncertain to quantify reliably. We therefore report this carbon sink conservatively as zero.

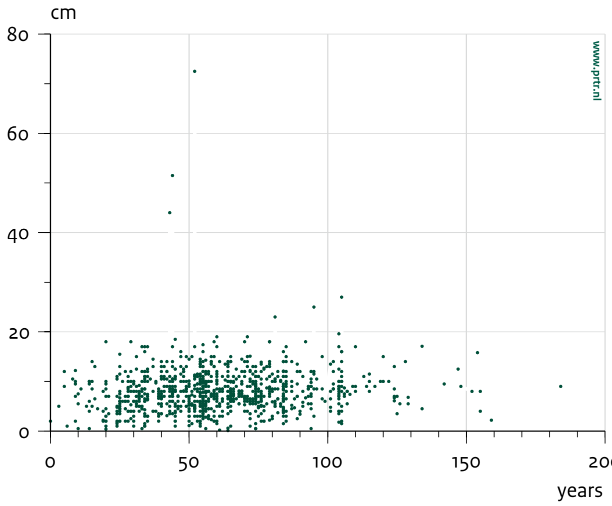
N_2O emissions due to nitrogen fertilization in units of land subject to article 3.3 AR

Forest fertilization does not occur in the Netherlands. Therefore, fertilization 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

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.



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. A new land-use map for 1-1-2013 is available, allowing the calculation of a the land-use change matrix over the period 2009-2012. Until the NIR 2013 the rate of land-use change was extrapolated from the period 2004-2008. This resulted in changes in the ARD data for 2009, 2010 and 2011.
2. Over the period 2012-2013 the 6th Dutch Forest Inventory (NBI6) was carried out. Based on this new forest carbon stock data are available . Because the methodology was the same as the previous forest inventory in 2000 (MFV), the actual carbon stock changes in living biomass between 2000 and 2013 could be determined. Previously changes in living biomass since 2000 were calculated using a simple forest growth model. Consequently emission factors involving living forest biomass were recalculated. Also the emissions from forest fires were updated, using the new estimates of carbon stocks in living biomass on forest land.
3. CO_2, N_2O and CH_4 emissions from wild fires on D land were estimated and included in this NIR for the years 2008-2012
4. Emissions from liming for 2011 were updated. In the previous NIR fertilizer data were not available for 2011 and therefore 2011 emissions were set equal to 2010 emissions. These fertilizer data have become available and have been used to calculate 2011 emissions.

These recalculations correspond with part of the recalculations described in par. 7.4 for the submission under the Convention.

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 (compare NIR 2009), it is likely that the current estimate is an overestimate of the actual uncertainty.

Table 11.6 Net emissions from AR and D for accounting years 2008–2012 (Gg CO2 eq).

Activities	Net emissions/removals						Accounting quantity
	2008	2009	2010	2011	2012	Total	
A. Article 3.3 activities							
A.1. Afforestation and Reforestation							
A.1.1. Units of land not harvested since the beginning of the commitment period	-413.65	-434.83	-633.14	-644.86	-656.21	-2,782.69	-2,782.69
A.2. Deforestation	759.91	983.07	1,005.73	1,035.97	1,066.07	4,850.75	4,850.75

11.3.1.6 Information on other methodological issues
There is no additional information on other methodological issues.

11.3.1.7 The year of the onset of an activity, if after 2008
The forestry activities under article 3, paragraph 3 are reported from the beginning of the commitment period.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are directly human-induced

Land use and land-use change is mapped using regularly updated land-use maps covering the whole land area of the Netherlands. Land use maps with dates 1 January 1990,2004, 2009 and 2013 have been used to track changes in land-use on units of land. All ARD activities between 1 January 1990 (map 1 January 1990) and 31 December 2012 (map 1 January 2013) 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; Arets et al., 2014).

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. From the national forest inventory, however, it can be estimated that approximately 0.3% of Forest was classified as clear-cut area, i.e. without tree cover.

11.4.4 Information on accounting for activities under Article 3.3 activities A1 (afforestation 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 the definition of forests under the Convention and under the Kyoto Protocol, 5A2 is a corresponding category and as such reforestation/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 the definition of 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 a level for Tier 1 level analysis including LULUCF is 637 Gg CO_2 (1B1b CO_2 from coke production; see Annex 1). With 656.21Gg CO_2, the annual contribution of reforestation/afforestation under the KP is just larger than the smallest key category (Tier 1 level analysis including LULUCF). Deforestation under the KP in 2012 causes an emission of 1,066.07 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 that is 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 2013 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_2014_1_13-52-30 13-1-2014.xls.

12.2 Summary of information reported in the SEF tables

There were 948,206,092 AAUs in the Netherlands' National Emission Trading Registry at the end of the year 2013, 363,216,637 AAUs of which were in the Party holding accounts, 25,807 in entity holding accounts, 11,430 AAUs in the other cancellation accounts and 584,952,218 AAUs in the retirement account.

There were 35,437,868 ERUs in the registry at the end of 2013: 8,569,516 ERUs were held in the Party holding accounts, 15,830,048 ERUs were held in entity holding accounts, 10,900 ERUs in the other cancellation accounts and 11,027,404 ERUs were held in the retirement account.

There were 59,171,713 CERs in the registry at the end of 2013: 31,382,231 CERs were held in the Party holding accounts, 9,825,706 CERs were held in entity holding accounts, 390,357 CERs in the other cancellation accounts and 17,573,419 CERs 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 1,042,815,673 tonnes CO_2 eq.

The Netherlands' assigned amount is 1,001,262,141 tonnes CO_2 eq.

Annual Submission Item	Submission
15/CMP.1 annex I.E paragraph 11: Standard Electronic Format (SEF)	The Standard Electronic Format report for 2013 has been submitted to the UNFCCC Secretariat electronically (SEF_NL_2014_1_13-52-30 13-1-2014.xls). The contents of the report (R1) can also be found in Annex A6.6 of this document.

12.3 Discrepancies and notifications

Annual Submission Item	Submission
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	No discrepant transactions occurred in 2013.
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	No CDM notifications occurred in 2013.
15/CMP.1 annex I.E paragraph 15: List of non-replacements	No non-replacements occurred in 2013.
15/CMP.1 annex I.E paragraph 16: List of invalid units	No invalid units exist as at 31 December 2013.
15/CMP.1 annex I.E paragraph 17 : Actions and changes to address discrepancies	No actions were taken or changes made to address discrepancies for the period under review.

12.4 Publicly accessible information

Annual Submission Item	Submission
15/CMP.1 annex I.E **Publicly accessible information**	The information as described in 13/CMP.1 annex II.E paragraphs 44-48 is publicly available at the following internet address (URL); http://www.emissieautoriteit.nl/english/public-information-kyoto All required information for a Party with an active Kyoto registry is provided with the following exceptions; **paragraph 46** Article 6 Project Information. the Netherlands does not host JI projects as laid down in National legislation. This fact is stated on the mentioned internet address. That the Netherlands does not host JI projects is implied by article 16.46c of the Environment Act (Wet milieubeheer) and explicitly stated in the explanatory memorandum to the act implementing the EC linking Directive (Directive 2004/101/EC, the Directive that links the ETS to the project based activities under the Kyoto Protocol). As is explained in the memorandum, the government decided not to allow JI projects in the Netherlands since it would only increase the existing shortage of emission allowances / assigned amount units. **paragraph 47a/d/f/l in/out/current** Holding and transaction information is provided on a holding type level, due to more detailed information being declared confidential by EU regulation. This follows from article 10 of EU Regulation 2216/2004/EC, that states that "All information, including the holdings of all accounts and all transactions made, held in the registries and the Community independent transaction log shall be considered confidential for any purpose other than the implementation of the requirements of this Regulation, Directive 2003/87/EC or national law." **paragraph 47c** the Netherlands does not host JI projects as laid down in National legislation (ref. submission paragraph 46 above). **paragraph 47e** the Netherlands does not perform LULUCF activities and therefore does not issue RMUs. **paragraph 47g** No ERUs, CERs, AAUs and RMUs have been cancelled on the basis of activities under Article 3, paragraphs 3 and 4 to date. **paragraph 47h** No ERUs, CERs, AAUs and RMUs have been cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1 to date. **paragraph 47i** The number of other ERUs, CERs, AAUs and RMUs that have been cancelled is published by means of the SEF report. **paragraph 47j** The number of other ERUs, CERs, AAUs and RMUs that have been retired is published by means of the SEF report. **paragraph 47k** There is no previous commitment period to carry ERUs, CERs, and AAUs over from.

Table 12.1 Information table on accounting for activities under Articles 3.3 and 3.4 of the Kyoto Protocol (Gg CO_2 eq).

Activities	Net emissions/removals						Accounting quantity
	2008	2009	2010	2011	2012	Total	
A. Article 3.3 activities							
A.1. Afforestation and Reforestation							
A.1.1. Units of land not harvested since the beginning of the commitment period	-413.65	-434.83	-633.14	-644.86	-656.21	-2,782.69	-2,782.69
A.2. Deforestation	759.91	983.07	1,005.73	1,035.97	1,066.07	4,850.75	4,850.75

12.5 Calculation of the commitment period reserve (CPR)

In April 2008, the Netherlands became eligible under the Kyoto Protocol. Its assigned amount was fixed at 1,001,262,141 tonnes CO_2 equivalent. The CPR was calculated at that point in time at 901,135,927 tonnes CO_2 equivalent. The CPR has not been changed.

12.6 KP-LULUCF accounting

The Netherlands has elected to account for KP-LULUCF activities at the end of the commitment period. This year, for the first time, information on the accounting of the KP-LULUCF is therefore included in the SEF tables.
In Table 12.1, data on accounting for the KP-LULUCF activities are given. According to this information, the Netherlands would be able to issue RMUs corresponding to the amount of 2.1 Tg CO2 eq.

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 6th National Communication and in the Initial Report. The Initial Review in 2007 concluded that the Netherlands National System has been established in accordance with the guidelines.

There have been no changes in the National System since the last submission and since the Initial Report, with the exception of the following issues:

- The co-ordination of the Emission Registration Project, in which emissions of about 350 substances are annually calculated, was performed until 1 January 2010 by PBL. As of 1 January 2010, co-ordination has been assigned to RIVM. Processes, protocols and methods remain unchanged. Many of the former experts from PBL have also shifted to RIVM.
- The name of SenterNovem (single national entity/NIE) has changed, as of 1 January 2010, to of NL Agency.
- The name of NL Agency (single national entity/NIE) has changed, as of 1 January 2014, to Netherlands Enterprise Agency (RVO.nl)
- The name of the Ministry of Housing, Spatial Planning and the Environment (VROM) has changed, as of October 2010, to the Ministry of Infrastructure and the Environment (IenM), as a result of a merger with the Ministry of Transport, Public Works and Water Management.
- As a result of a merger with the Ministry 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 the National Registry

The following changes to the National Registry of the Netherlands have occurred in 2013.

Reporting Item	Description
15/CMP.1 Annex II.E paragraph 32.(a) Change of name or contact	No change in the name the registry administrator occurred during the reported period. The contact information changed, due to a move of office. The current contact information is: **Administrator** Dutch Emissions Authority P.O. Box 91503 NL-2509 EC The Hague Tel.: +31 70 456 8050 Fax: +31 70 456 8247 Web: www.emissieautoriteit.nl/english/ **Main Contact** Mr. Harm VAN DE WETERING Registry Manager Emission Trading Dutch Emissions Authority P.O. Box 91503 NL-2509 EC The Hague Tel.: +31 70 456 8311 Fax: +31 70 456 8247 E-mail: harm.vandewetering@emissieautoriteit.nl **Alternative Contact** Mr. Alexander BRANDT ICT-coordinator Dutch Emissions Authority P.O. Box 91503 NL-2509 EC The Hague Tel.: +31 70 456 8522 Fax: +31 70 456 8247 E-mail: alexander.brandt@emissieautoriteit.nl **Release Manager** Mr. Alexander BRANDT ICT-coordinator Dutch Emissions Authority P.O. Box 91503 NL-2509 EC The Hague Tel.: +31 70 456 8522 Fax: +31 70 456 8247 E-mail: alexander.brandt@emissieautoriteit.nl
15/CMP.1 Annex II.E paragraph 32.(b) Change regarding co-operation arrangement	No change of co-operation arrangement occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(c) Change to database structure or the capacity of National Registry	An updated diagram of the database structure is attached as Annex A (confidential information, separately submitted to the UNFCCC). Iteration 5 of the National Registry released in January 2013 and Iteration 6 of the National Registry released in June 2013 introduce changes in the structure of the database. Changes introduced in release 5 and 6 of the National Registry were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the National Registry occurred during the reported period.

Reporting Item	Description
15/CMP.1 Annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced in releases 5 and 6 of the National Registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and they were successfully carried out prior to the relevant major release of the version to Production (see Annex B, confidential information, separately submitted to the UNFCCC). Annex H testing was carried out in February 2014 and the successful test report has been attached (confidential information, separately submitted to the UNFCCC). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 Annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 Annex II.E paragraph 32.(g) Change to 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	No change of the registry internet address occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(j) Change regarding test results	Changes introduced in releases 5 and 6 of the National Registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B (confidential information, separately submitted to the UNFCCC). Annex H testing was carried out in February 2014 and the successful test report has been attached (confidential information, separately submitted to the UNFCCC).

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

The Netherlands has reported information on the minimization of adverse impacts in its 6th National Communication and its 1st Biennial Report, both submitted to the UNFCCC in December 2013.
Since the submission of the NIR 2013, there have been limited changes in the activities on minimizing 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. 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. During COP 19 in Warsaw, the Netherlands has actively contributed to reaching a timetable with agreements aimed at arriving at a new climate agreement in 2015, which will go into effect after 2020. Among other things, all countries have agreed to make their contribution to reducing greenhouse gasses known well in advance to the next COP, to be held in December 2015.

In addition to mitigation, the Netherlands attaches great importance to the effort to adapt to climate change. For some time now it has been assisting other countries financially or with knowledge provided by the business community to make them more resilient to the consequences of climate change. Recent Dutch efforts to minimize adverse impacts include active engagement for a full operationalization of the Green Climate Fund and New Market Mechanisms.

Green Climate Fund

The Netherlands actively contributes to the full and timely operationalization of the Green Climate Fund and is committed to providing climate finance to support developing countries in their mitigation and adaptation activities. This Fund will, among other things, seek to use public funds to attract private finance for both mitigation and adaptation investments. On the Board of the Green Climate Fund, the Netherlands again shares a chair with Denmark, as it did in the Transitional Committee. Full operationalization of the Green Climate Fund is crucial to support developing countries in their transformation to low-carbon and climate-resilient development. In doing so, the GCF should try to maximize development benefits by linking climate change to poverty reduction and gender. Enhancing the role of the private sector is a Dutch priority to which the Netherlands has actively contributed through the operationalization of the private sector facility.

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 security, 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 customization 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. The Netherlands provided € 300 million in Fast Start Finance over the period 2010-2012. In 2013, € 200 million was contributed.
In the context of meaningful mitigation actions and transparency of implementation and collective action, the Netherlands stands ready to continue scaling up its climate finance action in order to contribute its share to the developed countries' goal to jointly mobilize 100 billion dollars per year by 2020.
The Netherlands has also contributed to enhancing transparency regarding the Fast Start Financing initiative. On the initiative of the Netherlands, a special module on fast start finance has been established on the financial portal of the UNFCCC website, http://www3.unfccc.int/pls/apex/f?p=116:13:601354855187581. With the establishment of this module on the UNFCCC website, the Netherlands is confident this transparency of fast start finance will be safeguarded.

Market Mechanisms

The flexible mechanisms under the Protocol – (1) International Emissions Trading (i.e. the European Union Emissions Trading Scheme EU ETS), (2) Joint Implementation and (3) Clean Development Mechanism – are all tools incorporated into the Protocol in order to share efforts aimed at reducing greenhouse gases, ensuring that investments are made where the money has optimal greenhouse gas reducing effects, and thus ensuring a minimum impact on the world economy. The Netherlands has made use of each of the flexible mechanisms. It has also signed MoUs regarding CDM and JI projects with several countries worldwide. The Netherlands is supporting the World Bank's "Partnership for Market Readiness", which will help countries to make use of the benefits and advantages of the carbon market. The PMR promotes collective innovation and piloting of market-based instruments for GHG emissions reduction. In addition, the PMR also provides a platform for technical discussions of such instruments to spur innovation and support implementation.

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'. Work continues on developing the modalities and procedures for the use of this new market-based mechanism, which will actually allow different approaches, including sectoral ones, to accommodate the differing needs of countries. The Netherlands also intends, however, to actively participate in the further discussions on the development and implementation of the Framework for Various Approaches in order, on the one hand, to allow flexibility in the use of market instruments and, on the other, to ensure that environmental integrity is safeguarded. Through this approach, fragmentation of the carbon market can be beminimized.
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.

Minimizing adverse effects regarding biofuels production

All biofuels on the market in Europe and the Netherlands must comply with the sustainability criteria laid down by the Renewable Energy Directive (2009/28/EG). Only if the biofuels are sustainable, are they allowed to be used for fulfilling the blending target. Compliance with these criteria must be demonstrated through one of the adopted certification systems. These certification systems are controlled by an independent audit. All biofuels produced in the Netherlands fulfil these requirements.

Annexes

Annex 1

Key sources

A1.1 Introduction

As explained in the Good Practice Guidance (IPCC, 2001), a key source category is prioritized 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 significant sources of greenhouse gas emissions in the Netherlands. The most significant 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, the total of which adds up to 95 per cent of the national total (excluding LULUCF): 32 sources for annual level assessment (emissions in 2012) and 33 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 summarized in Table A1.1 and show a total of 43 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, five sources are added to the list of 38 Tier 1 level and trend key sources (excluding LULUCF):

- 1A3 Mobile combustion: road vehicles N_2O (Tier 2 level and trend);
- 2B5 Other chemical product manufacture (Tier 2 level);
- 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 significant 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 five 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) 2014 version 1.2, submitted to the European Union (EU) in March 2014.

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 for 2012 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(L,T)	1	1	1	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	Key(L,T1)	1	1	1	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	Key(L1,T)	1	1	0	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	Key(L,T)	1	1	1	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	Non key	0	0	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	Key(L,T)	1	1	1	1
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	Key(L,T)	1	1	1	1
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	CO_2	Key(L,T1)	1	1	1	0
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	Key(L,T)	1	1	1	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	Key(L1,T)	1	1	0	1
1A3	Mobile combustion: water-borne navigation	CO_2	Key(L1,T1)	1	1	0	0
1A3	Mobile combustion: aircraft	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (railways)	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	N_2O	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	N_2O	Key(L2,T2)	0	0	1	1
1A4	Stationary combustion: Other Sectors, solids	CO_2	Non key	0	0	0	0
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	Key(L,T)	1	1	1	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	Key(L,T1)	1	1	1	0
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	Key(L,T)	1	1	1	1
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	Key(L,T)	1	1	1	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	Key(,T)	0	1	0	1
1A5	Military use of fuels (1A5 Other)	CO_2	Non key	0	0	0	0
1A	Emissions from stationary combustion: non-CO_2	CH_4	Key(L,T)	1	1	1	1

IPCC	Source category	Gas	Key source?	Tier 1 level recent year without LULUCF	Tier 1 trend without LULUCF	Tier 2 level recent year without LULUCF	Tier 2 trend without LULUCF
1A	Emissions from stationary combustion: non-CO_2	N_2O	Non key	0	0	0	0
1B1	Coal mining	CH_4					
1B1b	Coke production	CO_2	Key(L,T)	0	0	0	0
1B2	Fugitive emissions from venting/flaring: CO_2	CO_2	Key(,T)	0	1	0	1
1B2	Fugitive emissions venting/flaring	CH_4	Key(,T)	0	1	0	1
1B2	Fugitive emissions from oil and gas: gas distribution	CH_4	Non key	0	0	0	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	Non key	0	0	0	0
	INDUSTRIAL PROCESSES						
2A1	Cement production	CO_2	Non key	0	0	0	0
2A3	Limestone and dolomite use	CO_2	Non key	0	0	0	0
2A7	Other minerals	CO_2	Non key	0	0	0	0
2B1	Ammonia production	CO_2	Key(L1,)	1	0	1	0
2B2	Nitric acid production	N_2O	Key(,T)	0	1	0	1
2B5	Caprolactam production	N_2O	Key(L1,)	1	0	1	0
2B5	Other chemical product manufacture	CO_2	Key(L,)	0	0	1	0
2C1	Iron and steel production (carbon inputs)	CO_2	Key(L1,T1)	1	1	0	0
2C3	CO_2 from aluminium production	CO_2	Non key	0	0	0	0
2C3	PFC from aluminium production	PFC	Key(,T)	0	1	0	1
2F	SF_6 emissions from SF_6 use	SF_6	Non key	0	0	0	0
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	Key(L,T)	1	1	1	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	Key(,T)	0	1	0	1
2E	HFC by-product emissions from HFC manufacture	HFC	Non key	0	0	0	0
2F	PFC emissions from PFC use	PFC	Non key	0	0	0	0
2G	Other industrial: CO_2	CO_2	Non key	0	0	0	0
2G	Other industrial: CH_4	CH_4	Non key	0	0	0	0
2G	Other industrial: N_2O	N_2O	Non key	0	0	0	0
	SOLVENTS AND OTHER PRODUCT USE						
3	Indirect CO_2 from solvents/product use	CO_2	Non key	0	0	0	0
3	Solvents and other product use	CH_4					
	AGRICULTURAL SECTOR						
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	Key(L,)	1	0	1	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	Non key	0	0	0	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	Key(L,T1)	1	1	1	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	Non key	0	0	1	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	Non key	0	0	0	0
4B	Emissions from manure management	N_2O	Key(L,T2)	1	0	1	0
4B1	Emissions from manure management: cattle	CH_4	Key(L,T)	1	1	1	1
4B8	Emissions from manure management: swine	CH_4	Key(L,)	1	0	1	1
4B9	Emissions from manure management: poultry	CH_4	Key(,T2)	0	0	0	1

IPCC	Source category	Gas	Key source?	Tier 1 level recent year without LULUCF	Tier 1 trend without LULUCF	Tier 2 level recent year without LULUCF	Tier 2 trend without LULUCF
4B	Emissions from manure management: other	CH_4	Non key	0	0	0	0
4C	Rice cultivation	CH_4					
4D1	Direct N_2O emissions from agricultural soils	N_2O	Key(L,T)	1	1	1	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	Key(L,T)	1	1	1	1
4D2	Animal production on agricultural soils	N_2O	Key(L,T)	1	1	1	1
	WASTE SECTOR						
6A1	CH_4 emissions from solid waste disposal sites	CH_4	Key(L,T)	1	1	1	1
6B	Emissions from wastewater handling	CH_4	Non key	0	0	0	0
6B	Emissions from wastewater handling	N_2O	Key(L2,)	0	0	1	0
6C	Emissions from waste incineration	all					
	OTHER						
6D	OTHER CH_4	CH_4	Non key	0	0	0	0
3, 6D	OTHER N_2O	N_2O	Non key	0	0	0	0
	[1)] = 6D Other waste						
	[2)] = 4D animal production - waste dropped on soils + 3D Solvents						
			SUM	32	33	30	26

Table A1.2 Key source list identified by the Tier 1 level and trend assessments. Level assessment for 2012 emissions (including LULUCF sources).

IPCC	Source category	Gas	Key source?	Tier 1 level recent year with LULUCF	Tier 1 trend with LULUCF	Tier 2 level recent year with LULUCF	Tier 2 trend with LULUCF
	ENERGY SECTOR						
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	Key(L1,)	1	1	1	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	Key(L,T1)	1	1	1	0
1A1a	Stationary combustion: Public Electricity and Heat Production: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	Key(L,T)	1	1	0	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	Key(L,T)	1	1	1	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	Key(L1,T1)	1	1	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	Non key	0	0	0	0
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	Key(L,T)	1	1	1	1
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	Key(L,T1)	1	1	1	1
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, solids	CO_2	Key(L,T1)	1	1	1	0
1A2	Emissions from stationary combustion: Manufacturing Industries and Construction, gases	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	Key(L,T1)	1	1	1	0
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	Key(L,T)	1	1	1	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	Key(L1,T)	1	1	0	1
1A3	Mobile combustion: water-borne navigation	CO_2	Key(L1)	1	1	0	0
1A3	Mobile combustion: aircraft	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (railways)	CO_2	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: other (non-road)	N2O	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	CH_4	Non key	0	0	0	0
1A3	Mobile combustion: road vehicles	N2O	Key(L2,)	0	0	0	1
1A4	Stationary combustion: Other Sectors, solids	CO_2	Non key	0	0	0	0
1A4a	Stationary combustion: Other Sectors: Commercial/Institutional, gases	CO_2	Key(L,T)	1	1	1	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	Key(L,T1)	1	1	1	0
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	Key(L,T)	1	1	1	0
1A4c	Stationary combustion: Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	Key(L,T)	1	1	1	1
1A4	Stationary combustion: Other Sectors, liquids excl. From 1A4c	CO_2	Key(,T)	0	1	0	1
1A5	Military use of fuels (1A5 Other)	CO_2	Non key	0	0	0	0

IPCC	Source category	Gas	Key source?	Tier 1 level recent year with LULUCF	Tier 1 trend with LULUCF	Tier 2 level recent year with LULUCF	Tier 2 trend with LULUCF
1A	Emissions from stationary combustion: non-CO_2	CH_4	Key(L,T)	1	1	1	1
1A	Emissions from stationary combustion: non-CO_2	N_2O	Non key	0	0	0	0
1B1	Coal mining	CH_4					
1B1b	Coke production	CO_2	Key(L,T)	0	0	0	0
1B2	Fugitive emissions from venting/flaring: CO_2	CO_2	Key(,T)	0	1	0	1
1B2	Fugitive emissions venting/flaring	CH_4	Key(,T)	0	1	0	1
1B2	Fugitive emissions from oil and gas: gas distribution	CH_4	Non key	0	0	0	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	Non key	0	0	0	0
	INDUSTRIAL PROCESSES						
2A1	Cement production	CO_2	Non key	0	0	0	0
2A3	Limestone and dolomite use	CO_2	Non key	0	0	0	0
2A7	Other minerals	CO_2	Non key	0	0	0	0
2B1	Ammonia production	CO_2	Key(L1,)	1	0	1	0
2B2	Nitric acid production	N_2O	Key(,T)	0	1	0	1
2B5	Caprolactam production	N_2O	Key(L1,)	1	0	1	0
2B5	Other chemical product manufacture	CO_2	Key(L,)	1	0	1	0
2C1	Iron and steel production (carbon inputs)	CO_2	Key(L1,T1)	1	1	0	0
2C3	CO_2 from aluminium production	CO_2	Non key	0	0	0	0
2C3	PFC from aluminium production	PFC	Key(,T)	0	1	0	1
2F	SF_6 emissions from SF_6 use	SF_6	Non key	0	0	0	0
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	Key(L,T)	1	1	1	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	Key(,T)	0	1	0	1
2E	HFC by-product emissions from HFC manufacture	HFC	Non key	0	0	0	0
2F	PFC emissions from PFC use	PFC	Non key	0	0	0	0
2G	Other industrial: CO_2	CO_2	Non key	0	0	0	0
2G	Other industrial: CH_4	CH_4	Non key	0	0	0	0
2G	Other industrial: N_2O	N_2O	Non key	0	0	0	0
	SOLVENTS AND OTHER PRODUCT USE						
3	Indirect CO_2 from solvents/product use	CO_2	Non key	0	0	0	0
3	Solvents and other product use	CH_4					
	AGRICULTURAL SECTOR						
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	Key(L,)	1	0	1	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	Non key	0	0	0	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	Key(L,T1)	1	1	1	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	Non key	0	0	0	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	Non key	0	0	0	0
4B	Emissions from manure management	N_2O	Key(L,T2)	1	0	1	0
4B1	Emissions from manure management: cattle	CH_4	Key(L,T)	1	1	1	1
4B8	Emissions from manure management: swine	CH_4	Key(L,)	1	1	1	1

IPCC	Source category	Gas	Key source?	Tier 1 level recent year with LULUCF	Tier 1 trend with LULUCF	Tier 2 level recent year with LULUCF	Tier 2 trend with LULUCF
4B9	Emissions from manure management: poultry	CH_4	Key(,T2)	0	0	0	0
4B	Emissions from manure management: other	CH_4	Non key				
4C	Rice cultivation	CH_4		1	1	1	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	Key(L,T)	1	1	1	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	Key(L,T)	1	1	1	1
4D2	Animal production on agricultural soils	N_2O	Key(L,T)				
	LULUCF			1	1	1	1
5A1	Forest Land remaining Forest Land	CO_2	Key(L,)	0	1	1	1
5A2	Land converted to Forest Land	CO_2	Key(L2,T)	1	1	1	1
5B2	Land converted to Cropland	CO_2	Non key	1	1	1	1
5C1	Grassland remaining Grassland	CO_2	Key(L,)	0	0	0	0
5C2	Land converted to Grassland	CO_2	Non key	0	0	0	0
5D2	Land converted to Wetlands	CO_2	Non key	1	1	1	1
5E2	Land converted to Settlements	CO_2	Key(L,T)	0	0	0	0
5F2	Land converted to Other Land	CO_2	Non key	0	0	0	0
5G	Other (liming of soils)	CO_2	Non key	0	0	0	0
	WASTE SECTOR						
6A1	CH_4 emissions from solid waste disposal sites	CH_4	Key(L,T)	1	1	1	1
6B	Emissions from wastewater handling	CH_4	Non key	0	0	0	0
6B	Emissions from wastewater handling	N_2O	Key(L2,)	0	0	1	0
6C	Emissions from waste incineration	all					
	OTHER						
6D	OTHER CH_4	CH_4	Non key	0	0	0	0
3, 6D	OTHER N_2O	N_2O	Non key	0	0	0	0
	[1] = 6D Other waste						
	[2] = 4D animal production - waste dropped on soils + 3D Solvents						
			SUM	37	39	33	30

A1.2 Changes in key sources compared with previous submission

Due to the use of emissions data for 2012 and new uncertainty data concerning traffic emissions, the following changes have taken place compared with the previous NIR:

- 1B1b Coke production (CO_2), now non-key (key L2,T2 in NIR 2013);
- 5B2 Land converted to Cropland (CO_2): now key (L2,T) (non-key in NIR 2013).

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 2012 annual emissions total and the base year to 2012 trend, respectively. This resulted in 32 level key sources and 33 trend key sources (indicated in blue at the top, 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 2012, 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	25909	14%	14%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: solids	CO_2	19334	10%	24%	1
1A4b	Stationary combustion: Other Sectors, Residential, gases	CO_2	18566	10%	33%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	17659	9%	43%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, gases	CO_2	13210	7%	49%	1
1A4a	Stationary combustion: Other Sectors: Commercial/ Institutional, gases	CO_2	12641	7%	56%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10823	6%	62%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, liquids	CO_2	8583	4%	66%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7509	4%	70%	1
1A1b	Stationary combustion: Petroleum Refining: liquids	CO_2	7150	4%	74%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	4018	2%	76%	1
1A2	Stationary combustion: Manufacturing Industries and Construction, solids	CO_2	3996	2%	78%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3339	2%	80%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3233	2%	81%	1
2B1	Ammonia production	CO_2	2973	2%	83%	1
1A1b	Stationary combustion: Petroleum Refining: gases	CO_2	2595	1%	84%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: waste incineration	CO_2	2578	1%	86%	1
1A1c	Stationary combustion: Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2068	1%	87%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1874	1%	88%	1
1A4c	Stationary combustion: Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	1803	1%	89%	1
4B1	Emissions from manure management: cattle	CH_4	1692	1%	90%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1642	1%	90%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1477	1%	91%	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1432	1%	92%	1
4D2	Animal production on agricultural soils	N_2O	1240	1%	93%	1
4B8	Emissions from manure management: swine	CH_4	1045	1%	93%	1
4B	Emissions from manure management	N_2O	1040	1%	94%	1
1B1b	CO_2 from coke production	CO_2	1007	1%	94%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	856	0%	95%	1
2B5	Other chemical product manufacture	CO_2	838	0%	95%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	757	0%	95%	1
2C1	Iron and steel production (carbon inputs)	CO_2	699	0%	96%	1
2B5	Caprolactam production	N_2O	631	0%	96%	0
1A3	Mobile combustion: water-borne navigation	CO_2	559	0%	96%	0
2A3	Limestone and dolomite use	CO_2	574	0%	96%	0

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	512	0%	97%	0
6B	Emissions from wastewater handling	N_2O	457	0%	97%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	385	0%	97%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	380	0%	97%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	351	0%	98%	0
1A5	Military use of fuels (1A5 Other)	CO_2	341	0%	98%	0
2A7	Other minerals	CO_2	322	0%	98%	0
1B2	Fugitive emissions venting/flaring	CH_4	312	0%	98%	0
2A1	Cement production	CO_2	308	0%	98%	0
2G	Other industrial: CO_2	CO_2	300	0%	98%	0
2G	Other industrial: CH_4	CH_4	287	0%	98%	0
1B1b	CO_2 from coke production	CO_2	284	0%	99%	0
1A3	Mobile combustion: road vehicles	N_2O	277	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	264	0%	99%	0
2B2	Nitric acid production	N_2O	264	0%	99%	0
6B	Emissions from wastewater handling	CH_4	199	0%	99%	0
2F	SF_6 emissions from SF6 use	SF_6	196	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	179	0%	99%	0
2C3	CO_2 from aluminium production	CO_2	164	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	151	0%	100%	0
3, 6D	OTHER N_2O	N_2O	126	0%	100%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	125	0%	100%	0
3	Indirect CO_2 from solvents/product use	CO_2	120	0%	100%	0
2F	PFC emissions from PFC use	PFC	113	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	85	0%	100%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	62	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	55	0%	100%	0
1A3	Mobile combustion: road vehicles	CH_4	46	0%	100%	0
4B9	Emissions from manure management : poultry	CH_4	40	0%	100%	0
2C3	PFC from aluminium production	PFC	38	0%	100%	0
4B	Emissions from manure management : other	CH_4	24	0%	100%	0
6D	OTHER CH_4	CH_4	24	0%	100%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	23	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	21	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%	0
			191625			32

Table A1.3b Source ranking using IPCC Tier 1 level assessment 2012, 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: solids	CO_2	25909	13%	13%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	19334	10%	22%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	18566	9%	32%	1
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	17659	9%	40%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13210	7%	47%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12641	6%	53%	1
1A4a	Stationary combustion : Other Sectors: Commercial/ Institutional, gases	CO_2	10823	5%	58%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8583	4%	63%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7509	4%	66%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7150	4%	70%	1
5C1	5C1. Grassland remaining Grassland	CO_2	4249	2%	72%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4018	2%	74%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	2%	76%	1
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3339	2%	78%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3233	2%	79%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	2973	1%	81%	1
5A1	5A1. Forest Land remaining Forest Land	CO_2	2881	1%	82%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2595	1%	83%	1
2B1	Ammonia production	CO_2	2578	1%	85%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2068	1%	86%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1874	1%	87%	1
4B1	Emissions from manure management : cattle	CH_4	1803	1%	88%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	1692	1%	88%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1642	1%	89%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1477	1%	90%	1
4D3	Indirect N2O emissions from nitrogen used in agriculture	N_2O	1432	1%	91%	1
5B2	5B2. Land converted to Cropland	CO_2	1251	1%	91%	1
2C1	Iron and steel production (carbon inputs)	CO_2	1240	1%	92%	1
5E2	5E2. Land converted to Settlements	CO_2	1126	1%	92%	1
4D2	Animal production on agricultural soils	N_2O	1045	1%	93%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	1040	1%	94%	1
4B	Emissions from manure management	N_2O	1007	0%	94%	1
2B5	Caprolactam production	N_2O	856	0%	94%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	838	0%	95%	1
4B8	Emissions from manure management : swine	CH_4	757	0%	95%	1
1A3	Mobile combustion: water-borne navigation	CO_2	699	0%	96%	1

IPCC	Category	Gas	CO_2-eq last year	Share	Cum. Share	Key ?
2B5	Other chemical product manufacture	CO_2	631	0%	96%	1
5A2	5A2. Land converted to Forest Land	CO_2	581	0%	96%	0
2A3	Limestone and dolomite use	CO_2	559	0%	96%	0
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	512	0%	97%	0
6B	Emissions from wastewater handling	N_2O	457	0%	97%	0
4A8	CH4 emissions from enteric fermentation in domestic livestock: swine	CH_4	385	0%	97%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	380	0%	97%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	351	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	341	0%	98%	0
2A7	Other minerals	CO_2	322	0%	98%	0
1B2	Fugitive emissions venting/flaring	CH_4	312	0%	98%	0
2A1	Cement production	CO_2	308	0%	98%	0
2G	Other industrial: CO_2	CO_2	300	0%	98%	0
2G	Other industrial: CH_4	CH_4	287	0%	98%	0
1B1b	CO2 from coke production	CO_2	284	0%	99%	0
1A3	Mobile combustion: road vehicles	N_2O	277	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	264	0%	99%	0
2B2	Nitric acid production	N_2O	264	0%	99%	0
6B	Emissions from wastewater handling	CH_4	199	0%	99%	0
2F	SF6 emissions from SF6 use	SF_6	196	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	179	0%	99%	0
2C3	CO_2 from aluminium production	CO_2	164	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	151	0%	99%	0
5F2	5F2. Land converted to Other Land	CO_2	128	0%	99%	0
3, 6D	OTHER N_2O	N_2O	126	0%	99%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	125	0%	100%	0
3	Indirect CO_2 from solvents/product use	CO_2	120	0%	100%	0
2F	PFC emissions from PFC use	PFC	113	0%	100%	0
5D2	5D2. Land converted to Wetlands	CO_2	113	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	85	0%	100%	0
5G	5G. Other (liming of soils)	CO_2	73	0%	100%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	62	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	55	0%	100%	0
1A3	Mobile combustion: road vehicles	CH_4	46	0%	100%	0
4B9	Emissions from manure management : poultry	CH_4	40	0%	100%	0
5C2	5C2. Land converted to Grassland	CO_2	40	0%	100%	0
2C3	PFC from aluminium production	PFC	38	0%	100%	0
4B	Emissions from manure management : other	CH_4	24	0%	100%	0
6D	OTHER CH_4	CH_4	24	0%	100%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	23	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	21	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	100%	0
			202067	100%		37

Table A1.4a Source ranking using IPCC Tier 1 trend assessment 2012, 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 ?
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	19334	10%	5%	12%	12%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	2973	2%	5%	10%	22%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	18566	10%	4%	9%	31%	1
2B2	Nitric acid production	N_2O	6330	264	0%	3%	7%	38%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	125	0%	3%	7%	45%	1
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7632	10823	6%	2%	5%	50%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19020	13210	7%	2%	5%	55%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12641	7%	2%	4%	59%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	25909	14%	2%	4%	63%	1
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	3339	2%	1%	3%	66%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2595	1%	1%	3%	68%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	7150	4%	1%	2%	71%	1
4D2	Animal production on agricultural soils	N_2O	3150	1045	1%	1%	2%	73%	1
2C3	PFC from aluminium production	PFC	1901	38	0%	1%	2%	76%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1874	1%	1%	2%	78%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	838	0%	1%	2%	80%	1
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1432	1%	1%	2%	82%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1477	1%	1%	1%	83%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7330	7509	4%	1%	1%	84%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	1040	1%	0%	1%	86%	1
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	17659	9%	0%	1%	87%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	312	0%	0%	1%	88%	1
2C1	Iron and steel production (carbon inputs)	CO_2	2267	1240	1%	0%	1%	89%	1
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1356	512	0%	0%	1%	90%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2068	1%	0%	1%	91%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	62	0%	0%	1%	92%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2587	1692	1%	0%	1%	92%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8956	8583	4%	0%	1%	93%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5033	4018	2%	0%	1%	94%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3233	2%	0%	1%	94%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1642	1%	0%	1%	95%	1
4B1	Emissions from manure management : cattle	CH_4	1593	1803	1%	0%	0%	96%	1
1A3	Mobile combustion: water-borne navigation	CO_2	405	699	0%	0%	0%	96%	1
4B8	Emissions from manure management : swine	CH_4	1154	757	0%	0%	0%	96%	0
4B9	Emissions from manure management : poultry	CH_4	275	40	0%	0%	0%	97%	0
2B1	Ammonia production	CO_2	3096	2578	1%	0%	0%	97%	0
2C3	CO_2 from aluminium production	CO_2	395	164	0%	0%	0%	97%	0
1A3	Mobile combustion: road vehicles	N_2O	101	277	0%	0%	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	566	341	0%	0%	0%	98%	0
2B5	Caprolactam production	N_2O	766	856	0%	0%	0%	98%	0
3	Indirect CO_2 from solvents/product use	CO_2	316	120	0%	0%	0%	98%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	351	0%	0%	0%	98%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	23	0%	0%	0%	98%	0
2A3	Limestone and dolomite use	CO_2	481	559	0%	0%	0%	99%	0
3, 6D	OTHER N_2O	N_2O	256	126	0%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	158	46	0%	0%	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4351	3996	2%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	37	113	0%	0%	0%	99%	0
1B1b	CO_2 from coke production	CO_2	403	284	0%	0%	0%	99%	0
2A7	Other minerals	CO_2	275	322	0%	0%	0%	99%	0
2A1	Cement production	CO_2	416	308	0%	0%	0%	99%	0
2F	SF_6 emissions from SF6 use	SF_6	287	196	0%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	0%	100%	0
4B	Emissions from manure management	N_2O	1183	1007	1%	0%	0%	100%	0
2B5	Other chemical product manufacture	CO_2	649	631	0%	0%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	55	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	264	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	179	0%	0%	0%	100%	0
2G	Other industrial: CO_2	CO_2	304	300	0%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	2	24	0%	0%	0%	100%	0
2G	Other industrial: CH4	CH_4	297	287	0%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	385	0%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	380	0%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	151	0%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	28	21	0%	0%	0%	100%	0
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	85	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	0%	100%	0
			213179	191625		44%			33

Table A1.4b Source ranking using IPCC Tier 1 trend assessment 2012, 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 ?
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	19334	10%	5%	11%	11%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	2973	1%	4%	10%	21%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	18566	9%	3%	8%	29%	1
2B2	Nitric acid production	N_2O	6330	264	0%	3%	7%	36%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	125	0%	3%	7%	43%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19020	13210	7%	2%	5%	48%	1
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7632	10823	5%	2%	5%	53%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12641	6%	1%	3%	56%	1
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	3339	2%	1%	3%	59%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	25909	13%	1%	3%	62%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2595	1%	1%	3%	65%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	7150	4%	1%	3%	67%	1
4D2	Animal production on agricultural soils	N_2O	3150	1045	1%	1%	2%	70%	1
2C3	PFC from aluminium production	PFC	1901	38	0%	1%	2%	72%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	838	0%	1%	2%	74%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1874	1%	1%	2%	76%	1
4D3	Indirect N2O emissions from nitrogen used in agriculture	N_2O	3358	1432	1%	1%	2%	78%	1
5B2	5B2. Land converted to Cropland	CO_2	158	1251	1%	1%	1%	80%	1
1A	Emissions from stationary combustion: non-CO2	CH_4	573	1477	1%	1%	1%	81%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	1040	1%	0%	1%	82%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	312	0%	0%	1%	83%	1
2C1	Iron and steel production (carbon inputs)	CO_2	2267	1240	1%	0%	1%	84%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7330	7509	4%	0%	1%	85%	1
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1356	512	0%	0%	1%	86%	1
5E2	5E2. Land converted to Settlements	CO_2	459	1126	1%	0%	1%	87%	1
5A1	5A1. Forest Land remaining Forest Land	CO_2	2407	2881	1%	0%	1%	88%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2587	1692	1%	0%	1%	89%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2068	1%	0%	1%	90%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	62	0%	0%	1%	90%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5033	4018	2%	0%	1%	91%	1
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	17659	9%	0%	1%	92%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3233	2%	0%	1%	93%	1
5A2	5A2. Land converted to Forest Land	CO_2	54	581	0%	0%	1%	93%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1642	1%	0%	1%	94%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8956	8583	4%	0%	1%	94%	1
5C1	5C1. Grassland remaining Grassland	CO_2	4249	4249	2%	0%	0%	95%	1
4B1	Emissions from manure management : cattle	CH_4	1593	1803	1%	0%	0%	95%	1
1A3	Mobile combustion: water-borne navigation	CO_2	405	699	0%	0%	0%	96%	1
4B8	Emissions from manure management : swine	CH_4	1154	757	0%	0%	0%	96%	1
2B1	Ammonia production	CO_2	3096	2578	1%	0%	0%	96%	0
4B9	Emissions from manure management : poultry	CH_4	275	40	0%	0%	0%	97%	0
2C3	CO2 from aluminium production	CO_2	395	164	0%	0%	0%	97%	0
1A3	Mobile combustion: road vehicles	N_2O	101	277	0%	0%	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	566	341	0%	0%	0%	97%	0
3	Indirect CO_2 from solvents/product use	CO_2	316	120	0%	0%	0%	97%	0
2B5	Caprolactam production	N_2O	766	856	0%	0%	0%	98%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	23	0%	0%	0%	98%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	351	0%	0%	0%	98%	0
5C2	5C2. Land converted to Grassland	CO_2	198	40	0%	0%	0%	98%	0
3, 6D	OTHER N_2O	N_2O	269	126	0%	0%	0%	98%	0
2A3	Limestone and dolomite use	CO_2	481	559	0%	0%	0%	99%	0
5F2	5F2. Land converted to Other Land	CO_2	25	128	0%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	158	46	0%	0%	0%	99%	0
5G	5G. Other (liming of soils)	CO_2	183	73	0%	0%	0%	99%	0
1B1b	CO_2 from coke production	CO_2	403	284	0%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	37	113	0%	0%	0%	99%	0
4B	Emissions from manure management	N_2O	1183	1007	0%	0%	0%	99%	0
2A1	Cement production	CO_2	416	308	0%	0%	0%	99%	0
2A7	Other minerals	CO_2	275	322	0%	0%	0%	99%	0
2F	SF_6 emissions from SF6 use	SF_6	287	196	0%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	0%	100%	0
5D2	5D2. Land converted to Wetlands	CO_2	74	113	0%	0%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	55	0%	0%	0%	100%	0
2B5	Other chemical product manufacture	CO_2	649	631	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	264	0%	0%	0%	100%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	179	0%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
6D	OTHER CH_4	CH_4	2	24	0%	0%	0%	100%	0
2G	Other industrial: CO_2	CO_2	304	300	0%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4351	3996	2%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	0%	100%	0
2G	Other industrial: CH_4	CH_4	297	287	0%	0%	0%	100%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	385	0%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	380	0%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	28	21	0%	0%	0%	100%	0
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	151	0%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	85	0%	0%	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	0%	100%	0
			220999	201878		42%			39

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 2012 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 (30 and 26, respectively, instead of 32 and 33). 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 2012, excluding LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1432	1%	206%	2%	11%	11%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8583	4%	25%	1%	8%	19%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3233	2%	61%	1%	7%	26%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7150	4%	25%	1%	7%	33%	1
4B1	Emissions from manure management : cattle	CH_4	1803	1%	100%	1%	7%	40%	1
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	10823	6%	10%	1%	4%	44%	1
4D2	Animal production on agricultural soils	N_2O	1045	1%	100%	1%	4%	48%	1
4B	Emissions from manure management	N_2O	1007	1%	100%	1%	4%	52%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1874	1%	54%	1%	4%	55%	1
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	17659	9%	5%	0%	3%	59%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25909	14%	3%	0%	3%	62%	1
4B8	Emissions from manure management : swine	CH_4	757	0%	100%	0%	3%	64%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7509	4%	10%	0%	3%	67%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1477	1%	50%	0%	3%	70%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	2%	16%	0%	2%	72%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	2973	2%	20%	0%	2%	75%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	19334	10%	3%	0%	2%	77%	1
2B5	Other chemical product manufacture	CO_2	631	0%	71%	0%	2%	78%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2068	1%	21%	0%	2%	80%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4018	2%	10%	0%	2%	81%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12641	7%	3%	0%	1%	83%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1642	1%	21%	0%	1%	84%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13210	7%	2%	0%	1%	85%	1
2B1	Ammonia production	CO_2	2578	1%	10%	0%	1%	86%	1
2B5	Caprolactam production	N_2O	856	0%	30%	0%	1%	87%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	1692	1%	15%	0%	1%	88%	1
6B	Emissions from wastewater handling	N_2O	457	0%	54%	0%	1%	89%	1

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	1040	1%	20%	0%	1%	90%	1
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	385	0%	50%	0%	1%	90%	1
1A3	Mobile combustion: road vehicles	N_2O	277	0%	70%	0%	1%	91%	1
1A	Emissions from stationary combustion: non-CO_2	N_2O	351	0%	50%	0%	1%	92%	0
2A7	Other minerals	CO_2	322	0%	50%	0%	1%	92%	0
2G	Other industrial: CO_2	CO_2	300	0%	50%	0%	1%	93%	0
2G	Other industrial: CH_4	CH_4	287	0%	51%	0%	1%	93%	0
2A3	Limestone and dolomite use	CO_2	559	0%	25%	0%	1%	94%	0
1A3	Mobile combustion: water-borne navigation	CO_2	699	0%	20%	0%	1%	94%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	264	0%	50%	0%	0%	95%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2595	1%	5%	0%	0%	95%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	380	0%	30%	0%	0%	96%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	18566	10%	1%	0%	0%	96%	0
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	512	0%	20%	0%	0%	97%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	179	0%	54%	0%	0%	97%	0
1B2	Fugitive emissions venting/flaring	CH_4	312	0%	25%	0%	0%	97%	0
2C1	Iron and steel production (carbon inputs)	CO_2	1240	1%	6%	0%	0%	97%	0
1A5	Military use of fuels (1A5 Other)	CO_2	341	0%	20%	0%	0%	98%	0
2F	SF_6 emissions from SF6 use	SF_6	196	0%	34%	0%	0%	98%	0
6B	Emissions from wastewater handling	CH_4	199	0%	32%	0%	0%	98%	0
1A3b	Mobile combustion: road vehicles: LPG	CO_2	838	0%	5%	0%	0%	98%	0
1B1b	CO2 from coke production	CO_2	284	0%	15%	0%	0%	99%	0
4B9	Emissions from manure management : poultry	CH_4	40	0%	100%	0%	0%	99%	0
2A1	Cement production	CO_2	308	0%	11%	0%	0%	99%	0
3	Indirect CO_2 from solvents/product use	CO_2	120	0%	27%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	46	0%	70%	0%	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	151	0%	21%	0%	0%	99%	0
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	62	0%	50%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	113	0%	25%	0%	0%	99%	0
4B	Emissions from manure management : other	CH_4	24	0%	100%	0%	0%	99%	0
3, 6D	OTHER N_2O	N_2O	126	0%	17%	0%	0%	100%	0
2B2	Nitric acid production	N_2O	264	0%	8%	0%	0%	100%	0
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3339	2%	1%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	125	0%	14%	0%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	55	0%	22%	0%	0%	100%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	23	0%	51%	0%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	164	0%	5%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	71%	0%	0%	100%	0
2C3	PFC from aluminium production	PFC	38	0%	20%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	21	0%	30%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	85	0%	5%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	24	0%	17%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	50%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	50%	0%	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0%	0%	100%	0
			191625			14%			30

Table A1.5b Source ranking using IPCC Tier 2 level assessment 2012, including LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	1432	1%	206%	1%	9%	9%	1
5C1	5C1. Grassland remaining Grassland	CO_2	4249	2%	56%	1%	7%	16%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8583	4%	25%	1%	6%	23%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	3233	2%	61%	1%	6%	29%	1
5A1	5A1. Forest Land remaining Forest Land	CO_2	2881	1%	67%	1%	6%	34%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	7150	4%	25%	1%	6%	40%	1
4B1	Emissions from manure management : cattle	CH_4	1803	1%	100%	1%	5%	45%	1
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	10823	5%	10%	1%	3%	49%	1
4D2	Animal production on agricultural soils	N_2O	1045	1%	100%	1%	3%	52%	1
4B	Emissions from manure management	N_2O	1007	0%	100%	1%	3%	55%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	1874	1%	54%	0%	3%	58%	1
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	17659	9%	5%	0%	3%	61%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25909	13%	3%	0%	2%	63%	1
4B8	Emissions from manure management : swine	CH_4	757	0%	100%	0%	2%	65%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7509	4%	10%	0%	2%	68%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	1477	1%	50%	0%	2%	70%	1
5B2	5B2. Land converted to Cropland	CO_2	1251	1%	56%	0%	2%	72%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	3996	2%	16%	0%	2%	74%	1
5E2	5E2. Land converted to Settlements	CO_2	1126	1%	56%	0%	2%	76%	1
6A1	CH4 emissions from solid waste disposal sites	CH_4	2973	1%	20%	0%	2%	78%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	19334	10%	3%	0%	2%	79%	1
2B5	Other chemical product manufacture	CO_2	631	0%	71%	0%	1%	81%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	2068	1%	21%	0%	1%	82%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	4018	2%	10%	0%	1%	83%	1
5A2	5A2. Land converted to Forest Land	CO_2	581	0%	63%	0%	1%	84%	1
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	12641	6%	3%	0%	1%	85%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	1642	1%	21%	0%	1%	86%	1

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	13210	7%	2%	0%	1%	87%	1
2B1	Ammonia production	CO_2	2578	1%	10%	0%	1%	88%	1
2B5	Caprolactam production	N_2O	856	0%	30%	0%	1%	89%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	1692	1%	15%	0%	1%	90%	1
6B	Emissions from wastewater handling	N_2O	457	0%	54%	0%	1%	90%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	1040	1%	20%	0%	1%	91%	1
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	385	0%	50%	0%	1%	92%	0
1A3	Mobile combustion: road vehicles	N_2O	277	0%	70%	0%	1%	92%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	351	0%	50%	0%	1%	93%	0
2A7	Other minerals	CO_2	322	0%	50%	0%	0%	93%	0
2G	Other industrial: CO_2	CO_2	300	0%	50%	0%	0%	94%	0
2G	Other industrial: CH_4	CH_4	287	0%	51%	0%	0%	94%	0
2A3	Limestone and dolomite use	CO_2	559	0%	25%	0%	0%	94%	0
1A3	Mobile combustion: water-borne navigation	CO_2	699	0%	20%	0%	0%	95%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	264	0%	50%	0%	0%	95%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	2595	1%	5%	0%	0%	96%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	380	0%	30%	0%	0%	96%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	18566	9%	1%	0%	0%	96%	0
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	512	0%	20%	0%	0%	97%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	179	0%	54%	0%	0%	97%	0
1B2	Fugitive emissions venting/flaring	CH_4	312	0%	25%	0%	0%	97%	0
2C1	Iron and steel production (carbon inputs)	CO_2	1240	1%	6%	0%	0%	97%	0
5F2	5F2. Land converted to Other Land	CO_2	128	0%	56%	0%	0%	98%	0
1A5	Military use of fuels (1A5 Other)	CO_2	341	0%	20%	0%	0%	98%	0
2F	SF_6 emissions from SF6 use	SF_6	196	0%	34%	0%	0%	98%	0
6B	Emissions from wastewater handling	CH_4	199	0%	32%	0%	0%	98%	0
5D2	5D2. Land converted to Wetlands	CO_2	113	0%	56%	0%	0%	98%	0
1A3b	Mobile combustion: road vehicles: LPG	CO_2	838	0%	5%	0%	0%	99%	0
1B1b	CO_2 from coke production	CO_2	284	0%	15%	0%	0%	99%	0
4B9	Emissions from manure management : poultry	CH_4	40	0%	100%	0%	0%	99%	0
2A1	Cement production	CO_2	308	0%	11%	0%	0%	99%	0
3	Indirect CO_2 from solvents/product use	CO_2	120	0%	27%	0%	0%	99%	0
1A3	Mobile combustion: road vehicles	CH_4	46	0%	70%	0%	0%	99%	0

IPCC	Category	Gas	CO_2-eq last year	CO_2-eq last year	level assessment last year	trend assess-ment	% Contr. to trend	Cumulative	Key ?
4A1	CH4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	151	0%	21%	0%	0%	99%	0
1B2	Fugitive emissions venting/flaring: CO2	CO_2	62	0%	50%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	113	0%	25%	0%	0%	99%	0
4B	Emissions from manure management : other	CH_4	24	0%	100%	0%	0%	99%	0
5C2	5C2. Land converted to Grassland	CO_2	40	0%	56%	0%	0%	100%	0
3, 6D	OTHER N_2O	N_2O	126	0%	17%	0%	0%	100%	0
2B2	Nitric acid production	N_2O	264	0%	8%	0%	0%	100%	0
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	3339	2%	1%	0%	0%	100%	0
5G	5G. Other (liming of soils)	CO_2	73	0%	25%	0%	0%	100%	0
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	125	0%	14%	0%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	55	0%	22%	0%	0%	100%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	23	0%	51%	0%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	164	0%	5%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	11	0%	71%	0%	0%	100%	0
2C3	PFC from aluminium production	PFC	38	0%	20%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	21	0%	30%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	85	0%	5%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	24	0%	17%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	2	0%	50%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	0%	50%	0%	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	1	0%	20%	0%	0%	100%	0
			202067			16%			33

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 and one small CO_2 source are now in the top five lists of level key sources:

- 4D3 indirect N_2O emissions from nitrogen used in agriculture;
- 4D1 direct N_2O emissions from agricultural soils.
- 1A2 Stationary combustion: Manufacturing Industries and Construction, liquids

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	3358	1432	1%	1%	206%	2%	22%	22%	1
4D2	Animal production on agricultural soils	N_2O	3150	1045	1%	1%	100%	1%	12%	34%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	2973	2%	5%	20%	1%	11%	45%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1874	1%	1%	54%	1%	6%	51%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	125	0%	3%	14%	0%	5%	56%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1477	1%	1%	50%	0%	3%	59%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	7150	4%	1%	25%	0%	3%	63%	1
2B2	Nitric acid production	N_2O	6330	264	0%	3%	8%	0%	3%	65%	1
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7632	10823	6%	2%	10%	0%	3%	68%	1
4B1	Emissions from manure management : cattle	CH_4	1593	1803	1%	0%	100%	0%	3%	71%	1
2C3	PFC from aluminium production	PFC	1901	38	0%	1%	20%	0%	2%	73%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	62	0%	0%	50%	0%	2%	75%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3233	2%	0%	61%	0%	2%	77%	1
4B8	Emissions from manure management : swine	CH_4	1154	757	0%	0%	100%	0%	2%	79%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	19334	10%	5%	3%	0%	2%	81%	1
4B9	Emissions from manure management : poultry	CH_4	275	40	0%	0%	100%	0%	1%	82%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	312	0%	0%	25%	0%	1%	83%	1
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	1040	1%	0%	20%	0%	1%	85%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2068	1%	0%	21%	0%	1%	86%	1
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1356	512	0%	0%	20%	0%	1%	87%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8956	8583	4%	0%	25%	0%	1%	87%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A3	Mobile combustion: road vehicles	N_2O	101	277	0%	0%	70%	0%	1%	88%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2595	1%	1%	5%	0%	1%	89%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2587	1692	1%	0%	15%	0%	1%	90%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7330	7509	4%	1%	10%	0%	1%	90%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	838	0%	1%	5%	0%	1%	91%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	25909	14%	2%	3%	0%	1%	92%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1642	1%	0%	21%	0%	1%	92%	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12641	7%	2%	3%	0%	1%	93%	0
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19020	13210	7%	2%	2%	0%	1%	93%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	23	0%	0%	51%	0%	1%	94%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	351	0%	0%	50%	0%	1%	94%	0
1A3	Mobile combustion: road vehicles	CH_4	158	46	0%	0%	70%	0%	0%	95%	0
1A3	Mobile combustion: water-borne navigation	CO_2	405	699	0%	0%	20%	0%	0%	95%	0
4B	Emissions from manure management	N_2O	1183	1007	1%	0%	100%	0%	0%	95%	0
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5033	4018	2%	0%	10%	0%	0%	96%	0
2B5	Caprolactam production	N_2O	766	856	0%	0%	30%	0%	0%	96%	0
2C1	Iron and steel production (carbon inputs)	CO_2	2267	1240	1%	0%	6%	0%	0%	96%	0
3	Indirect CO_2 from solvents/ product use	CO_2	316	120	0%	0%	27%	0%	0%	97%	0
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	17659	9%	0%	5%	0%	0%	97%	0
2A7	Other minerals	CO_2	275	322	0%	0%	50%	0%	0%	97%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	18566	10%	4%	1%	0%	0%	98%	0
2B5	Other chemical product manufacture	CO_2	649	631	0%	0%	71%	0%	0%	98%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A5	Military use of fuels (1A5 Other)	CO_2	566	341	0%	0%	20%	0%	0%	98%	0
2A3	Limestone and dolomite use	CO_2	481	559	0%	0%	25%	0%	0%	98%	0
2B1	Ammonia production	CO_2	3096	2578	1%	0%	10%	0%	0%	98%	0
2F	SF_6 emissions from SF_6 use	SF_6	287	196	0%	0%	34%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	37	113	0%	0%	25%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	32%	0%	0%	99%	0
3, 6D	OTHER N_2O	N_2O	256	126	0%	0%	17%	0%	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	264	0%	0%	50%	0%	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	179	0%	0%	54%	0%	0%	99%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4351	3996	2%	0%	16%	0%	0%	99%	0
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	3339	2%	1%	1%	0%	0%	99%	0
2G	Other industrial: CO_2	CO_2	304	300	0%	0%	50%	0%	0%	99%	0
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	54%	0%	0%	100%	0
1B1b	CO_2 from coke production	CO_2	403	284	0%	0%	15%	0%	0%	100%	0
2G	Other industrial: CH4	CH_4	297	287	0%	0%	51%	0%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	395	164	0%	0%	5%	0%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	55	0%	0%	22%	0%	0%	100%	0
2A1	Cement production	CO_2	416	308	0%	0%	11%	0%	0%	100%	0
2G	Other industrial: N2O	N_2O	3	11	0%	0%	71%	0%	0%	100%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	385	0%	0%	50%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	2	24	0%	0%	17%	0%	0%	100%	0
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	100%	0%	0%	100%	0
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	380	0%	0%	30%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	28	21	0%	0%	30%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	151	0%	0%	21%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	50%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	50%	0%	0%	100%	0

Table A1.6b Source ranking using IPCC Tier 2 trend assessment, including LULUCF (in Gg CO_2 eq).

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1432	1%	1%	206%	2%	20%	20%	1
4D2	Animal production on agricultural soils	N_2O	3150	1045	1%	1%	100%	1%	11%	30%	1
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	2973	1%	4%	20%	1%	9%	40%	1
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1874	1%	1%	54%	0%	5%	45%	1
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	125	0%	3%	14%	0%	4%	49%	1
5B2	5B2. Land converted to Cropland	CO_2	158	1251	1%	1%	56%	0%	4%	53%	1
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	7150	4%	1%	25%	0%	3%	56%	1
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1477	1%	1%	50%	0%	3%	59%	1
5A1	5A1. Forest Land remaining Forest Land	CO_2	2407	2881	1%	0%	67%	0%	3%	61%	1
2B2	Nitric acid production	N_2O	6330	264	0%	3%	8%	0%	3%	64%	1
5E2	5E2. Land converted to Settlements	CO_2	459	1126	1%	0%	56%	0%	2%	66%	1
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7632	10823	5%	2%	10%	0%	2%	68%	1
4B1	Emissions from manure management : cattle	CH_4	1593	1803	1%	0%	100%	0%	2%	70%	1
2C3	PFC from aluminium production	PFC	1901	38	0%	1%	20%	0%	2%	72%	1
5A2	5A2. Land converted to Forest Land	CO_2	54	581	0%	0%	63%	0%	2%	74%	1
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3233	2%	0%	61%	0%	2%	76%	1
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	62	0%	0%	50%	0%	2%	78%	1
4B8	Emissions from manure management : swine	CH_4	1154	757	0%	0%	100%	0%	2%	80%	1
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	19334	10%	5%	3%	0%	1%	81%	1
4B9	Emissions from manure management : poultry	CH_4	275	40	0%	0%	100%	0%	1%	83%	1
1B2	Fugitive emissions venting/flaring	CH_4	1252	312	0%	0%	25%	0%	1%	84%	1
5C1	5C1. Grassland remaining Grassland	CO_2	4249	4249	2%	0%	56%	0%	1%	85%	1

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	1040	1%	0%	20%	0%	1%	86%	1
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1356	512	0%	0%	20%	0%	1%	87%	1
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2068	1%	0%	21%	0%	1%	88%	1
1A3	Mobile combustion: road vehicles	N_2O	101	277	0%	0%	70%	0%	1%	88%	1
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, liquids	CO_2	2587	1692	1%	0%	15%	0%	1%	89%	1
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2595	1%	1%	5%	0%	1%	90%	1
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8956	8583	4%	0%	25%	0%	1%	90%	1
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	838	0%	1%	5%	0%	1%	91%	1
4A1	CH_4 emissions from enteric fermentation in domestic livestock: young cattle	CH_4	2264	1642	1%	0%	21%	0%	1%	91%	0
1A2	Stationary combustion : Manufacturing Industries and Construction, gases	CO_2	19020	13210	7%	2%	2%	0%	0%	92%	0
1A4c	Stationary combustion : Other Sectors, Agriculture/ Forestry/Fisheries, gases	CO_2	7330	7509	4%	0%	10%	0%	0%	92%	0
5C2	5C2. Land converted to Grassland	CO_2	198	40	0%	0%	56%	0%	0%	93%	0
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	23	0%	0%	51%	0%	0%	93%	0
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12641	6%	1%	3%	0%	0%	94%	0
4B	Emissions from manure management	N_2O	1183	1007	0%	0%	100%	0%	0%	94%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	25909	13%	1%	3%	0%	0%	94%	0
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	351	0%	0%	50%	0%	0%	95%	0
1A3	Mobile combustion: road vehicles	CH_4	158	46	0%	0%	70%	0%	0%	95%	0
1A3	Mobile combustion: water-borne navigation	CO_2	405	699	0%	0%	20%	0%	0%	96%	0
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5033	4018	2%	0%	10%	0%	0%	96%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
5F2	5F2. Land converted to Other Land	CO_2	25	128	0%	0%	56%	0%	0%	96%	0
2C1	Iron and steel production (carbon inputs)	CO_2	2267	1240	1%	0%	6%	0%	0%	97%	0
2B5	Caprolactam production	N_2O	766	856	0%	0%	30%	0%	0%	97%	0
3	Indirect CO_2 from solvents/ product use	CO_2	316	120	0%	0%	27%	0%	0%	97%	0
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	18566	9%	3%	1%	0%	0%	97%	0
2A7	Other minerals	CO_2	275	322	0%	0%	50%	0%	0%	98%	0
1A5	Military use of fuels (1A5 Other)	CO_2	566	341	0%	0%	20%	0%	0%	98%	0
2A3	Limestone and dolomite use	CO_2	481	559	0%	0%	25%	0%	0%	98%	0
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	17659	9%	0%	5%	0%	0%	98%	0
2B5	Other chemical product manufacture	CO_2	649	631	0%	0%	71%	0%	0%	98%	0
2B1	Ammonia production	CO_2	3096	2578	1%	0%	10%	0%	0%	98%	0
5D2	5D2. Land converted to Wetlands	CO_2	74	113	0%	0%	56%	0%	0%	99%	0
5G	5G. Other (liming of soils)	CO_2	183	73	0%	0%	25%	0%	0%	99%	0
2F	SF_6 emissions from SF_6 use	SF_6	287	196	0%	0%	34%	0%	0%	99%	0
6B	Emissions from wastewater handling	CH_4	290	199	0%	0%	32%	0%	0%	99%	0
3, 6D	OTHER N_2O	N_2O	269	126	0%	0%	17%	0%	0%	99%	0
2F	PFC emissions from PFC use	PFC	37	113	0%	0%	25%	0%	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	264	0%	0%	50%	0%	0%	99%	0
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	3339	2%	1%	1%	0%	0%	99%	0
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	179	0%	0%	54%	0%	0%	99%	0
1B1b	CO_2 from coke production	CO_2	403	284	0%	0%	15%	0%	0%	99%	0
2G	Other industrial: CO_2	CO_2	304	300	0%	0%	50%	0%	0%	100%	0
2C3	CO_2 from aluminium production	CO_2	395	164	0%	0%	5%	0%	0%	100%	0
2E	HFC by-product emissions from HFC manufacture	HFC	12	55	0%	0%	22%	0%	0%	100%	0
6B	Emissions from wastewater handling	N_2O	482	457	0%	0%	54%	0%	0%	100%	0
2A1	Cement production	CO_2	416	308	0%	0%	11%	0%	0%	100%	0
2G	Other industrial: CH_4	CH_4	297	287	0%	0%	51%	0%	0%	100%	0
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	385	0%	0%	50%	0%	0%	100%	0
2G	Other industrial: N_2O	N_2O	3	11	0%	0%	71%	0%	0%	100%	0

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq last year	level assessment last year	trend assess-ment	Uncertainty estimate	Trend * uncer-tainty	% Contr. to trend	Cumulative	Key ?
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	380	0%	0%	30%	0%	0%	100%	0
6D	OTHER CH_4	CH_4	2	24	0%	0%	17%	0%	0%	100%	0
4B	Emissions from manure management : other	CH_4	31	24	0%	0%	100%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4351	3996	2%	0%	16%	0%	0%	100%	0
1A3	Mobile combustion: aircraft	CO_2	28	21	0%	0%	30%	0%	0%	100%	0
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	151	0%	0%	21%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	N_2O	1	2	0%	0%	50%	0%	0%	100%	0
1A3	Mobile combustion: other (non-road)	CH_4	1	1	0%	0%	50%	0%	0%	100%	0
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: liquids	CO_2	2	1	0%	0%	20%	0%	0%	100%	0
1A3	Mobile combustion: other (railways)	CO_2	91	85	0%	0%	5%	0%	0%	100%	0
			220999	202067		43%		9%			30

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 14-002 for stationary sources and protocols 14-004 to 14-011 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 also 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 used for the national monitoring as well.
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 for each energy carrier, substantiating the values given, presenting synonyms for fuel names and possible specifications, and providing an overview of the codes that organizations 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, e.g. national monitoring of greenhouse gas emissions, the European CO_2 emissions trade and the e-MJV. It also includes background information. The list, plus this document and the background documents for substantiating the specific Netherlands values, can be found on the website: http://english.rvo.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 2012 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 CO_2 emission factors in the Netherlands (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, e.g. of coke coals used in coke ovens and in blast furnaces.

Natural gas
In 2006, a study was commissioned to research methods for determining the CO_2 emission factor for natural gas (TNO, 2006). This resulted in a recommendation 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 2012. Incinerated waste is a mixture of biogenic and non-biogenic waste. The percentage of biogenic waste, therefore, is given for both the heating value and the EF.

Biomass
The list also includes biomass as a fuel, with accompanying specific Netherlands CO_2 emission factors. Biomass emissions are reported separately in the national monitoring of greenhouse gas emissions under the UNFCCC framework (as a memo element) and are not included in the national emissions figures. For the European CO_2 emissions trading, the emissions are not included because an emission factor of zero is used for biomass.
The CO_2 emission factor for wood is used for solid biomass and that of palm oil is used for liquid biomass.[1] A weighted average of three specified biogases is used as the standard factor for gaseous biomass:

1. 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.

[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
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

Main group (Dutch language)	Main group (English) IPCC (supplemented)	Unit	Heating value (MJ/unit)	CO_2 EF (kg/GJ)
	D. Other fuels			
Afval [3)]	Waste	kg	9.5	106.6

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 2012. 56% of the heating value and 66% of the emissionfactor is attributed to biogenic waste. In the emission year 2011 the heating value was 9.6 MJ/kg (54% biogenic) and the emission factor was 106.3 kg/GJ (65% biogenic). 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).

For information purposes we include hereafter the fuel list which will be used for the calculation of the emissions from reporting year 2013 onwards (so not in the present inventory). The list is included in the Electronic Annual Reporting System (E-MJV) for reporting the emissions of 2013. On 20 March 2014 the list was formally approved by the Working Group Emission Monitoring (WEM).

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*	*77.7*
Aardgascondensaat	*Natural gas liquids*	*kg*	*44.0*	*64.2*
Fossiele additieven	*Fossil fuel additives*	*kg*	*44.0*	*73.3*
	Liquid fossil, secondary fuels/products			
Motorbenzine	*Petrol/gasoline*	*kg*	*44.0*	*72.0*
Vliegtuigbenzine	*Aviation 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*	*43.1*	*71.9*
LPG	*LPG*	*kg*	*38.1*	*73.3*
Ethaan	*Ethane*	*kg*	*42.7*	*74.3*
Nafta's	*Naphtha*	*kg*	*41.0*	*77.4*
Bitumen	*Bitumen*	*kg*	*45.2*	*66.7*
Smeeroliën	*Lubricants*	*kg*	*45.2*	*61.6*
Petroleumcokes	*Petroleum coke*	*kg*	*44.0*	*73.3*
Raffinaderij grondstoffen	*Refinery feedstocks*	*kg*	*41.9*	*80.7*
Raffinaderijgas	*Refinery gas*	*kg*	*41.4*	*73.3*
Chemisch restgas	*Chemical waste gas*	*kg*	*35.2*	*97.5*
Overige oliën	*Other Oil*	*kg*	*43.0*	*73.3*
Paraffine	*Paraffin Waxes*	*kg*	*45.2*	*67.0*

Main group (Dutch language)	Main group (English) IPCC (supplemented)	Unit	Heating value (MJ/unit)	CO_2 EF (kg/GJ)
Terpentine	White Spirit and SBP	kg	45.2	62.4
Overige aardolie producten	Other Petroleum Products	kg	40.2	73.3
	B. Solid fossil, primary fuels			
Antraciet	Anthracite	kg	29.3	98.3
Cokeskolen	Coking coal	kg	28.6	94.0
Cokeskolen (cokeovens)	Coking coal (used in coke oven)	kg	28.6	95.4
Cokeskolen (basismetaal)	Coking coal (used in blast furnaces)	kg	28.6	89.8
Overige bitumineuze steenkool	Other bituminous coal	kg	24.7	94.7
Sub-bitumineuze kool	Sub-bituminous coal	kg	18.9	96.1
Bruinkool	Lignite	kg	20.0	101.0
Bitumineuze Leisteen	Oil shale	kg	8.9	107.0
Turf	Peat	kg	9.76	106.0
	Solid fossil, secondary fuels			
Steenkool- en bruinkoolbriketten	BKB & patent fuel	kg	20.7	97.5
Cokesoven/gascokes	Coke oven/Gas coke	kg	28.5	106.8
Cokesovengas	Coke oven gas	MJ	1.0	42.8
Hoogovengas	Blast furnace gas	MJ	1.0	247.4
Oxystaalovengas	Oxy gas	MJ	1.0	191.9
Fosforovengas	Phosphor gas	Nm^3	11.0	143.9
Steenkool bitumen	Coal tar	kg	41.9	80.7
	C. Gaseous fossil fuels			
Aardgas	Natural gas (dry)	Nm^3	31.65	56.5
Compressed natural gas (CNG)	Compressed natural gas (CNG)	Nm3 ae	31.65	56.5
Liquified natural gas (LNG)	Liquified natural gas (LNG)	Nm3 ae	31.65	56.5
Koolmonoxide	Carbon monoxide	Nm^3	12.6	155.2
Methaan	Methane	Nm^3	35.9	54.9
Waterstof	Hydrogen	Nm^3	10.8	0
	Biomass [2)]			
Biomassa vast	Solid biomass	kg	15.1	109.6
Houtskool	Charcoal	kg	30.0	112.0
Biobenzine	Biogasoline	kg	27.0	72.0
Biodiesel	Biodiesels	kg	37.0	74.3
Overige vloeibare biobrandstoffen	Other liquid biofuels	kg	36.0	79.6
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	Waste	kg	9.5	106.6

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 m^3 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).

A2.5 Using the Netherlands list in national monitoring, European CO_2 emissions trading and in 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 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 harmonizing 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 Netherlands Enterprise Agency, and other relevant organizations, such as the e-MJV, CO_2 emissions trade and ECN. The Steering Committee Emission Registration (the collaborative agency implementing the national monitoring system) compiled the list during its meeting in October 2004.
The list will be maintained within the National System, the organizational 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 on the website http://english.rvo.nl/nie. As part of the quality monitoring system for the 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, 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) was approved by the WEM. In this document, the CO_2 emission factor for natural gas for the emission year 2012 and 2013 has been determined. For the fuel Waste, the heating value and EF for the emission year 2011 were also determined, including the percentage to be attributed to biogenic waste in both parameters.

A2.7 Application of the Netherlands standard and source-specific CO2 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, IPCC default EFs are used (see Table A2.1). For some of the derived fuels, however, the chemical composition and thus the CO_2 emission factor is highly variable between source categories and over time.
So for blast furnace and oxygen furnace gas, refinery gas, chemical waste gas (liquids and solids treated separately) and solid waste (the biogenic and fossil carbon parts treated separately), mostly source-specific (or plant-specific) EFs have been used, which 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 has been used. This refers to the 'own use' of unprocessed natural gas used by the gas and oil production industry, whose composition may differ significantly from that of treated standard natural gas supplied to end-users. These EFs 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 http://english.rvo.nl/nie, including country-specific emission factors. Annex 6 provides an overview of the available monitoring protocols at this site.

Annex 4
CO_2 Reference Approach and comparison with Sectoral Approach

A4.1 Comparison of CO_2 emissions

The IPCC Reference Approach (RA) for CO_2 from energy use uses apparent consumption data per fuel type to estimate CO_2 emissions from fossil fuel use. This has been used as a means of verifying the sectoral total CO_2 emissions from fuel combustion (IPCC, 2001). For the Reference Approach, energy statistics (production, imports, 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 1990–2012, 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 a 4 per cent RA vs. 5 per cent NA increase in emissions from liquid fuels (1990–2012) and a 6 per cent RA vs. 7 per cent NA increase from gaseous fuels; CO_2 emissions from solid fuels decreased in this period by 5 per cent in the RA vs. a decrease of 3 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 2012. These numbers cannot be compared well, however, 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 (category 1B) are not included in the Sectoral Approach total of category 1A. The most significant are gas used as feedstock in Ammonia production (2B1) and Losses from coke/coal inputs in blast furnaces (2C1).
2. 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 EFs 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 oxidized 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/oxidized 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 oxidized, 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 along with the average values derived from them. The table shows, indeed, that the factors are subject to significant interannual variation, particularly 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

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
RA											
Liquid fuels	45.5	46.6	53.8	55.2	54.6	58.2	55.9	53.1	54.5	54.2	54.2
Solid fuels	34.0	34.7	30.5	32.2	30.2	33.2	31.4	29.4	29.7	29.3	32.3
Gaseous fuels	71.9	79.9	81.0	81.8	79.6	77.1	80.6	81.3	91.1	79.3	76.0
Others[1)]	0.6	0.8	1.6	2.1	2.1	2.2	2.2	2.5	2.5	2.6	2.6
Total RA	152.0	162.0	166.9	171.3	166.6	170.7	170.2	166.3	177.8	165.4	165.0
NA											
Liquid fuels	49.7	52.4	54.6	56.3	56.0	56.1	56.1	53.0	53.8	53.4	52.2
Solid fuels	31.0	32.4	28.8	30.2	28.7	30.7	30.1	27.6	28.3	27.4	29.9
Gaseous fuels	68.6	76.0	76.7	78.5	77.0	74.5	78.4	78.4	88.2	76.5	73.2
Others [1)]	0.6	0.8	1.6	2.1	2.1	2.2	2.2	2.5	2.5	2.6	2.6
Total NA	149.9	161.6	161.7	167.1	163.8	163.5	166.9	161.4	172.7	159.8	158.0
Difference (%)											
Liquid fuels	-8.4%	-11.1%	-1.4%	-2.0%	-2.5%	3.7%	-0.3%	0.2%	1.3%	1.6%	3.8%
Solid fuels	9.8%	7.2%	6.1%	6.6%	5.3%	8.2%	4.2%	6.6%	5.0%	6.9%	7.8%
Gaseous fuels	4.8%	5.2%	5.5%	4.2%	3.4%	3.4%	2.8%	3.8%	3.3%	3.6%	3.7%
Others	0%	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%	3.0%	2.9%	3.5%	4.5%

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	2012
Reference Approach	152.0	162.0	166.9	171.3	170.2	166.3	177.8	165.4	165.0
National Approach	149.9	161.6	161.7	167.1	166.9	161.4	172.7	159.8	158.0
Difference RA-NA	2.2	0.4	5.2	4.2	3.3	4.9	5.0	5.5	7.1
CO_2 fossil in Sector 1B									
1B1b Solid Fuel Transf.	0.4	0.5	0.4	0.6	0.7	0.5	1.0	0.6	0.3
1B2c Flaring	0.4	0.3	0.2	0.1	0.0	0.0	0.1	0.0	0.1
1B2a iv. Oil refining	0.0	0.0	0.0	0.9	0.8	1.0	1.0	0.8	0.7
CO_2 fossil in Sector 2	6.0	5.9	5.1	4.7	4.2	4.2	4.4	4.4	4.3
A Mineral Products									
Soda Ash Production	0.1	0.3	0.1	0.1	0.1	0.0	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	2.6
5 Other, excl. act. carbon	0.4	0.2	0.2	0.4	0.4	0.3	0.4	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	1.2
D Other Production									
2 Food and Drink	0.1	0.0	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	0.1
Not in NA-1A:	0.8	0.8	0.6	1.6	1.6	1.6	2.0	1.5	1.1
NA+1B+Ind. Proc.	156.8	168.2	167.5	173.4	172.7	167.3	179.2	165.7	163.3
RA	152.0	162.0	166.9	171.3	170.2	166.3	177.8	165.4	165.0
New difference (abs)	4.7	6.2	0.5	2.2	2.5	1.0	1.4	0.4	-1.7
New difference (%)	3.1%	3.9%	0.3%	1.3%	1.5%	0.6%	0.8%	0.2%	-1.1%

cent can be observed, is one reason for the differences between the RA and the corrected NA.

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 the 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 of bituminous coal and coal bitumen, respectively, are used.
- ***Fuel consumption in international marine and aviation bunkers***
  Some changes are made annually in the national energy statistics on 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 (very) small/ negligible. For those sources that were not small, 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’, since data for estimating emissions are not available and the source is very small. Of course, it is being checked/ re-assessed on a regular basis whether there are developments in NE sources that indicate any (major) increase in emissions or new data sources for estimating emissions.

Following the 2011 review, one NE source has been reviewed for the potential magnitude and then an estimate was made and included in the inventory. As a result, Charcoal production (1B2) and Charcoal use (1A4) are no longer included in this Annex. The Netherlands greenhouse gas emission inventory includes all sources identified by the Revised IPCC Guidelines (IPCC, 1996) – with the exception of the following (very) minor sources:

- CO_2 from asphalt roofing (2A5) and CO_2 from road paving (2A6), both due to missing activity data; information on the use of bitumen is only available for two groups: the chemical industry and all others. There is no information on the amount of asphalt roofing production and also no information on road paving with asphalt. The statistical information on the sales (value) of asphalt roofing and asphalt for road paving was finalized 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 were the rationale of the decision to not estimate these emissions. As a follow up to the 2008 review, information has been collected from the branch organization for roofing, indicating that the number of producers of asphalt roofing declined from about fifteen in 1990 to less than five in 2008 and that the import of asphalt roofing has increased. Also, information has been researched on asphalt production (for road paving), as reported in the progress of the voluntary agreements for energy efficiency. A first estimate indicates that the CO_2 emissions could be approximately 0.5 kton.
- CH_4 from Enteric fermentation poultry (4A9), due to missing emission factors; for this source category, no IPCC default emission factor is available.
- N_2O from Industrial wastewater (6B1), due to negligible amounts. As presented in the NIR 2008, on page 194, the annual source for activity data are yearly questionnaires which cover all urban WWTPs and all anaerobic industrial WWTPs. From this anaerobic pre-treatment, there is no N_2O emission.

In 2000, the Netherlands investigated sources for non-CO_2 emissions not previously estimated. One of these sources was waste water handling (DHV, 2000). As a result of this study, emissions were estimated (Oonk, 2004) and the methods are presented in the protocols CH_4, N_2O from wastewater treatment (6B). We are not able to estimate N_2O emissions from aerobic industrial WWTPs, as there is no information available on these installations. In the priority setting for the allocation of budgets for improvements in emission estimates, we did consider this as a source for which it could not be argued that a new data collection process or new statistics was a priority. Arguments for this decision include:

- The majority of the small and medium enterprises are linked to the municipal wastewater treatment plants (for which we made emission estimates) and do not have their own wastewater treatment;
- The anaerobic pre-treatment reduces the N load to the aerobic final treatment;
- Aerobic (post) treatment is done for several of the industrial companies in the municipal WWTPs;
- The composition of the industrial wastewater is primarily process water and, although we have no specific information on the N-content of the influent, it is assumed that it is low in N content.
  In addition, there are indications that the number of industrial wastewater treatment plants will be reduced in the near future and this will also further minimize the minor 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 emits into the sewer system, which is connected to municipal wastewater treatment. These emissions are included in the category: Domestic and commercial wastewater.
  - In case of anaerobic wastewater treatment, the emissions from sludge handling are included in the 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 industrial WWTP, the sludge undergoes simultaneous

stabilization in the aerobic wastewater reactors. The industrial sludge produced is therefore already very stable in terms of digestible matter. CH_4 emissions therefore are considered to be very low and do not justify setting up a yearly monitoring and estimation method.

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

Annex 6 Additional information to be considered as part of the NIR submission

The following information should be considered as part of this NIR submission:

A6.1 List of protocols

Table A6.1 Methodological description (monitoring protocols 2014, from 15 April 2014, available at the website)

Table A6.1 Methodological description (monitoring protocols 2014, from 15 April 2014 available at the website).

Protocol	IPCC code	Description	Gases
14-001	All	Reference approach	CO_2
14-002	1A1 1A2 1A4	Stationary combustion (fossil) *	CO_2 N_2O CH_4
14-003	1A1b 1B1b 1B2aiv 2A4i 2B1 2B4i 2B5i 2B5vii 2B5viii 2C1vi 2D2 2Giv	Process emissions (fossil)	CO_2 N_2O CH_4
14-004	1A2f 1A4c	Mobile equipment	CO_2 N_2O CH_4
14-005	1A3a	Inland aviation	CO_2 N_2O CH_4
14-006	1A3b	Road transport	CO_2
14-007	1A3b	Road transport	N_2O CH_4
14-008	1A3c	Rail transport	CO_2 N_2O CH_4
14-009	1A3d	Inland navigation	CO_2 N_2O CH_4
14-010	1A4c	Fisheries	CO_2 N_2O CH_4
14-011	1A5	Defence	CO_2 N_2O CH_4
14-012	1B2	Oil & gas production	CO_2 CH_4
14-013	1B2	Oil & gas distribution/transport	CO_2 CH_4
14-014	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
14-015	2B2	Nitric acid	N_2O
14-016	2B5	Caprolactam	N_2O
14-017	2C3	Aluminium production	PFC
14-018	2E1	HCFC-22 production	HFC
14-019	2E3	HFC by product emissions	HFC
14-020	2F1	Stationary refrigeration	HFC
14-021	2F1	Mobile refrigeration	HFC
14-022	2F2, 2F4	Hard foams, Aerosols	HFC
14-024	2F8	Soundproof windows, Electron microscopes	SF_6
14-025	2F8	Semi-conductors	SF_6 PFC
14-026	2F8	Electrical equipment	SF_6
14-027	4A	Enteric fermentation,	CH_4
14-028	4B	Manure management	N_2O
14-029	4B	Manure management	CH_4
14-030	4D	Agricultural soils, indirect	N_2O
14-031	4D	Agricultural soils, direct	N_2O
14-032	5A	Forest	CO_2
14-033	5D-5G	Soil	CO_2
14-034	6A1	Waste disposal	CH_4
14-035	6B	Waste water treatment	CH_4 N_2O
14-036	6D	Large-scale composting	CH_4 N_2O
14-037	Memo item	International bunker emissions	CO_2 N_2O CH_4
14-038	1A, (CO_2 memo item)	Biomass	CO_2 CH_4 N_2O
14-039	5(KP-I KP-II)	KP LULUCF	CO_2 CH_4 N_2O

A6.2 Documentation of uncertainties used in IPCC Tier 1 uncertainty assessments and Tier 2 key source identification

- Olivier, J.G.J., L.J. Brandes, R.A.B. te Molder, 2009: Estimate of annual and trend uncertainty for Dutch sources of greenhouse gas emissions using the IPCC Tier 1 approach. PBL Report 500080013, PBL, Bilthoven.
- Olsthoorn, X. and A. Pielaat, 2003: Tier-2 uncertainty analysis of the Dutch greenhouse gas emissions 1999. Institute for Environmental Studies (IVM), Free University, Amsterdam. IVM Report no. R03-06.
- Ramírez-Ramírez, A., C. de Keizer and J.P. van der Sluijs, 2006: Monte Carlo Analysis of Uncertainties in the Netherlands Greenhouse Gas Emission Inventory for 1990–2004, report NWS-E-2006-58, Department of Science, Technology and Society, Copernicus Institute for Sustainable Development and Innovation, Utrecht University, Utrecht, the Netherlands.

A6.3 Background documents and uncertainty discussion papers

- Van Amstel, A.R., J.G.J. Olivier and P.G. Ruyssenaars (eds.), 2000a: Monitoring of Greenhouse Gases in the Netherlands: Uncertainty and Priorities for Improvement. Proceedings of a National Workshop held in Bilthoven, the Netherlands, 1 September 1999. WIMEK report/RIVM report no. 773201 003. Bilthoven, May 2000.
- Kuikman, P.J., J.J.H van den Akker and F. de Vries, 2005: Lachgasemissie uit organische landbouwbodems. Alterra, Wageningen. Alterra rapport 1035-II.
- Hoek, K. W. van der and M. W. van Schijndel, 2006: Methane and nitrous oxide emissions from animal manure management, including an overview of emissions 1990-2003. Background document for the Dutch National Inventory Report. RIVM report 680.125.002, Bilthoven.
- Hoek, K.W. van der, M.W. van Schijndel, P.J. Kuikman, 2007. Direct and indirect nitrous oxide emissions from agricultural soils, 1990 - 2003. Background document on the calculation method for the Dutch National Inventory Report. RIVM Report No. 68012.003/2007 MNP Report No. 500080003/2007 Bilthoven, the Netherlands.
- Nabuurs, G.J., I.J. van den Wyngaert, W.D. Daamen, A.T.F. Helmink, W de Groot, W.C. Knol, H. Kramer, P Kuikman, 2005: National System of Greenhouse Gas Reporting for Forest and Nature Areas under UNFCCC in the Netherlands - version 1.0 for 1990–2002. Alterra, Wageningen. Alterra rapport 1035-I.
- Van den Wyngaert, I.J.J., Kramer, H., Kuikman, P.,
- Nabuurs, G.J. (2009) Greenhouse gas reporting of the LULUCF sector, revisions and updates related to the Dutch NIR 2009. Alterra report1035.7, Alterra, Wageningen.

A6.4 Documentation of Quality Assurance and Quality Control for national greenhouse gas inventory compilation and reporting

- DHV, 2002: Quality Assurance and Quality Control for the Dutch National Inventory Report; report on phase 1, January 2002, report no. ML-BB-20010367. DHV, Amersfoort.
- RIVM, 2011. Werkplan Emissie Registratie ronde 2011 – 2012. RIVM, Bilthoven, 2011.
- NL Agency, 2013, The Netherlands National System: QA/QC programme 2013/2014 Version 9.0

A6.5 Documentation of Changes to the National Registry

The changes introduced in versions 5 and 6 of the CSEUR primarily concerned EU ETS functionality and accounting. More detailed descriptions of the changes can be found in Annex B (confidential information, separately submitted to the UNFCCC). In summary, these changes include:

- Enabling ETS phase 3 allocation
- Enabling ETS end of Phase 2 banking and clearing processes
- Disabling of ETS phase 2 functionality
- Functionality for operators to surrender allowances valid for the third trading period
- Functionality to allow account holders to distinguish international credits that are eligible in the EU ETS from those not eligible and to limit the holding of non-eligible units to Kyoto Protocol accounts only.
- Blocking of transfer of ineligible units from KP accounts to EU ETS accounts
- Multiple bug fixes
- Improvements in the user interface

A6.6 Registry Information

Report R1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	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

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							7451	10900	NO	269665	NO	NO
Sub-total		NO	NO				7451	10900	NO	269665	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	24821878	10132291	NO	10185924	NO	NO

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												
CH	17766	3229078	NO	3470780	NO	NO	NO	10501403	NO	4235204	NO	NO
JP	NO	8455	NO	2248103	NO	NO	NO	NO	NO	625120	NO	NO
AU	NO	NO	NO	NO	NO	NO	NO	NO	NO	500	NO	NO
GB	25807	5705909	NO	1703706	NO	NO	NO	4960077	NO	199659	NO	NO
FR	NO	449692	NO	59500	NO	NO	NO	300000	NO	NO	NO	NO
DE	NO	6283	NO	NO	NO	NO	NO	NO	NO	2199	NO	NO
NO	NO	NO	NO	260356	NO	NO	NO	NO	NO	NO	NO	NO
LU	NO	NO	NO	51489	NO	NO	NO	120388	NO	247735	NO	NO
IT	NO	NO	NO	508946	NO	NO	NO	NO	NO	875826	NO	NO
PL	62177	430270	NO	NO	NO	NO	NO	276425	NO	NO	NO	NO
ES	NO	NO	NO	NO	NO	NO	NO	1201831	NO	10696	NO	NO
CDM	NO	NO	NO	19431193	NO	NO	NO	NO	NO	NO	NO	NO
EU	NO	12618101	NO	21533881	NO	NO	154706988	31928720	NO	29479042	NO	NO
BE	NO	3711	NO	NO	NO	NO	NO	NO	NO	75232	NO	NO
IE	NO	NO	NO	NO	NO	NO	NO	13359	NO	NO	NO	NO
NZ	NO	92910	NO	NO	NO	NO	NO	1100000	NO	NO	NO	NO
BG	NO	21506	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HU	NO	159850	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FI	NO	NO	NO	NO	NO	NO	NO	868067	NO	NO	NO	NO
UA	NO	3212590	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LT	NO	42101	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SE	NO	NO	NO	NO	NO	NO	NO	122831	NO	NO	NO	NO
RU	NO	9378882	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	105750	35359338	NO	49267954	NO	NO	154706988	51393101	NO	35751213	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	105750	35359338	NO	49267954	NO	NO	154714439	51404001	NO	36020878	NO	NO

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

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	363216637	8569516	NO	31382231	NO	NO
Entity holding accounts	25807	15830048	NO	9825706	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	11430	10900	NO	390357	NO	NO
Retirement account	584952218	11027404	NO	17573419	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	948206092	35437868	NO	59171713	NO	NO

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)	105750	35359338	NO	49267954	NO	NO	154714439	51404001	NO	36020878	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	716626549	147654724	4000000	368655615	NO	NO	769694028	112227756	4000000	309874259	NO	NO
Total	1717888690	147654724	4000000	368655615	NO	NO	769694028	112227756	4000000	309874259	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	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	83512630	NO	NO	NO	NO	NO
Year 3 (2010)	204469645	NO	NO	NO	NO	NO
Year 4 (2011)	84411123	NO	NO	NO	NO	NO
Year 5 (2012)	187736942	895113	NO	7387495	NO	NO
Year 6 (2013)	24821878	10132291	NO	10185924	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	584952218	11027404	NO	17573419	NO	NO

Add transaction Delete transaction No corrective transaction

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

Add transaction Delete transaction No corrective 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

Add transaction Delete transaction No corrective transaction

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

	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Annex 7
Tables 6.1 and 6.2 of the IPCC Good Practice Guidance

As described in section 1.7, a Tier 1 uncertainty assessment was made to estimate the uncertainty in total national greenhouse gas emissions and in their trend. Tier 1 here means that non-Gaussian uncertainty distributions and correlations between sources have been neglected. The uncertainty estimates for activity data and 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%'.

As of 2012, all data on uncertainty for each source is included in the PRTR database. When new data becomes available from the taskforces, this will be included in the annual key source assessment for the NIR. At the start of the NIR compilation, the taskforces are requested to submit changed uncertainty information.

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 in the order of 50 per cent). The reason for making these estimates, however, 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 prioritize 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 concerning the sources. Another part, however, can be attributed to elements of the inventory of which the uncertainty could be reduced over 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.

	Uncertainty in emission level	Uncertainty in emission trend
CO_2	± 2%	± 2%-points of 4% increase
CH_4	± 16%	± 5%-points of 42% decrease
N_2O	± 43%	± 8%-points of 55% decrease
F-gases	± 42%	± 13%-points of 71% decrease

Table A7.2 Tier 1 level and trend uncertainty assessment 1990–2012 (for F-gases with base year 1995) with the categories of the IPCC potential key source list (without adjustment for correlation sources).

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last ye	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1A	Emissions from stationary combustion: non-CO_2	CH_4	573	1477	3%	50%	50%	0,4%	0,4%	0,7%	0,2%	0,0%	0,2%
1A	Emissions from stationary combustion: non-CO_2	N_2O	225	351	3%	50%	50%	0,1%	0,1%	0,2%	0,0%	0,0%	0,0%
1A1a	Stationary combustion : Public Electricity and Heat Production: solids	CO_2	25776	25909	1%	3%	3%	0,4%	1,1%	11,7%	0,0%	0,2%	0,2%
1A1a	Stationary combustion: Public Electricity and Heat Production: liquids	CO_2	207	1040	1%	20%	20%	0,1%	0,4%	0,5%	0,1%	0,0%	0,1%
1A1a	Stationary combustion : Public Electricity and Heat Production: waste incineration	CO_2	601	2595	2%	5%	5%	0,1%	0,9%	1,2%	0,0%	0,0%	0,1%
1A1a	Stationary combustion : Public Electricity and Heat Production: gases	CO_2	13348	18566	1%	0%	1%	0,1%	2,9%	8,4%	0,0%	0,1%	0,1%
1A1b	Stationary combustion : Petroleum Refining: liquids	CO_2	9999	7150	5%	25%	25%	0,9%	-0,9%	3,2%	-0,2%	0,2%	0,3%
1A1b	Stationary combustion : Petroleum Refining: gases	CO_2	1042	3339	1%	0%	1%	0,0%	1,1%	1,5%	0,0%	0,0%	0,0%
1A1c	Stationary combustion : Manuf. of Solid Fuels and Other En. Ind.: gases	CO_2	1526	2068	20%	5%	21%	0,2%	0,3%	0,9%	0,0%	0,3%	0,3%
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%
1A2	Stationary combustion : Manufacturing Industries and Construction, liquids	CO_2	8956	8583	1%	25%	25%	1,1%	0,2%	3,9%	0,0%	0,1%	0,1%
1A2	Stationary combustion : Manufacturing Industries and Construction, solids	CO_2	5033	4018	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	19020	13210	2%	0%	2%	0,1%	-1,9%	6,0%	0,0%	0,2%	0,2%
1A3	Mobile combustion: road vehicles	N_2O	101	277	50%	50%	70%	0,1%	0,1%	0,1%	0,0%	0,1%	0,1%
1A3	Mobile combustion: water-borne navigation	CO_2	405	699	20%	0%	20%	0,1%	0,1%	0,3%	0,0%	0,1%	0,1%
1A3	Mobile combustion: road vehicles	CH_4	158	46	50%	50%	70%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: aircraft	CO_2	28	21	30%	4%	30%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
1A3	Mobile combustion: other (railways)	CO_2	91	85	5%	0%	5%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
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: other (non-road)	CH_4	1	1	36%	36%	50%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
1A3b	Mobile combustion: road vehicles: diesel oil	CO_2	11821	19334	2%	2%	3%	0,3%	3,9%	8,7%	0,1%	0,2%	0,3%
1A3b	Mobile combustion: road vehicles: gasoline	CO_2	10908	12641	2%	2%	3%	0,2%	1,2%	5,7%	0,0%	0,2%	0,2%
1A3b	Mobile combustion: road vehicles: LPG	CO_2	2740	838	5%	2%	5%	0,0%	-0,8%	0,4%	0,0%	0,0%	0,0%
1A4	Stationary combustion : Other Sectors, liquids excl. From 1A4c	CO_2	1356	512	20%	2%	20%	0,1%	-0,3%	0,2%	0,0%	0,1%	0,1%
1A4	Stationary combustion : Other Sectors, solids	CO_2	189	23	50%	10%	51%	0,0%	-0,1%	0,0%	0,0%	0,0%	0,0%
1A4a	Stationary combustion : Other Sectors: Commercial/Institutional, gases	CO_2	7632	10823	10%	0%	10%	0,5%	1,7%	4,9%	0,0%	0,7%	0,7%
1A4b	Stationary combustion : Other Sectors, Residential, gases	CO_2	18696	17659	5%	0%	5%	0,4%	0,3%	8,0%	0,0%	0,6%	0,6%
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, gases	CO_2	7330	7509	10%	0%	10%	0,4%	0,4%	3,4%	0,0%	0,5%	0,5%

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last ye	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1A4c	Stationary combustion : Other Sectors, Agriculture/Forestry/Fisheries, liquids	CO_2	2587	1692	15%	2%	15%	0,1%	-0,3%	0,8%	0,0%	0,2%	0,2%
1A5	Military use of fuels (1A5 Other)	CO_2	566	341	20%	2%	20%	0,0%	-0,1%	0,2%	0,0%	0,0%	0,0%
1B1b	CO_2 from coke production	CO_2	403	284	2%	15%	15%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
1B2	Fugitive emissions from oil and gas operations: gas distribution	CH_4	255	264	2%	50%	50%	0,1%	0,0%	0,1%	0,0%	0,0%	0,0%
1B2	Fugitive emissions from oil and gas operations: other	CH_4	169	179	20%	50%	54%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
1B2	Fugitive emissions venting/flaring	CH_4	1252	312	2%	25%	25%	0,0%	-0,4%	0,1%	-0,1%	0,0%	0,1%
1B2	Fugitive emissions venting/flaring: CO_2	CO_2	775	62	50%	2%	50%	0,0%	-0,3%	0,0%	0,0%	0,0%	0,0%
2A1	Cement production	CO_2	416	308	5%	10%	11%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
2A3	Limestone and dolomite use	CO_2	481	559	25%	5%	25%	0,1%	0,1%	0,3%	0,0%	0,1%	0,1%
2A7	Other minerals	CO_2	275	322	50%	5%	50%	0,1%	0,0%	0,1%	0,0%	0,1%	0,1%
2B1	Ammonia production	CO_2	3096	2578	2%	10%	10%	0,1%	-0,1%	1,2%	0,0%	0,0%	0,0%
2B2	Nitric acid production	N_2O	6330	264	5%	6%	8%	0,0%	-2,5%	0,1%	-0,1%	0,0%	0,2%
2B5	Other chemical product manufacture	CO_2	649	631	50%	50%	71%	0,2%	0,0%	0,3%	0,0%	0,2%	0,2%
2B5	Caprolactam production	N_2O	766	856	20%	23%	30%	0,1%	0,1%	0,4%	0,0%	0,1%	0,1%
2C1	Iron and steel production (carbon inputs)	CO_2	2267	1240	3%	5%	6%	0,0%	-0,4%	0,6%	0,0%	0,0%	0,0%
2C3	CO_2 from aluminium production	CO_2	395	164	2%	5%	5%	0,0%	-0,1%	0,1%	0,0%	0,0%	0,0%
2C3	PFC from aluminium production	PFC	1901	38	2%	20%	20%	0,0%	-0,8%	0,0%	-0,2%	0,0%	0,2%
2E	HFC-23 emissions from HCFC-22 manufacture	HFC	5759	125	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	55	10%	20%	22%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
2F	Emissions from substitutes for ozone depleting substances (ODS substitutes): HFC	HFC	248	1874	20%	50%	54%	0,5%	0,7%	0,8%	0,4%	0,2%	0,4%
2F	SF_6 emissions from SF_6 use	SF_6	287	196	30%	15%	34%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
2F	PFC emissions from PFC use	PFC	37	113	5%	25%	25%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
2G	Other industrial: CO_2	CO_2	304	300	5%	50%	50%	0,1%	0,0%	0,1%	0,0%	0,0%	0,0%
2G	Other industrial: CH_4	CH_4	297	287	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	120	25%	10%	27%	0,0%	-0,1%	0,1%	0,0%	0,0%	0,0%
3, 6D	OTHER N_2O	N_2O	269	126	0%	17%	17%	0,0%	-0,1%	0,1%	0,0%	0,0%	0,0%
4A	CH_4 emissions from enteric fermentation in domestic livestock: other	CH_4	432	380	5%	30%	30%	0,1%	0,0%	0,2%	0,0%	0,0%	0,0%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature dairy cattle	CH_4	4351	3996	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: young cattle	CH_4	2264	1642	5%	20%	21%	0,2%	-0,2%	0,7%	0,0%	0,1%	0,1%
4A1	CH_4 emissions from enteric fermentation in domestic livestock: mature non-dairy cattle	CH_4	163	151	5%	20%	21%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
4A8	CH_4 emissions from enteric fermentation in domestic livestock: swine	CH_4	438	385	5%	50%	50%	0,1%	0,0%	0,2%	0,0%	0,0%	0,0%
4B	Emissions from manure management	N_2O	1183	1007	10%	100%	100%	0,5%	0,0%	0,5%	0,0%	0,1%	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%
4B1	Emissions from manure management : cattle	CH_4	1593	1803	10%	100%	100%	0,9%	0,2%	0,8%	0,2%	0,1%	0,2%

IPCC	Category	Gas	CO_2-eq base year abs	CO_2-eq last ye	AD unc	EF unc	Uncertainty estimate	Combined Uncertainty as % of total national emissions	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
4B8	Emissions from manure management : swine	CH_4	1154	757	10%	100%	100%	0,4%	-0,1%	0,3%	-0,1%	0,0%	0,1%
4B9	Emissions from manure management : poultry	CH_4	275	40	10%	100%	100%	0,0%	-0,1%	0,0%	-0,1%	0,0%	0,1%
4D1	Direct N_2O emissions from agricultural soils	N_2O	4137	3233	10%	60%	61%	1,0%	-0,2%	1,5%	-0,1%	0,2%	0,3%
4D2	Animal production on agricultural soils	N_2O	3150	1045	10%	100%	100%	0,5%	-0,8%	0,5%	-0,8%	0,1%	0,8%
4D3	Indirect N_2O emissions from nitrogen used in agriculture	N_2O	3358	1432	50%	200%	206%	1,5%	-0,7%	0,6%	-1,5%	0,5%	1,6%
5A1	5A1. Forest Land remaining Forest Land	CO_2	2407	2881	25%	62%	67%	1,0%	0,3%	1,3%	0,2%	0,5%	0,5%
5A2	5A2. Land converted to Forest Land	CO_2	54	581	25%	58%	63%	0,2%	0,2%	0,3%	0,1%	0,1%	0,2%
5B2	5B2. Land converted to Cropland	CO_2	158	1251	25%	50%	56%	0,3%	0,5%	0,6%	0,3%	0,2%	0,3%
5C1	5C1. Grassland remaining Grassland	CO_2	4249	4249	25%	50%	56%	1,2%	0,2%	1,9%	0,1%	0,7%	0,7%
5C2	5C2. Land converted to Grassland	CO_2	198	40	25%	50%	56%	0,0%	-0,1%	0,0%	0,0%	0,0%	0,0%
5D2	5D2. Land converted to Wetlands	CO_2	74	113	25%	50%	56%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
5E2	5E2. Land converted to Settlements	CO_2	459	1126	25%	50%	56%	0,3%	0,3%	0,5%	0,2%	0,2%	0,2%
5F2	5F2. Land converted to Other Land	CO_2	25	128	25%	50%	56%	0,0%	0,0%	0,1%	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%
6A1	CH_4 emissions from solid waste disposal sites	CH_4	12011	2973	1%	20%	20%	0,3%	-3,6%	1,3%	-0,7%	0,0%	0,7%
6B	Emissions from wastewater handling	N_2O	482	457	20%	50%	54%	0,1%	0,0%	0,2%	0,0%	0,1%	0,1%
6B	Emissions from wastewater handling	CH_4	290	199	20%	25%	32%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
6D	OTHER CH_4	CH_4	2	24	0%	17%	17%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	TOTAL	GHG	220999	202067				3,3%					2,6%

Table A7.3 Emissions (Gg) and uncertainty estimates for the subcategories of Sector 5 LULUCF, as used in the Tier 1 uncertainty analysis.

IPCC	Category	Gas	CO_2-eq base year	CO_2-eq latest year	AD unc	EF unc	Uncertainty estimate
5A1	5A1. Forest Land remaining Forest Land	CO_2	-2407	-2881	25%	62%	67%
5A2	5A2. Land converted to Forest Land	CO_2	54	-581	25%	58%	63%
5B2	5B2. Land converted to Cropland	CO_2	158	1251	25%	50%	56%
5C1	5C1. Grassland remaining Grassland	CO_2	4249	4249	25%	50%	56%
5C2	5C2. Land converted to Grassland	CO_2	198	-40	25%	50%	56%
5D2	5D2. Land converted to Wetlands	CO_2	74	113	25%	50%	56%
5E2	5E2. Land converted to Settlements	CO_2	459	1126	25%	50%	56%
5F2	5F2. Land converted to Other Land	CO_2	25	128	25%	50%	56%
5G	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 Bruggen et al., 2014

Table A8.1 Animal numbers.

	1990	1995	2000	2005	2010	2011	2012
Cattle for breeding							
Female young stock under 1 yr	752,658	696,063	562,555	499,937	545,419	536,887	541,759
Male young stock under 1 yr	53,229	44,163	37,431	33,778	28,856	30,662	33,265
Female young stock, 1-2 yrs	734,078	682,888	594,079	515,972	563,966	531,881	521,835
Male young stock, 1-2 yrs	34,635	33,118	26,324	18,149	13,808	11,574	11,139
Female young stock, 2 yrs and over	145,648	124,970	104,627	74,180	86,913	89,841	79,632
Cows in milk and in calf	1,877,684	1,707,875	1,504,076	1,433,202	1,478,635	1,469,720	1,483,991
Bulls for service 2 yrs and over	8,762	8,674	10,403	12,382	7,756	7,599	6,592
Cattle for fattening							
Meat calves, for rosé veal production	28,876	85,803	145,828	204,227	293,901	303,553	329,556
Meat calves, for white veal production	572,709	583,516	636,907	624,513	633,798	602,623	578,811
Female young stock < 1 yr	53,021	57,218	41,165	43,105	39,231	38,525	37.950
Male young stock (incl. young bullocks) < 1 yr	255,375	188,193	83,308	66,454	48,790	46,085	47,696
Female young stock, 1-2 yrs	56,934	66,653	44,642	43,204	43,080	40,151	40,299
Male young stock (incl. young bullocks), 1-2 yrs	178,257	169,546	88,571	52,632	46,391	41,690	40,686
Female young stock, 2 yrs and over	42,555	48,365	16,883	15,105	19,848	20,101	18,934
Male young stock (incl. young bullocks) ≥ 2 yrs	12,073	10,969	9,277	9,148	9,463	9,480	9,135
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	119,529	146,181	162,779	150,790	115,339	104,973	98,512
Pigs							
Piglets	5,190,749	5,596,117	5,102,434	4,562,991	5,123,807	5,297,469	5,179,813
Fattening pigs	7,025,102	7,123,923	6,504,540	5,504,295	5,904,172	5,905,007	5,873,911
Gilts not yet in pig	385,502	357,520	339,570	274,085	232,261	238,473	233,181
Sows	1,272,215	1,287,224	1,129,174	946,466	983,552	978,487	937,799
Young boars	13,893	11,382	6,917	6,486	3,946	2,864	2,698
Boars for service	27,587	21,297	35,182	17,235	7,234	6,838	6,247
Poultry							
Broilers	41,172,110	43,827,286	50,936,625	44,496,116	44,747,893	43,911,647	43,846,343
Broiler parents under 18 weeks	2,882,250	3,065,170	3,644,120	2,191,650	2,895,975	3,200,749	3,052,853
Broiler parents 18 weeks and over	4,389,830	4,506,840	5,397,520	3,596,700	4,447,519	4,136,991	4,322,291
Laying hens < 18 weeks, liq. manure	7,339,708	4,889,555	2,865,850	1,035,581	663,430	42,429	41,687
Laying hens < 18 weeks, solid manure	3,781,062	4,000,545	8,597,550	9,751,719	12,345,009	10,564,849	10,380,111
Laying hens ≥ 18 weeks, liq. manure	19,919,466	12,294,122	7,166,060	2,292,654	253,035	210,372	201,780
Laying hens ≥ 18 weeks, solid manure	13,279,644	16,977,598	25,406,940	29,549,756	35,894,850	34,851,574	33,428,204
Ducks for slaughter	1,085,510	868,965	958,466	1,030,867	1,086,990	1,015,801	915,770
Turkeys for slaughter	1,003,350	1,175,527	1,543,830	1,245,420	1,036,277	990,348	826,766
Turkey parents under 7 months	28,550	13,930					
Turkey parents 7 months and over	20,460	17,290					
Fur bearing animals							
Rabbits (mother animals)	105,246	64,234	52,252	48,034	38,512	39,353	42,981
Minks (mother animals)	543,969	456,104	584,806	691,862	962,409	976,551	1,031,233
Foxes (mother animals)	10,029	7,102	3,816	5,240			

	1990	1995	2000	2005	2010	2011	2012
Other grazing animals							
Sheep (ewes)	789,691	770,730	680,127	646,993	558,184	546,293	544,373
Sheep , other	912,715	903,445	625,059	713,516	571,316	542,192	498,385
Goats (mothers)	37,472	43,231	98,077	172,159	221,977	220,140	243,554
Goats, other	23,313	32,832	80,494	119,732	130,851	160,211	153,171
Horses	369,592	400,004	417,499	432,551	441,481	436,118	431,363
Mules and asses	NO	NO	NO	NO	1,050	1,108	1,048

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

	1990	1995	2000	2005	2010	2011	2012
Cattle for breeding							
Female young stock under 1 yr	73.6	75.6	75.0	75.8	74.0	74.0	74.8
Male young stock under 1 yr	86.1	86.7	85.1	89.1	85.2	85.7	86.0
Female young stock, 1-2 yrs	139.5	142.5	139.5	144.6	144.9	144.2	146.1
Male young stock, 1-2 yrs	151.1	162.2	155.9	154.1	151.0	150.6	154.0
Female young stock, 2 yrs and over	139.4	142.5	139.5	144.6	144.9	144.3	146.1
Cows in milk and in calf	279.6	292.1	306.7	321.2	333.2	333.8	334.9
Bulls for service 2 yrs and over	151.1	162.2	155.9	154.1	151.0	150.6	154.0
Cattle for fattening							
Meat calves, for rosé veal production	77.9	77.9	95.5	82.8	77.1	77.1	77.1
Meat calves, for white veal production	30.9	32.7	35.6	34.8	41.9	42.1	41.7
Female young stock < 1 yr	73.6	75.5	74.9	75.8	73.8	73.8	74.5
Male young stock (incl. young bullocks) < 1 yr	82.3	87.6	88.8	86.7	84.7	85.1	84.7
Female young stock, 1-2 yrs	139.5	142.4	139.3	144.4	144.9	144.2	146.0
Male young stock (incl. young bullocks), 1-2 yrs	167.3	164.1	154.1	157.5	154.7	155.3	154.8
Female young stock, 2 yrs and over	139.5	142.5	139.4	144.5	144.9	144.2	146.0
Male young stock (incl. young bullocks) ≥ 2 yrs	167.3	164.1	154.1	157.5	154.7	155.3	154.8
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	165.0	167.1	169.1	180.0	183.2	185.5	185.5

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

	1990	1995	2000	2005	2010	2011	2012
Cattle for breeding							
Female young stock under 1 yr	29.0	29.8	29.5	29.8	29.1	29.1	29.4
Male young stock under 1 yr	33.9	34.1	33.5	35.0	33.5	33.7	33.9
Female young stock, 1-2 yrs	54.9	56.1	54.9	56.9	57.0	56.8	57.5
Male young stock, 1-2 yrs	59.5	63.8	61.3	60.7	59.4	59.3	60.6
Female young stock, 2 yrs and over	54.9	56.1	54.9	56.9	57.0	56.8	57.5
Cows in milk and in calf	110.3	114.3	119.9	124.9	128.1	128.3	128.2
Bulls for service 2 yrs and over	59.5	63.8	61.3	60.7	59.4	59.3	60.6
Cattle for fattening							
Meat calves, for rosé veal production	30.6	30.6	37.6	32.6	30.3	30.3	30.3
Meat calves, for white veal production	8.1	8.6	9.3	9.1	11.0	11.0	11.0
Female young stock < 1 yr	29.0	29.7	29.5	29.8	29.0	29.0	29.3
Male young stock (incl. young bullocks) < 1 yr	32.4	34.5	34.9	34.1	33.3	33.5	33.3
Female young stock, 1-2 yrs	54.9	56.0	54.8	56.8	57.0	56.7	57.5
Male young stock (incl. young bullocks), 1-2 yrs	65.8	64.6	60.7	62.0	60.9	61.1	60.9
Female young stock, 2 yrs and over	54.9	56.1	54.9	56.9	57.0	56.8	57.5
Male young stock (incl. young bullocks) ≥ 2 yrs	65.8	64.6	60.7	62.0	60.9	61.1	60.9
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	64.9	65.8	66.6	70.8	72.1	73.0	73.0

Table A8.4 Volatile Solids (= Organic Matter) per 1,000 kg manure.

		1990	1995	2000	2005	2010	2011	2012
Cattle for breeding								
Female young stock under 1 yr	liquid manure	60	66	64	64	64	64	64
Male young stock under 1 yr	liquid manure	60	66	64	64	64	64	64
Female young stock, 1-2 yrs	liquid manure	60	66	64	64	64	64	64
Male young stock, 1-2 yrs	liquid manure	60	66	64	64	64	64	64
Female young stock, 2 yrs and over	liquid manure	60	66	64	64	64	64	64
Cows in milk and in calf	liquid manure	60	66	64	64	64	64	64
Bulls for service 2 yrs and over	liquid manure	60	66	64	64	64	64	64
Cattle for fattening								
Meat calves, for rosé veal production	liquid manure	22.5	22.5	22.5	22.5	22.5	71	71
Meat calves, for white veal production	liquid manure	15	15	15	15	15	17	17
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	152	152
Cattle for breeding								
Female young stock under 1 yr	Pasture	60	66	64	64	64	64	64
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	60	66	64	64	64	64	64
Male young stock, 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	60	66	64	64	64	64	64
Cows in milk and in calf	Pasture	60	66	64	64	64	64	64
Bulls for service 2 yrs and over								
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	60	66	64	64	64	64	64
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	60	66	64	64	64	64	64
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	60	66	64	64	64	64	64
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	60	66	64	64	64	64	64
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	43	43
Gilts not yet in pig	liquid manure	35	35	35	35	35	25	25
Sows	liquid manure	35	35	35	35	35	25	25
Young boars 1	liquid manure	35	35	35	35	35	25	25
Boars for service	liquid manure	35	35	35	35	35	25	25
Poultry								
Broilers	solid manure	508	508	508	508	508	419	419
Broiler parents under 18 weeks	solid manure	423	423	423	423	423	419	419
Broiler parents 18 weeks and over	solid manure	423	423	423	423	423	419	419

		1990	1995	2000	2005	2010	2011	2012
Laying hens < 18 weeks, liq. manure	liquid manure	90	93	93	93	93	93	93
Laying hens < 18 weeks, solid manure	solid manure	350	350	350	350	350	359	359
Laying hens ≥ 18 weeks, liq. manure	liquid manure	90	93	93	93	93	93	93
Laying hens ≥ 18 weeks, solid manure	solid manure	350	350	350	350	350	359	359
Ducks for slaughter	solid manure	209	209	209	209	209	237	237
Turkeys for slaughter	solid manure	464	464	464	464	464	427	427
Turkey parents under 7 months	solid manure	464	464	464	464	464	427	427
Turkey parents 7 months and over	solid manure	464	464	464	464	464	427	427
Fur bearing animals								
Rabbits (mother animals)	solid manure	367	367	367	367	367	332	332
Minks (mother animals)	solid manure	185	185	185	185	185	293	293
Foxes (mother animals)	solid manure	185	185	185	185	185	293	293
Ruminants, not cattle								
Sheep (ewes)	solid manure	205	205	205	205	205	195	195
Goats (mothers)	solid manure	182	182	182	182	182	174	174
Horses	solid manure	250	250	250	250	250	160	160
Ponies	solid manure	250	250	250	250	250	160	160
Ruminants, not cattle								
Sheep (ewes)	Pasture	60	66	64	64	64	64	64
Goats (mothers)								
Horses	Pasture	60	66	64	64	64	64	64
Ponies	Pasture	60	66	64	64	64	64	64

Table A8.5 Methane conversion factor for pigs and poultry.

		1990	1995	2000	2005	2010	2011	2012
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
Broiler parents under 18 weeks	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Broiler 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
Turkey parents under 7 months	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Turkey parents 7 months and over	solid manure	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Fur bearing Animals								
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			
Meat calves, for rosé veal production	liquid manure	0.14	0.25
Meat calves, for white veal production	liquid manure	0.14	0.25
Female young stock < 1 yr	liquid manure	0.17	0.25
Male young stock (incl. young bullocks) < 1 yr	liquid manure	0.17	0.25
Female young stock, 1-2 yrs	liquid manure	0.17	0.25
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	0.17	0.25
Female young stock, 2 yrs and over	liquid manure	0.17	0.25
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	0.17	0.25
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	0.015	0.25
Cattle for breeding			
Female young stock under 1 yr	Pasture	0.01	0.25
Male young stock under 1 yr			
Female young stock, 1-2 yrs	Pasture	0.01	0.25
Male young stock, 1-2 yrs			
Female young stock, 2 yrs and over	Pasture	0.01	0.25
Cows in milk and in calf	Pasture	0.01	0.25
Bulls for service 2 yrs and over			
Cattle for fattening			
Meat calves, for rosé veal production			
Meat calves, for white veal production			
Female young stock < 1 yr	Pasture	0.01	0.25
Male young stock (incl. young bullocks) < 1 yr			
Female young stock, 1-2 yrs	Pasture	0.01	0.25
Male young stock (incl. young bullocks), 1-2 yrs			
Female young stock, 2 yrs and over	Pasture	0.01	0.25
Male young stock (incl. young bullocks) ≥ 2 yrs			
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	0.01	0.25
Pigs			
Piglets			
Fattening pigs	liquid manure		0.34
Gilts not yet in pig	liquid manure		0.34
Sows	liquid manure		0.34
Young boars	liquid manure		0.34
Boars for service	liquid manure		0.34
Poultry			
Broilers	solid manure		0.34
Broiler parents under 18 weeks	solid manure		0.34
Broiler parents 18 weeks and over	solid manure		0.34

		MCF	B0
Laying hens < 18 weeks, liq. manure	liquid manure		0.34
Laying hens < 18 weeks, solid manure	solid 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
Turkey parents under 7 months	solid manure		0.34
Turkey parents 7 months and over	solid manure		0.34
Fur bearing animals			
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	2010	2011	2012
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 rosé veal production	liquid manure	0.00053	0.00053	0.00053	0.00053	0.00053	0.00166	0.00166
Meat calves, for white veal production	liquid manure	0.00035	0.00035	0.00035	0.00035	0.00035	0.00040	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								
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Pigs								
Piglets								
Fattening pigs	liquid manure	0.00387	0.00492	0.00533	0.00533	0.00533	0.00382	0.00382
Gilts not yet in pig	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00222	0.00222
Sows	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00222	0.00222
Young boars	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00222	0.00222
Boars for service	liquid manure	0.00271	0.00287	0.00311	0.00311	0.00311	0.00222	0.00222
Poultry								
Broilers	solid manure	0.00174	0.00174	0.00174	0.00174	0.00174	0.00143	0.00143
Broiler parents under 18 weeks	solid manure	0.00145	0.00145	0.00145	0.00145	0.00145	0.00143	0.00143
Broiler parents 18 weeks and over	solid manure	0.00145	0.00145	0.00145	0.00145	0.00145	0.00143	0.00143

		1990	1995	2000	2005	2010	2011	2012
Laying hens < 18 weeks, liq. 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	0.00123	0.00123
Laying hens ≥ 18 weeks, liq. 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	0.00123	0.00123
Ducks for slaughter	solid manure	0.00071	0.00071	0.00071	0.00071	0.00071	0.00081	0.00081
Turkeys for slaughter	solid manure	0.00159	0.00159	0.00159	0.00159	0.00159	0.00146	0.00146
Turkey parents under 7 months	solid manure	0.00159	0.00159	0.00159	0.00159	0.00159	0.00146	0.00146
Turkey parents 7 months and over	solid manure	0.00159	0.00159	0.00159	0.00159	0.00159	0.00146	0.00146
Fur bearing animals								
Rabbits (mother animals)	solid manure	0.00125	0.00125	0.00125	0.00125	0.00125	0.00113	0.00113
Minks (mother animals)	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00100	0.00100
Foxes (mother animals)	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00100	0.00100
Ruminants, not cattle								
Sheep (ewes)	solid manure	0.00052	0.00052	0.00052	0.00052	0.00052	0.00049	0.00049
Goats (mothers)	solid manure	0.00046	0.00046	0.00046	0.00046	0.00046	0.00044	0.00044
Horses	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00040	0.00040
Ponies	solid manure	0.00063	0.00063	0.00063	0.00063	0.00063	0.00040	0.00040
Ruminants, not cattle								
Sheep (ewes)	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Goats (mothers)								
Horses	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Ponies	Pasture	0.00010	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011

Table A8.8 Manure production (kg/animal/year).

		1990	1995	2000	2005	2010	2011	2012
Cattle for breeding								
Female young stock under 1 yr	liquid manure	3,500	3,500	3,500	3,500	4,000	4,500	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	9,500	9,500
Male young stock, 1-2 yrs	liquid manure	11,500	11,500	11,500	11,500	12,000	12,500	12,500
Female young stock, 2 yrs and over	liquid manure	6,000	6,000	6,000	6,000	8,000	9,500	9,500
Cows in milk and in calf	liquid manure	16,000	16,000	18,000	20,500	23,500	23,500	23,500
Bulls for service 2 yrs and over	liquid manure	11,500	11,500	11,500	11,500	12,000	12,500	12,500
Cattle for fattening								
Meat calves, for rosé 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	4,500	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	9,500	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	9,500	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	500	500
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	5,500	5,500	5,500	5,500	4,000	3,000	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	3,000	3,000
Cows in milk and in calf	Pasture	7,000	7,000	7,000	5,500	2,500	2,500	2,500
Bulls for service 2 yrs and over								
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	1,500	1,500	1,500	1,500	1,000	500	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	3,000	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	3,000	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
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	1,100	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

		1990	1995	2000	2005	2010	2011	2012
Poultry								
Broilers	solid manure	10.0	11.0	11.0	10.9	10.9	10.9	10.9
Broiler parents under 18 weeks	solid manure	15.4	13.4	13.4	8.2	8.2	8.2	8.2
Broiler parents 18 weeks and over	solid manure	25.3	23.0	23.0	20.6	20.6	20.6	20.6
Laying hens < 18 weeks, liq. manure	liquid manure	25.4	25.4	25.4	22.5	22.5	22.5	22.5
Laying hens < 18 weeks, solid manure	solid manure	10.0	10.0	9.0	7.6	7.6	7.6	7.6
Laying hens ≥ 18 weeks, liq. manure	liquid manure	63.5	63.5	63.5	53.4	53.4	53.4	53.4
Laying hens ≥ 18 weeks, solid manure	solid manure	22.5	23.5	24.0	18.9	18.9	18.9	18.9
Ducks for slaughter	solid manure	86.3	70.0	70.0	70.0	70.0	70.0	70.0
Turkeys for slaughter	solid manure	37.9	45.0	45.0	45.0	45.0	45.0	45.0
Turkey parents under 7 months	solid manure	49.4	49.4					
Turkey parents 7 months and over	solid manure	78.6	78.6					
Fur bearing animals								
Rabbits (mother animals)	solid manure	377	377	377	377	377	377	377
Minks (mother animals), liq. manure	liquid manure					155	155	155
Minks (mother animals), solid manure	solid manure	104	104	104	104			
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)								
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	2010	2011	2012
Cattle for breeding								
Female young stock under 1 yr	liquid manure	26.5	29.8	29.0	23.0	28.6	28.9	28.7
Male young stock under 1 yr	liquid manure	39.6	40.8	37.0	37.0	33.2	32.4	31.2
Female young stock, 1-2 yrs	liquid manure	43.1	48.4	46.4	42.7	44.4	49.2	48.6
Male young stock, 1-2 yrs	liquid manure	90.6	101.9	96.8	88.5	83.4	82.7	80.9
Female young stock, 2 yrs and over	liquid manure	43.0	48.4	46.3	42.7	44.5	49.3	48.7
Cows in milk and in calf	liquid manure	95.9	104.0	97.2	103.2	107.9	108.1	104.2
Bulls for service 2 yrs and over	liquid manure	90.6	101.9	96.8	88.5	83.4	82.7	80.9
Cattle for fattening								
Meat calves, for rosé veal production	liquid manure	28.9	28.9	34.1	27.2	28.2	27.3	25.2
Meat calves, for white veal production	liquid manure	10.6	11.6	11.9	10.6	12.4	14.0	14.4
Female young stock < 1 yr	liquid manure	26.2	29.4	28.6	22.8	28.2	28.6	28.2
Male young stock (incl. young bullocks) < 1 yr	liquid manure	28.9	29.5	26.6	27.0	26.8	23.9	21.9
Female young stock, 1-2 yrs	liquid manure	43.0	48.2	46.0	42.4	43.6	48.6	48.2
Male young stock (incl. young bullocks), 1-2 yrs	liquid manure	72.6	64.7	56.1	56.8	53.8	51.1	47.8
Female young stock, 2 yrs and over	liquid manure	43.1	48.4	46.1	42.5	43.6	48.6	48.2
Male young stock (incl. young bullocks) ≥ 2 yrs	liquid manure	72.6	64.7	56.1	56.8	53.8	51.1	47.8
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	solid manure	42.3	48.0	42.4	39.1	37.6	37.6	35.7
Cattle for breeding								
Female young stock under 1 yr	Pasture	15.3	14.4	13.0	17.0	7.4	5.9	5.3
Male young stock under 1 yr								
Female young stock, 1-2 yrs	Pasture	51.2	47.5	42.9	33.1	28.8	22.0	21.0
Male young stock, 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	51.2	47.5	42.9	33.1	28.7	22.0	21.0
Cows in milk and in calf	Pasture	52.6	52.5	39.3	30.8	22.3	19.5	18.1
Bulls for service 2 yrs and over								
Cattle for fattening								
Meat calves, for rosé veal production								
Meat calves, for white veal production								
Female young stock < 1 yr	Pasture	15.2	14.3	12.8	16.9	7.2	5.7	5.0
Male young stock (incl. young bullocks) < 1 yr								
Female young stock, 1-2 yrs	Pasture	51.2	47.5	42.9	33.1	29.2	22.1	21.0
Male young stock (incl. young bullocks), 1-2 yrs								
Female young stock, 2 yrs and over	Pasture	51.2	47.5	42.9	33.1	29.2	22.1	21.0
Male young stock (incl. young bullocks) ≥ 2 yrs								
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	Pasture	68.4	63.1	52.7	45.8	45.7	43.0	42.2
Pigs								
Piglets								
Fattening pigs	liquid manure	14.3	14.5	12.3	12.3	12.2	12.5	12.5
Gilts not yet in pig	liquid manure	14.0	14.4	14.2	14.3	15.4	15.9	15.3
Sows	liquid manure	33.8	31.4	30.9	30.7	30.2	30.1	29.6
Young boars	liquid manure	14.0	14.4	14.2	14.3	15.4	15.9	15.3
Boars for service	liquid manure	25.0	24.6	22.9	23.7	23.3	23.4	23.7

		1990	1995	2000	2005	2010	2011	2012
Poultry								
Broilers	solid manure	0.61	0.63	0.51	0.55	0.50	0.52	0.48
Broiler parents under 18 weeks	solid manure	0.52	0.45	0.37	0.32	0.35	0.36	0.35
Broiler parents 18 weeks and over	solid manure	1.33	1.29	1.13	1.10	1.11	1.12	1.11
Laying hens < 18 weeks, liq. manure	liquid manure	0.38	0.36	0.31	0.32	0.34	0.35	0.35
Laying hens < 18 weeks, solid manure	solid manure	0.38	0.36	0.31	0.32	0.34	0.35	0.35
Laying hens ≥ 18 weeks, liq. manure	liquid manure	0.75	0.81	0.67	0.71	0.80	0.78	0.76
Laying hens ≥ 18 weeks, solid manure	solid manure	0.75	0.81	0.67	0.71	0.80	0.78	0.76
Ducks for slaughter	solid manure	1.12	1.09	0.99	0.89	0.79	0.79	0.76
Turkeys for slaughter	solid manure	1.98	1.97	1.85	1.81	1.91	1.85	1.72
Turkey parents under 7 months	solid manure	2.38	2.78					
Turkey parents 7 months and over	solid manure	3.17	3.04					
Fur bearing animals								
Rabbits (mother animals)	solid manure	8.7	8.1	7.6	8.2	7.7	7.8	8.4
Minks (mother animals)	solid manure	4.1	4.1	3.5	2.7	2.2	2.2	2.3
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	1.3	1.2	1.2
Goats (mothers)	solid manure	19.9	21.5	19.4	17.7	17.5	17.6	17.1
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	12.8	11.8	11.5
Goats (mothers)								
Horses	Pasture	30.2	30.2	30.2	30.2	28.2	28.2	28.2
Ponies	Pasture	19.9	19.9	19.9	19.9	18.9	18.9	18.9

Table A8.10 Fraction liquid manure (fraction solid manure = 1 – fraction liquid manure)

	1990	1995	2000	2005	2010	2011	2012
Cattle for breeding							
Female young stock under 1 yr	0.56	0.56	0.56	0.56	0.56	0.62	0.62
Male young stock under 1 yr	0.56	0.56	0.56	0.56	0.56	0.62	0.62
Female young stock, 1-2 yrs	0.85	0.88	0.91	0.94	0.95	0.96	0.96
Male young stock, 1-2 yrs	0.85	0.88	0.91	0.94	0.95	0.96	0.96
Female young stock, 2 yrs and over	0.85	0.88	0.91	0.94	0.95	0.96	0.96
Cows in milk and in calf, winter	0.89	0.92	0.96	0.97	0.98	0.97	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	0.82	0.82
Cattle for fattening							
Meat calves, for rosé veal production	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Meat calves, for white veal production	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female young stock < 1 yr	0.66	0.66	0.66	0.66	0.66	0.61	0.61
Male young stock (incl. young bullocks) < 1 yr	0.67	0.67	0.67	0.67	0.67	0.63	0.63
Female young stock, 1-2 yrs	0.66	0.66	0.66	0.66	0.66	0.61	0.61
Male young stock (incl. young bullocks), 1-2 yrs	0.67	0.67	0.67	0.67	0.67	0.63	0.63
Female young stock, 2 yrs and over	0.66	0.66	0.66	0.66	0.66	0.61	0.61
Male young stock (incl. young bullocks) ≥ 2 yrs	0.65	0.65	0.65	0.65	0.65	0.55	0.55
Suckling cows (incl. fattening/grazing ≥ 2 yrs)	0.69	0.69	0.69	0.69	0.69	0.66	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	0.97	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	0.88	0.88
Poultry							
Broilers	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broiler parents under 18 weeks	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broiler 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	0.004	0.004
Laying hens ≥ 18 weeks	0.60	0.42	0.22	0.07	0.01	0.006	0.006
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
Turkey parents under 7 months	0.00	0.00					
Turkey parents 7 months and over	0.00	0.00					
Fur bearing animals							
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	2010	2011	2012
Winter wheat	13,510,369	12,559,909	12,050,981	11,603,963	13,499,853	11,315,342	13,638,805
Spring wheat	549,904	981,302	1,617,586	2,067,009	1,902,381	3,837,102	1,523,684
Winter barley	994,082	309,977	363,547	296,950	471,135	407,092	421,281
Spring barley	3,044,693	3,248,038	4,353,676	4,761,972	2,872,749	3,003,598	2,563,078
Rye	860,386	817,514	596,058	253,457	234,285	164,959	193,410
Oats	340,128	291,431	240,390	169,744	169,248	149,293	173,878
Triticale		257,947	664,635	408,259	267,869	182,753	192,460
Dried and green peas	1,090,832	69,149	75,204	192,508	49,319	15,744	14,133
Peas (green to harvest)	766,724	713,143	586,657	509,139	343,390	394,904	345,582
Marrowfats	79,350	36,732	38,849	39,585	45,673	27,964	39,078
Kidney beans	373,005	222,094	112,590	109,903	200,645	133,474	159,536
Broad and field beans	316,912	53,220	67,916	44,111	56,361	49,108	51,597
Grass seed	2,631,440	2,189,274	2,196,001	2,763,858	1,268,029	1,054,813	1,366,848
Rape seed	841,501	149,268	85,416	209,640	262,764	202,615	212,904
Caraway seed	34,158	121,059	13,806	9,034	11,087	12,937	9,572
Pop seed	26,356	141,119	58,806	28,286	70,837	50,829	37,011
Flax seed	553,468	440,738	437,930	473,339	189,613	215,619	207,650
Seed potatoes on sand or peat	548,553	536,058	709,599	352,313	336,534	385,463	461,002
Seed potatoes on clay	3,010,113	3,243,815	3,470,553	3,573,898	3,517,178	3,405,649	3,454,857
Potatoes on sand or peat	1,602,484	1,845,122	2,563,153	1,926,935	2,200,423	2,209,662	2,040,490
Potatoes on clay	6,086,924	6,170,599	6,180,900	4,656,037	5,103,070	5,051,063	4,704,726
Industrial potatoes	6,283,773	6,134,453	5,095,818	5,069,191	4,669,789	4,916,758	4,332,145
Sugar beets	12,499,462	11,608,057	11,099,810	9,131,265	7,058,416	7,332,911	7,272,396
Fodder beets	302,286	157,602	89,094	53,195	34,255	26,183	26,953
Lucerne	596,017	583,627	661,606	587,842	642,243	638,848	590,843
Green maize	20,181,089	21,921,725	20,532,074	23,508,819	23,076,537	22,963,655	23,181,135
Green manure	728,159	1,224,765	261,452	3,101,990	359,431	324,606	361,400
Grain maize		900,542	2,029,838	2,074,849	1,709,129	1,656,957	1,550,548
Corn cob mix		500,473	721,918	667,841	726,487	612,792	581,250
Chicory			475,596	433,848	468,640	319,574	291,296
Hemp			79,197	10,043	114,217	89,010	127,357
Onions	1,282,770	1,608,194	1,997,942	2,252,034	2,886,590	2,984,210	2,723,464
Other horticultural crops	808,437	598,220	1,088,320	1,186,888	1,063,448	792,473	826,959
Strawberry	186,688	176,313	174,568	230,089	311,100	321,133	355,311
Endive	23,392	27,629	25,198	27,971	21,136	23,850	22,967
Asparagus	266,313	232,356	208,408	233,366	269,453	292,248	289,310
Gherkin	25,738				49,189	47,768	46,713
Cabbage for preservation	157,620	178,353	152,753	139,794			
Cauliflower	236,792	242,970	216,038	239,408	236,926	226,723	224,861
Broccoli		53,379	84,602	131,115	196,558	207,990	180,267
Cabbage (spring and autumn)	100,151	113,850	101,629	107,505	275,274	277,463	261,697
Celeriac	136,263	141,421	128,519	112,772	131,064	164,954	155,873
Beetroot		35,349	29,015	27,619	40,509	49,594	46,785
Lettuce	95,475	104,217	108,978	130,353	191,408	193,874	195,509
Leeks	287,307	385,356	318,448	272,537	284,260	274,776	242,597
Scorzonera	139,536	148,006	113,796	86,697	85,167	84,387	88,103
Spinach	115,291	96,500	120,827	91,431	136,307	152,931	178,956
Brussels sprouts	480,319	438,811	483,409	309,508	294,997	291,704	270,740
Industrial French beans	369,501	467,764	362,736	425,410	275,278	228,021	239,036
Runner beans	22,493				4,440	5,184	4,237
Broad beans green	117,770	87,716	69,416	78,984	114,368	139,263	132,313
Carrot	302,983	327,442	298,512	255,140	240,223	284,484	245,846
Winter carrot (Danvers)	295,050	467,490	472,875	470,043	556,760	610,096	617,615
Chicory	591,896	388,881	419,858	342,321	301,631	327,208	335,667
Other outside horticultural crops	277,358	286,665	317,125	431,248	300,675	332,332	307,468

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

	N content (kg N/ha)	Crop residue (Frac)	N fixation (kg N/ha)
Winter wheat	28	0.1	
Spring wheat	28	0.1	
Winter barley	19	0.1	
Spring barley	19	0.1	
Rye	16	0.1	
Oats	19	0.1	
Triticale	24	0.1	
Dried and green peas	74	1.0	164
Peas (green to harvest)	194	1.0	164
Marrowfats	74	1.0	164
Kidney beans	74	1.0	164
Broad and field beans	16	1.0	325
Grass seed	28	1.0	
Rape seed	42	1.0	
Caraway seed	37	1.0	
Pop seed	20	1.0	
Flax seed	23	1.0	
Seed potatoes on sand or peat	26	1.0	
Seed potatoes on clay	26	1.0	
Potatoes on sand or peat	26	1.0	
Potatoes on clay	26	1.0	
Industrial potatoes	26	1.0	
Sugar beets	174	1.0	
Fodder beets	92	1.0	
Lucerne	23	1.0	422
Green maize	22	0.1	
Green manure	80	1.0	
Grain maize	70	1.0	
Corn cob mix	70	1.0	
Chicory	40	1.0	
Hemp	40	1.0	
Onions	4	1.0	
Other horticultural crops	40	1.0	
Strawberry	23	1.0	
Endive	78	1.0	
Asparagus	24	1.0	
Gherkin	78	1.0	
Cabbage for preservation	206	1.0	
Cauliflower	89	1.0	
Broccoli	89	1.0	
Cabbage (spring and autumn)	206	1.0	
Celeriac	78	1.0	
Beetroot	78	1.0	
Lettuce	25	1.0	
Leeks	62	1.0	
Scorzonera	78	1.0	
Spinach	62	1.0	
Brussels sprouts	206	1.0	
Industrial French beans	61	1.0	75
Runner beans	61	1.0	75
Broad beans green	13	1.0	185
Carrot	99	1.0	
Winter carrot (Danvers)	99	1.0	
Chicory	78	1.0	
Other outside horticultural crops	78	1.0	

Annex 9
Chemical compounds, global warming potentials, units and conversion factors

A9.1 Chemical compounds

CF_4	Perfluoromethane (tetrafluoromethane)
C_2F_6	Perfluoroethane (hexafluoroethane)
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HNO_3	Nitric Acid
NH_3	Ammonia
NO_x	Nitrogen oxide (NO and NO_2), expressed as NO_2
N_2O	Nitrous oxide
NMVOC	Non-Methane Volatile Organic Compounds
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride
SO_2	Sulphur dioxide
VOC	Volatile Organic Compounds (may include or exclude methane)

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 strato-spheric water vapour; the indirect effect due to the production of CO2 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 (notation key in CRF)
CO	Coke Oven (gas)
CS	Country-Specific (notation key in CRF)
Cap	capita (person)
CBS	Statistics Netherlands
CDM	Clean Development Mechanism (one of three mechanisms of the Kyoto Protocol)
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 a NIR)
CRT	Continuous Regeneration Trap
DM	Dry Matter
DOC	Degradable Organic Carbon
DOCF	Degradable Organic Carbon Fraction
EC-LNV	National Reference Centre for Agriculture
ECE	Economic Commission for Europe (UN)
ECN	Energy Research Centre of the Netherlands
EEA	European Environment Agency
EF	Emission Factor
EGR	Exhaust Gas Recirculation
EIT	Economies-In-Transition (countries from the former SU and Eastern Europe)
EL&I	Ministry of Economic Affairs, Agriculture and Innovation (formerly EZ and LNV)
EMEP	European programme for the Monitoring and Evaluation of long-range transmission of air Pollutants
EMS	Emission Monitor Shipping
EMSG	Emissions Registration Steering Group
ENINA	Task Group Energy, Industry and Waste Handling
EPA	US Environmental Protection Agency
ER-I	Emission Registration-Individual firms
ERT	Expert Review Team
ERU	Emission Reduction Unit
ET	Emissions Trading
ETC/ACC	European Topic Centre on Air and Climate Change
ETS	Emission Trading System
EU	European Union
FAD	Forest According to Definition
FADN	Farm Accountancy Data Network
FAO	Food and Agricultural Organization (UN)
F-gases	Group of fluorinated compounds comprising HFCs, PFCs and SF_6

FGD	Flue Gas Desulphurization
FO-I	Dutch Facilitating Organization for Industry
GE	Gross Energy
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GIS	Gas Insulated Switchgear
GWP	Global Warming Potential
HBO	Heating Oil
HDD	Heating-Degree Day
HFO	Heavy Fuel Oil
HOSP	Timber Production Statistics and Forecast (in Dutch: 'Hout Oogst Statistiek en Prognose oogstbaar hout')
IE	Included Elsewhere (notation key in CRF)
IEA	International Energy Agency
IEF	Implied Emission Factor
IenM	Ministry of Infrastructure and Environment (formerly VROM)
INK	Dutch Institute for Quality Management
IPCC	Intergovernmental Panel on Climate Change
KNMI	Royal Netherlands Meteorological Institute
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 (notation key in CRF); also: National Approach
NACE	Statistical Classification of Economic Activities from the European Union: Nomenclature générale des Activités économiques dans les Communautés Européennes.
NAM	Nederlandse Aardolie Maatschappij
NAV	Dutch Association of Aerosol Producers
ND	No Data
NDF	Neutral Detergent Fibre
NE	Not Estimated (notation key in CRF)
NEAT	Non-Energy CO_2 emissions Accounting Tables (model of NEU-CO_2 Group)
NEC	National Emission Ceilings
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	Oxidized 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
RVO.nl	Netherlands Enterprise Agency
SA	Sectoral Approach; also: National Approach (vs. Reference Approach)
SBI	Standaard bedrijven indeling (NACE)
SCR	Selective Catalytic Reduction
SBSTA	Subsidiary Body for Scientific and Technological Advice (of Parties to the UNFCCC)
SGHP	Shell Gasification and Hydrogen Production
SNCR	Selective Non-Catalytic Reduction
SoDM	State Supervision of Mines
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 Nation's Framework Convention on Climate Change
VOC	Volatile Organic Compound
VS	Volatile Solids
WBCSD	World Business Council for Sustainable Development
WEB	Working Group Emission Monitoring of Greenhouse Gases
WEM	Working Group Emission Monitoring
WIP	Waste Incineration Plant
WUR	Wageningen University and Research Centre (or: Wageningen UR)
WWTP	Wastewater Treatment Plant

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Total greenhouse gas emissions from the Netherlands in 2012 decreased by approximately 1.7 per cent, compared with 2011 emissions. This decrease is mainly the result of decreased fuel combustion in the Energy sector (increased electricity import) and in road transport.
In 2012, total direct greenhouse gas emissions (excluding emissions from LULUCF – land use, land use change and forestry) in the Netherlands amounted to 191.7 Tg CO_2 eq. This is approximately 10 per cent below the emissions in the base year (213.2 Tg CO_2 eq.). The 51% reduction in the non-CO_2 emissions in this period is counterbalanced by 4 per cent increase in CO_2 emissions since 1990.

This report documents the Netherlands' 2014 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.

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