Addendum to UK Greenhouse Gas Inventory, 1990 to 2004

Annual Report for submission under the Framework Convention on Climate Change

Main authors Baggott SL, Garnett E, Jackson J, Watterson JD

July 2006

This work forms part of the Global Atmosphere Research Programme of the Department for Environment, Food and Rural Affairs.

Title	Addendum to UK Greenhouse Gas Inventory, 1990 to 2004
Customer	Department for Environment, Food and Rural Affairs
Customer reference	RMP/2106
Confidentiality, copyright and reproduction	
File reference	N:\naei04\8_ghgi\02_NIR 2006\1_Report_and_appendices\addendum\ac4334jj_Addendum_UK_2006NIR_issue3.1.doc
NAEI contacts database reference	42502001/2004/AC4334/JJ
Reference number	AEAT/ENV/R/1971
ISBN	
Issue number	Issue 3.1

AEA Technology
National Environmental Technology Centre (NETCEN)
The Gemini Building, Fermi Avenue
Harwell
Didcot
Oxfordshire, OX11 0QR, UK.

Telephone 0870 190 6594
Facsimile 0870 190 6607

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AEA Technology plc

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Report Manager	Name	SL Baggott
Approved by	Name	JD Watterson
	Signature	
	Date	04.viii.2006

Contacts

This work is part of the Global Atmosphere Research Programme of the Department for Environment, Food and Rural Affairs (Contract RMP/2106). The Land Use Change and Forestry estimates were provided by the Centre for Ecology and Hydrology (CEH) Edinburgh (Contract CPEG 1). The Institute of Grassland and Environmental Research (IGER) provide the estimates of agricultural emissions.

Technical enquiries should be directed to:

Dr J D Watterson
National Environmental Technology Centre (NETCEN)
AEA Technology plc
The Gemini Building, Fermi Avenue
Harwell
Didcot
Oxfordshire OX11 0QR

Tel: +44 (0) 870 190 6594
Fax: +44 (0) 870 190 6607
E-mail: John.D.Watterson@aeat.co.uk

A copy of this report and related data may be found on the website maintained by NETCEN for Defra: http://www.naei.org.uk/

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Defra Publications
Admail 6000
London
SW1A 2XX

Tel: +44 (0) 8459 556 000
Fax: +44 (0) 20 8957 5012
Email: defra@iforcegroup.com

Document revision history

Issue	Revision history
Issue - Draft	• Review by UK Defra
1.0	• First release
2.0	• ES tables amended
3.0	• ES tables amended. Document information page and revision history added. Never issued as document became corrupt.
3.1	• File corruption repaired. Released on the EIONET (CDR) and the UK NAEI web site.

Introduction

This is an addendum to the UK's greenhouse gas inventory submission made in 2006 to the European Union (Decision 280/2004/EC[1]) and to the UNFCCC in accordance with Decision 18/CP8 and other relevant decisions of the Parties. It provides updated data to take account of:

- the decision of Gibraltar to join the UK's instrument of ratification of the Kyoto Protocol, and,

- revised estimates of methane emission from landfill, which adopt an factor of 0.1 for the proportion of methane oxidised in the cap covering the landfill. This is in response to a reassessment by the UK of the evidence on landfill emissions following the UNFCCC review of the inventory conducted in 2005. This increases the UK methane estimate in 1990 by about 12% and applies throughout the time series so the trend in emissions is not much affected.

The combined effect of these changes is to increase the base year emission used to calculate the assigned amount by about 11,653,440 tonnes of carbon dioxide equivalent per annum (about 1.5%). The UK's revised base year estimate is 779,904,144 tonnes of carbon dioxide equivalent, taking the UK's assigned amount to 3,412,080,629 tonnes of carbon dioxide equivalent.

The estimates for the other source categories in the inventory remain unchanged. The UK has already produced an updated CRF which has been submitted to the EU and is producing a full update of the National Inventory Report for submission to the EU and (with the updated CRF) to the UNFCCC.

[1] Decision 280/2004/EC[1] of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol

Contents

1 Executive Summary Tables

This section presents the revised Executive Summary tables to the 2006 UK National Inventory Report. These figures show revised total emissions for the UK, to incorporate the addition of Gibraltar and the revision to landfill methane emissions. Executive Summary tables ES4 and ES6 remain unchanged and are not presented in this addendum.

Table ES1a Emissions of GHGs in terms of carbon dioxide equivalent emissions including all estimated GHG emissions from the Crown Dependencies and relevant Overseas Territories, 1990-2004

Table ES 1	Mt CO2 equivalent															% change
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1990-2004
CO_2 (Emissions including LUCF emissions)	607.5	614.6	598.0	583.4	575.8	566.3	587.9	565.0	566.7	557.5	563.0	578.2	561.9	573.7	576.7	-5.1%
CH_4	103.7	102.8	101.3	98.2	91.2	90.3	87.8	83.0	78.3	73.1	68.5	62.7	59.7	53.6	51.8	-50.0%
N_2O	68.4	66.3	59.5	55.7	58.7	57.1	58.9	60.6	57.7	44.5	44.3	42.1	40.5	40.1	40.8	-40.3%
HFCs	11.4	11.9	12.3	13.0	14.0	15.5	16.7	19.2	17.3	10.8	9.1	9.7	9.9	10.2	8.9	-22.0%
PFCs	1.4	1.2	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.3	0.4	-74.9%
SF_6	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.2	1.3	1.4	1.8	1.4	1.5	1.3	1.1	9.5%
Total (Emissions)	793.4	797.8	772.8	751.9	741.3	730.9	753.1	729.4	721.7	687.7	687.2	694.6	673.8	679.3	679.7	-14.3%
CO_2 (Removals)	-14.3	-14.6	-14.9	-15.2	-15.5	-15.5	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4	-15.6	-16.0	-16.3	14.2%
CO_2 (Net Emissions)	593.2	600.0	583.1	568.2	560.3	550.9	572.6	549.6	551.4	542.1	547.6	562.8	546.2	557.8	560.4	-5.5%
Total (Net Emissions)	779.1	783.3	757.9	736.7	725.9	715.4	737.8	714.0	706.3	672.2	671.8	679.1	658.1	663.3	663.407	-14.8%
CO_2 (Emission excluding LUCF)	590.3	597.3	580.8	567.1	559.4	549.8	571.7	549.1	551.4	542.3	548.0	563.4	547.3	558.9	562.4	
Total (Emissions excluding LUCF)	776.1	780.5	755.6	735.6	725.0	714.3	736.8	713.4	706.3	672.5	672.2	679.7	659.2	664.5	665.3	
CO_2 emissions from LUCF	17.2	17.4	17.2	16.3	16.4	16.5	16.3	15.9	15.4	15.2	15.0	14.8	14.5	14.8	14.4	
CO_2 removals from LUCF	-14.3	-14.6	-14.9	-15.2	-15.5	-15.5	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4	-15.6	-16.0	-16.3	
CH_4 emissions from LUCF	0.014	0.013	0.013	0.010	0.011	0.012	0.014	0.014	0.015	0.018	0.019	0.023	0.019	0.018	0.017	
N_2O emissions from LUCF	0.0014	0.0013	0.0013	0.0010	0.0011	0.0012	0.0014	0.0015	0.0015	0.0018	0.0020	0.0024	0.0020	0.0019	0.0017	

1. One Mt equals one Tg, which is 10^{12} g (1,000,000,000,000 g) or one million tonnes
2. Net Emissions are reported in the Common Reporting Format
3 Geographical coverage of this table includes the Crown Dependencies Jersey, Guernsey and the Isle of Man, and the Overseas Territories which have joined, or are likely to join, the UK's instruments of ratification to the UNFCCC and the Kyoto Protocol. These are the Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

Table ES1b Emissions of GHGs in terms of carbon dioxide equivalent emissions including all estimated GHG emissions from the Crown Dependencies and excluding all estimated GHG emissions from relevant Overseas Territories, 1990-2004

Table ES1b	Mt CO_2 equivalent															% change
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1990-2004
CO_2 (Emissions including LUCF emissions)	606.4	613.5	596.8	582.2	574.6	565.2	586.8	563.8	565.5	556.2	561.7	576.9	560.6	572.4	575.4	-5.1%
CH_4	103.4	102.7	101.1	98.1	91.0	90.1	87.7	82.8	78.2	72.9	68.4	62.6	59.6	53.5	51.7	-50.0%
N_2O	68.3	66.3	59.5	55.6	58.6	57.0	58.8	60.5	57.6	44.4	44.2	42.1	40.4	40.1	40.7	-40.4%
HFCs	11.4	11.9	12.3	13.0	14.0	15.5	16.7	19.2	17.3	10.8	9.1	9.7	9.9	10.2	8.9	-22.1%
PFCs	1.4	1.2	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.3	0.4	-74.9%
SF_6	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.2	1.3	1.4	1.8	1.4	1.5	1.3	1.1	9.5%
Total (Emissions)	792.0	796.5	771.4	750.6	740.0	729.5	751.8	728.0	720.3	686.2	685.7	693.1	672.3	677.8	678.2	-14.4%
CO_2 (Removals)	-14.3	-14.6	-14.9	-15.2	-15.5	-15.5	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4	-15.6	-16.0	-16.3	14.2%
CO_2 (Net Emissions)	592.1	598.9	581.9	567.0	559.1	549.7	571.4	548.4	550.2	540.8	546.3	561.5	544.9	556.4	559.1	-5.6%
Total (Net Emissions)	777.7	781.9	756.5	735.4	724.5	714.0	736.4	712.6	704.9	670.8	670.3	677.6	656.6	661.8	661.9	-14.9%
CO_2 (Emission excluding LUCF)	589.2	596.1	579.6	565.9	558.3	548.6	570.5	547.9	550.2	541.0	546.8	562.1	546.0	557.6	561.0	
Total (Emissions excluding LUCF)	774.8	779.1	754.2	734.3	723.6	712.9	735.5	712.0	704.9	671.0	670.7	678.2	657.7	663.0	663.8	
CO_2 emissions from LUCF	17.2	17.4	17.2	16.3	16.4	16.5	16.3	15.9	15.4	15.2	15.0	14.8	14.5	14.8	14.4	
CO_2 removals from LUCF	-14.3	-14.6	-14.9	-15.2	-15.5	-15.5	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4	-15.6	-16.0	-16.3	
CH_4 emissions from LUCF	0.014	0.013	0.013	0.010	0.011	0.012	0.014	0.014	0.015	0.018	0.019	0.023	0.019	0.018	0.017	
N_2O emissions from LUCF	0.0014	0.0013	0.0013	0.0010	0.0011	0.0012	0.0014	0.0015	0.0015	0.0018	0.0020	0.0024	0.0020	0.0019	0.0017	

1. One Mt equals one Tg, which is 10^{12} g (1,000,000,000,000 g) or one million tonnes
2. Net Emissions are reported in the Common Reporting Format

Table ES2a Emissions of GHGs in terms of carbon equivalent emissions including all estimated GHG emissions from the Crown Dependencies and relevant Overseas Territories, 1990-2004

Table ES 2	Mt C equivalent															% change
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1990-2004
CO_2 (Emissions including LUCF emissions)	165.7	167.6	163.1	159.1	157.0	154.5	160.3	154.1	154.6	152.0	153.5	157.7	153.2	156.5	157.3	-5.1%
CH_4	28.3	28.0	27.6	26.8	24.9	24.6	24.0	22.6	21.4	19.9	18.7	17.1	16.3	14.6	14.1	-50.0%
N_2O	18.6	18.1	16.2	15.2	16.0	15.6	16.1	16.5	15.7	12.1	12.1	11.5	11.0	10.9	11.1	-40.3%
HFCs	3.1	3.2	3.4	3.5	3.8	4.2	4.6	5.2	4.7	3.0	2.5	2.6	2.7	2.8	2.4	-22.0%
PFCs	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-74.9%
SF_6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.4	0.4	0.4	0.3	9.5%
Total (Emissions)	216.4	217.6	210.8	205.1	202.2	199.3	205.4	198.9	196.8	187.5	187.4	189.4	183.8	185.3	185.4	-14.3%
CO_2 (Removals)	-3.9	-4.0	-4.1	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.3	-4.4	-4.5	14.2%
CO_2 (Net Emissions)	161.8	163.6	159.0	155.0	152.8	150.2	156.2	149.9	150.4	147.8	149.3	153.5	149.0	152.1	152.8	-5.5%
Total (Net Emissions)	212.5	213.6	206.7	200.9	198.0	195.1	201.2	194.7	192.6	183.3	183.2	185.2	179.5	180.9	180.9	-14.8%
CO_2 (Emission excluding LUCF)	161.0	162.9	158.4	154.7	152.6	150.0	155.9	149.7	150.4	147.9	149.5	153.6	149.3	152.4	153.4	
Total (Emissions excluding LUCF)	211.7	212.9	206.1	200.6	197.7	194.8	201.0	194.6	192.6	183.4	183.3	185.4	179.8	181.2	181.5	
CO_2 emissions from LUCF	4.7	4.7	4.7	4.4	4.5	4.5	4.4	4.3	4.2	4.1	4.1	4.0	4.0	4.0	3.9	
CO_2 removals from LUCF	-3.9	-4.0	-4.1	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.3	-4.4	-4.5	
CH_4 emissions from LUCF	0.004	0.003	0.004	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.005	0.005	0.005	
N_2O emissions from LUCF	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0005	0.0005	0.0006	0.0005	0.0005	0.0005	

1. One Mt equals one Tg, which is 10^{12} g (1,000,000,000,000 g) or one million tonnes
2. Net Emissions are reported in the Common Reporting Format
3. Geographical coverage of this table includes the Crown Dependencies Jersey, Guernsey and the Isle of Man, and the Overseas Territories which have joined, or are likely to join, the UK's instruments of ratification to the UNFCCC and the Kyoto Protocol. These are the Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

Table ES2b Emissions of GHGs in terms of carbon equivalent emissions including all estimated GHG emissions from the Crown Dependencies and excluding emissions from relevant Overseas Territories, 1990-2004

Table ES2b	Mt C equivalent															% change
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1990-2004
CO_2 (Emissions including LUCF emissions)	165.4	167.3	162.8	158.8	156.7	154.1	160.0	153.8	154.2	151.7	153.2	157.3	152.9	156.1	156.9	-5.1%
CH_4	28.2	28.0	27.6	26.7	24.8	24.6	23.9	22.6	21.3	19.9	18.6	17.1	16.2	14.6	14.1	-50.0%
N_2O	18.6	18.1	16.2	15.2	16.0	15.5	16.0	16.5	15.7	12.1	12.1	11.5	11.0	10.9	11.1	-40.4%
HFCs	3.1	3.2	3.4	3.5	3.8	4.2	4.6	5.2	4.7	3.0	2.5	2.6	2.7	2.8	2.4	-22.1%
PFCs	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-74.9%
SF_6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.4	0.4	0.4	0.3	9.5%
Total (Emissions)	216.0	217.2	210.4	204.7	201.8	198.9	205.0	198.5	196.4	187.2	187.0	189.0	183.4	184.8	185.0	-14.4%
CO_2 (Removals)	-3.9	-4.0	-4.1	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.3	-4.4	-4.5	14.2%
CO_2 (Net Emissions)	161.5	163.3	158.7	154.6	152.5	149.9	155.8	149.6	150.0	147.5	149.0	153.1	148.6	151.8	152.5	-5.6%
Total (Net Emissions)	212.1	213.3	206.3	200.6	197.6	194.7	200.8	194.3	192.2	182.9	182.8	184.8	179.1	180.5	180.5	-14.9%
CO_2 (Emission excluding LUCF)	160.7	162.6	158.1	154.3	152.3	149.6	155.6	149.4	150.0	147.6	149.1	153.3	148.9	152.1	153.0	
Total (Emissions excluding LUCF)	211.3	212.5	205.7	200.3	197.3	194.4	200.6	194.2	192.2	183.0	182.9	185.0	179.4	180.8	181.0	
CO_2 emissions from LUCF	4.7	4.7	4.7	4.4	4.5	4.5	4.4	4.3	4.2	4.1	4.1	4.0	4.0	4.0	3.9	
CO_2 removals from LUCF	-3.9	-4.0	-4.1	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.3	-4.4	-4.5	
CH_4 emissions from LUCF	0.004	0.003	0.004	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.005	0.005	0.005	
N_2O emissions from LUCF	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004	0.0005	0.0005	0.0006	0.0005	0.0005	0.0005	

1. One Mt equals one Tg, which is 10^{12} g (1,000,000,000,000 g) or one million tonnes
2. Net Emissions are reported in the Common Reporting Format

Table ES3a Aggregated emission trends per source category, including all estimated GHG emissions from the Crown Dependencies and selected relevant Overseas Territories (Mt CO_2 equivalent)

Table ES3	Aggregated emission trends per source category (Mt CO_2 equivalent)														
Source Category	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1. Energy	611.4	620.6	604.5	589.2	574.6	565.7	586.1	562.9	563.7	553.3	558.1	574.5	558.8	566.8	569.6
2. Industrial Processes	56.4	52.8	46.7	44.0	48.3	48.2	51.4	54.3	50.0	30.7	29.7	27.7	24.9	25.9	25.8
3. Solvents and other product use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	53.7	53.1	51.6	50.9	51.7	51.5	51.9	52.5	51.5	50.9	49.0	46.1	46.4	45.8	45.5
5. Land-use Change and Forestry (emissions)	17.2	17.4	17.2	16.3	16.4	16.5	16.3	15.9	15.4	15.2	15.0	14.9	14.5	14.8	14.4
5. Land-use Change and Forestry (removals)	-14.3	-14.6	-14.9	-15.2	-15.5	-15.5	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4	-15.6	-16.0	-16.3
6. Waste	52.9	52.0	50.9	49.5	48.4	46.9	45.5	41.7	39.0	35.6	33.4	29.4	27.0	23.9	22.3
7. Other	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.1
Total (emissions only)	**793.4**	**797.8**	**772.8**	**751.9**	**741.3**	**730.9**	**753.1**	**729.4**	**721.7**	**687.7**	**687.2**	**694.6**	**673.8**	**679.3**	**679.7**
Total (net CO_2 – sum of emissions and removals)	**779.1**	**783.3**	**757.9**	**736.7**	**725.9**	**715.4**	**737.8**	**714.0**	**706.3**	**672.2**	**671.8**	**679.1**	**658.1**	**663.3**	**663.4**

Footnotes:

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this Table which covers direct greenhouse gases

Geographical coverage of this table includes the Crown Dependencies Jersey, Guernsey and the Isle of Man, and the Overseas Territories which have joined, or are likely to join, the UK's instruments of ratification to the UNFCCC and the Kyoto Protocol. These are the Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

Table ES3b Aggregated emission trends per source category, including all estimated GHG emissions from the Crown Dependencies and excluding all estimated GHG emissions from relevant Overseas Territories

Table ES3b	Aggregated emission trends per source category (Mt CO_2 equivalent)														
Source Category	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1. Energy	610.2	619.5	603.3	588.1	573.4	564.4	584.9	561.6	562.5	552.0	556.8	573.2	557.5	565.4	568.3
2. Industrial Processes	56.4	52.8	46.7	44.0	48.3	48.2	51.4	54.3	50.0	30.7	29.6	27.7	24.9	25.9	25.8
3. Solvents and other product use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	53.5	53.0	51.4	50.7	51.5	51.4	51.7	52.4	51.4	50.7	48.9	45.9	46.3	45.6	45.3
5. Land-use Change and Forestry (emissions)	17.2	17.4	17.2	16.3	16.4	16.5	16.3	15.9	15.4	15.2	15.0	14.9	14.5	14.8	14.4
5. Land-use Change and Forestry (removals)	-14.3	-14.6	-14.9	-15.2	-15.5	-15.5	-15.4	-15.4	-15.4	-15.4	-15.4	-15.4	-15.6	-16.0	-16.3
6. Waste	52.8	52.0	50.8	49.5	48.4	46.9	45.5	41.7	39.0	35.6	33.4	29.4	27.0	23.9	22.3
7. Other	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.1
Total (emissions only)	**792.0**	**796.5**	**771.4**	**750.6**	**740.0**	**729.5**	**751.8**	**728.0**	**720.3**	**686.2**	**685.7**	**693.1**	**672.3**	**677.8**	**678.2**
Total (net CO_2 – sum of emissions and removals)	**777.7**	**781.9**	**756.5**	**735.4**	**724.5**	**714.0**	**736.4**	**712.6**	**704.9**	**670.8**	**670.3**	**677.6**	**656.6**	**661.8**	**661.9**

Footnotes:

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this Table which covers direct greenhouse gases

Table ES5a Kyoto basket of emissions, and emissions associated with Articles 3.3, 3.4 and 3.7, 1990-2004 (in Mt C equivalent)

Table ES5a	Mt C equivalent																%changes	
	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1990-2004	Base Year - 2004
CO2 (excluding all LULUCF emissions and removals)	161.0	161.0	162.9	158.4	154.7	152.6	150.0	155.9	149.7	150.4	147.9	149.5	153.6	149.3	152.4	153.4	-4.7%	-4.7%
CH4	28.3	28.3	28.0	27.6	26.8	24.9	24.6	24.0	22.6	21.4	19.9	18.7	17.1	16.3	14.6	14.1	-50.0%	-50.0%
N2O	18.6	18.6	18.1	16.2	15.2	16.0	15.6	16.1	16.5	15.7	12.1	12.1	11.5	11.0	10.9	11.1	-40.3%	-40.3%
HFC_C_equiv	4.2	3.1	3.2	3.4	3.5	3.8	4.2	4.6	5.2	4.7	3.0	2.5	2.6	2.7	2.8	2.4	-22.0%	-42.7%
PFC_C_equiv	0.1	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-74.9%	-25.2%
SF6_C_equiv	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.4	0.4	0.4	0.3	9.5%	-9.0%
Grand Total	**212.6**	**211.7**	**212.9**	**206.1**	**200.6**	**197.7**	**194.8**	**201.0**	**194.6**	**192.6**	**183.4**	**183.3**	**185.4**	**179.8**	**181.2**	**181.5**	**-14.3%**	**-14.7%**
Article 3.3		0.06	0.10	0.11	0.08	0.05	-0.01	-0.07	-0.13	-0.19	-0.24	-0.28	-0.31	-0.37	-0.42	-0.48		
Article 3.4 (capped at -0.37 MTC)		-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37		
Article 3.7	0.1																	
KP total	**212.7**	**211.4**	**212.6**	**205.8**	**200.3**	**197.4**	**194.4**	**200.5**	**194.1**	**192.1**	**182.8**	**182.7**	**184.7**	**179.1**	**180.4**	**180.6**	**-14.6%**	**-15.1%**

Footnotes:

Emissions and removals associated with LULUCF enter the table only through the rows labelled Article 3.3, Article 3.4 and Article 3.7. The UK has chosen to account only for forest management under Article 3.4.

Geographical coverage of this table includes the Crown Dependencies Jersey, Guernsey and the Isle of Man, and the Overseas Territories which have joined, or are likely to join, the UK's instruments of ratification to the UNFCCC and the Kyoto Protocol. These are the Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

Table ES5b Kyoto basket of emissions, and emissions associated with Articles 3.3, 3.4 and 3.7, 1990-2004 (in Mt CO_2 equivalent)

Table ES5b	Mt CO2 equivalent																%changes	
	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1990-2004	Base Year - 2004
CO2 (excluding all LULUCF emissions and removals)	590.3	590.3	597.3	580.8	567.1	559.4	549.8	571.7	549.1	551.4	542.3	548.0	563.4	547.3	558.9	562.4	-4.7%	-4.7%
CH4	103.6	103.6	102.8	101.3	98.2	91.2	90.2	87.8	83.0	78.3	73.0	68.5	62.7	59.7	53.6	51.8	-50.0%	-50.0%
N2O	68.4	68.4	66.3	59.5	55.7	58.7	57.1	58.9	60.6	57.7	44.5	44.3	42.1	40.5	40.1	40.8	-40.3%	-40.3%
HFC_C_equiv	15.5	11.375391	11.9	12.3	13.0	14.0	15.5	16.7	19.2	17.3	10.8	9.1	9.7	9.9	10.2	8.9	-22.0%	-42.7%
PFC_C_equiv	0.5	1.401488	1.2	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.3	0.4	-74.9%	-25.2%
SF6_C_equiv	1.2	1.029948	1.1	1.1	1.2	1.2	1.2	1.3	1.2	1.3	1.4	1.8	1.4	1.5	1.3	1.1	9.5%	-9.0%
Grand Total	**779.5**	**776.1**	**780.5**	**755.6**	**735.6**	**725.0**	**714.3**	**736.8**	**713.4**	**706.3**	**672.5**	**672.2**	**679.7**	**659.2**	**664.5**	**665.3**	**-14.3%**	**-14.7%**
Article 3.3		0.21	0.36	0.42	0.31	0.17	-0.04	-0.24	-0.49	-0.71	-0.87	-1.03	-1.14	-1.34	-1.55	-1.76		
Article 3.4 (capped at -0.37 MTC)		-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	-1.36		
Article 3.7	0.4																	
KP total	**779.904**	**775.0**	**779.5**	**754.6**	**734.6**	**723.8**	**712.9**	**735.2**	**711.6**	**704.2**	**670.2**	**669.8**	**677.2**	**656.5**	**661.6**	**662.2**	**-14.6%**	**-15.1%**

Footnotes:

Emissions and removals associated with LULUCF enter the table only through the rows labelled Article 3.3, Article 3.4 and Article 3.7. The UK has chosen to account only for forest management under Article 3.4.

Geographical coverage of this table includes the Crown Dependencies Jersey, Guernsey and the Isle of Man, and the Overseas Territories which have joined, or are likely to join, the UK's instruments of ratification to the UNFCCC and the Kyoto Protocol. These are the Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

2 Gibraltar Emissions

A greenhouse gas inventory for 2004 Gibraltar has been created which contains annual emission estimates from 1990 to 2004 inclusive and emissions for the Base Year. The year 1995 has been chosen as the Base Year for the fluorinated gases, in agreement with the year the UK has chosen, and in accordance with Article 3(8) of the Kyoto Protocol. Emission estimates of the indirect greenhouse gases have not been made.

At the time the 2006 NIR was written, Gibraltar had not made the decision to join the UK's instrument of ratification to the UNFCCC and the Kyoto Protocol. Emissions from Gibraltar were therefore not included in the first issues of the UK 2006 NIR or 2006 CRF. The decision has now been made that Gibraltar will join, and this issue of the NIR has been updated to report emissions from Gibraltar both in this section of the report, and in the Executive Summary tables. Graphs, figures and percentages presented elsewhere in this report have not been updated to reflect the inclusion of these emissions. The CRF has also been re-submitted to include total emissions from Gibraltar.

Gibraltar already reports emissions under other international agreements. During the compilation of the Gibraltar GHG inventory, steps have been taken to ensure the existing Gibraltar inventories and the GHG inventory share common activity data where appropriate.

Data specific to Gibraltar have been collected to estimate emissions as accurately as possible. In general the data were requested by questionnaire asking for information on fuel use, the vehicle fleet, shipping movements, aircraft, livestock numbers and waste treatment. Communications between the Gibraltar Environmental Agency and other companies is extremely good, allowing the acquisition of reliable data relating to the larger emission sources. The Gibraltar Environmental Agency was able to provide information from the government of Gibraltar statistics office, which holds much information relating to several source sectors. However, there are laws in Gibraltar restricting the data available from the Government statistics department. In general these were introduced to protect commercially sensitive information, which is more likely to occur in smaller administrations. For example it is not possible to obtain information on petrol sales from the eight petrol stations on Gibraltar without special dispensation. However, it is possible to obtain information on services that have no direct competitors (and hence the information is not regarded as being commercially sensitive).

There were some difficulties obtaining information for some sectors to estimate emissions using the same methods applied to the existing UK GHG inventory. Modifications were therefore made to the existing methods and surrogate data were used as necessary; this is discussed in the sections below. Where possible, emissions were estimated using same methods used in the UK inventory.

Emission factors for most sources are taken from the NAEI, to be consistent with the UK GHG inventory. Emissions from aircraft were calculated using default factors from the

EMEP/CORINAIR guidebook, since the information available about aircraft movements from Gibraltar was limited.

Whilst the data availability was regarded as good for an administrative area the size of Gibraltar, there were a number of sources for which detailed activity data was not available. In these cases expert judgement was required to enable an emission estimate to be obtained. **Table 2.1** summarises the methodologies used to produce emission estimates for Gibraltar.

Emissions from LULUCF have not been estimated from Gibraltar but are believed to be very small or negligible.

Emissions from military activities in Gibraltar have been excluded from the totals. This is because the fuel used for these activities is likely to be sourced from the UK, and therefore to include emissions in the Gibraltar inventory would result in a double-count. All shipping and aviation emissions are currently classified as international, on the basis that Gibraltar has only one port and one airport.

Table 2.1 Summary of methodologies used to estimate emissions from Gibraltar

Sector	Source name	Activity data	Emission factors	Notes
1	Energy - power stations, domestic, and small combustion sources	Fuel use data supplied for the three power stations. No activity data available for domestic, commercial and institutional combustion and so estimates made. Some fuel use available for industrial combustion.	2003 NAEI, EMEP/CORINAIR default factors used for waste incineration. Carbon content of some industrial fuels supplied.	In some cases time series were incomplete - other years were based on extrapolated (on population)/interpolated values.
	Energy - road transport	Time series of vehicle numbers and typical annual vehicle km per car, age profile calculated using UK figures.	Factors for vehicle types based on UK figures.	Breakdown of vehicle types not always detailed, some fuel use is based on extrapolated figures. Assumes the same vehicle age profile as the UK.
	Energy - other mobile sources	Aircraft and shipping movements supplied, and some data about off-road machinery.	Aircraft factors taken from EMEP/CORINAIR, shipping and off-road machinery from 2003/2002 NAEI.	Incomplete datasets were supplied in many cases - the time series were completed based on passenger number data or interpolated values. The off road machinery data was not in a detailed format - numbers for each type are best estimates.
2	Industrial processes	No industrial processes identified with GHG emissions. Emissions of F-gases from air conditioning units are included in this sector.	Per capita (or similar) emission factors based on UK emissions.	Estimates of HFCs from air conditioning were based on percentages of homes, cars etc using the equipment, provided by the Environmental Agency.
3	Solvent use	Population, GDP, vehicle and housing numbers, air conditioning usage estimates.	Per capita (or similar) emission factors based on UK emissions.	Assumes that solvent use for activities such as car repair, newspaper printing, and domestic painting will follow similar patterns to the UK, whilst the more industrial uses will be zero. There are no direct GHG emissions from this sector.
4	Agriculture	No commercial agricultural activity. No emissions from this sector.		
5	Land use change and forestry			Emissions Not Estimated (NE).
6	Waste - MSW	Incineration estimates based on limited data on the amount of waste incinerated up to 2001. After 2001, waste transported to Spain to be land filled.	1990 NAEI emission factor used for old incinerator (used in 1990 only) 2003 NAEI emission factor used for new incinerator.	Estimates of waste incinerated between 1990 and 1993 are based on extrapolated values. Data for the remainder of the time series was provide. Emissions from this source are assumed zero after the closure of the incinerator in 2000.
	Waste - Sewage treatment	No emissions from this sector; all sewage is piped directly out to sea, with no processing.		

A summary of the emissions of the direct GHGs from Gibraltar is given in **Table2.2**.

Table 2.2 Emissions of Direct GHGs (kt CO_2 equivalent) from Gibraltar

Sector	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1. Energy	112.2	112.2	123.0	131.6	107.5	122.6	121.3	120.3	126.2	128.6	135.0	140.4	143.1	144.8	148.6	157.8
2. Industrial Processes	1.13	0.01	0.02	0.02	0.21	0.65	1.13	1.67	2.17	2.87	3.50	4.14	4.75	5.21	5.53	5.94
3. Solvent and Other Products Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Agriculture	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use Change and Forestry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	5.68	5.68	4.66	4.66	4.66	5.37	5.40	5.49	5.52	5.77	5.77	6.85	0.00	0.00	0.00	0.00
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**119.0**	**117.9**	**127.6**	**136.3**	**112.3**	**128.6**	**127.8**	**127.5**	**133.9**	**137.2**	**144.3**	**151.4**	**147.9**	**150.0**	**154.1**	**163.7**

Notes

No emissions from military activities, shipping or aviation are included in the above totals

3 Landfill Methane Emissions

The following text updates the UK NIR (2006), Chapter 8, Section 8.2.

SOURCE CATEGORY 6A – SOLID WASTE DISPOSAL ON LAND

Source category description

Methane (CH_4) is emitted during the anaerobic decomposition of organic waste disposed of in solid waste disposal sites (SWDS). Organic waste decomposes at a diminishing rate, and takes many years to decompose completely.

The NAEI category Landfill maps directly on to IPCC category 6A1 Landfills (managed waste disposal on land) for methane emissions. Emissions are reported from managed landfills only, as open dumps and unmanaged landfills (unmanaged waste disposal sites) are considered insignificant sources in the UK.

Methodological issues

The AEA Technology model of methane generation from landfill sites, used until 2002 (Brown *et al*, 1999), was updated and revised for Defra by the consultants Land Quality Management (LQM, 2003). The LQM version of the model was revised again in 2005 by the consultants Golder Associates (Golder, 2005).

The UK method uses a first order decay (Tier 2) methodology based on estimates and historical data on waste quantities, composition and disposal practices over several decades.

The UK method is based on Equations 4 and 5 in the Revised 1996 IPCC guidelines (IPCC, 1997) (pp 6.10-6.11), which are compatible with Equations 5.1 and 5.2 in the Good Practice Guidance (IPCC, 2000). A slightly different version of Equation 5.1 is used, which takes into account the fact that the model uses a finite time interval (one year). The full derivation of the equations used is given in Appendix 6 of Golder (2005)

The UK method divides the waste stream into four categories of waste: rapidly degrading, moderately degrading, slowly degrading, and, inert waste. These categories each have a separate decay rate. The decay rates have been revised slightly for the 2002 version of the model (LQM, 2003) and have continued to be used. They now range from 0.046 (slowly degrading waste) to 0.076 (moderately degrading waste) to 0.116 (rapidly degrading waste), within the range of 0.030 to 0.200 quoted in the Good Practice Guidance.

The model uses data extending back to 1945, which gives a time period of around 4 half lives for the slowest of the three decay rates (0.046, half life 15 years). This lies within the range of 3 to 5 half-lives recommended by the Good Practice Guidance.

As recommended, the model aims to take account of changes in landfill practice over past decades by modifying the gas collection rate over time where appropriate.

The estimates of historical waste disposal and composition data are based on various data sources, described fully in Brown *et al.* (1999), LQM (2003) and Golder (2005). As recommended in the Good Practice Guidance, estimates for municipal waste are based on population where data are absent. Up until 1994 the waste arisings data are the same as that used for the AEA model (Brown *et al*., 1999) and is based on waste surveys in the UK using actual data combined with population data where necessary. After 1994, data are based on a new study carried out by a UK consultancy ERM for input to the LQM model, which uses updated waste survey data gathered by the Environment Agency for 1999. Years between 1995 and 1998 inclusive are extrapolated backwards from the 1999 data and years ahead of 1999 are extrapolated based on a projected scenario of waste disposal. The Golder (2005) model has revised MSW arisings from 2001 based on the Local Authority Waste Recycling and Disposal (LAWRRD) model (AEA Technology, 2005). The LAWRRD model provides arisings for England and so the data has been scaled upwards, assuming England represents 83% of the UK's total. A comparison between the LAWRRD data and actual waste arisings for 2002 and 2003 showed a discrepancy of 2% and 4%, respectively. These differences are considered insignificant and the LAWRRD model data were taken to be representative of the current situation.

As recommended in the Good Practice Guidance, the estimates of waste disposal quantities include commercial and industrial waste, demolition and construction waste sewage sludge disposal to landfill as well as municipal waste. There is, however, a great deal of uncertainty in both the amounts and composition of industrial and commercial wastes. The waste arisings for industrial and commercial waste determined by Brown *et al.* (1999), are based on national estimates from a 1995 survey. Historical data are also taken from this survey. In the absence of measured data, waste quantities were extrapolated to cover past years based on employment rates in the industries concerned. In the Golder (2005) model C&I arisings have been modified for 2002 (assumed constant thereafter) based on Environment Agency data; years 1999, 2000 and 2001 are scaled values between 1998 and 2002. The 2002 Environment Agency data includes England and Wales only; the data is scaled upwards to include Scotland and Northern Ireland.

All sites in the UK are managed, and therefore have a methane correction factor of 1.0.

Degradable organic carbon (DOC) was estimated assuming that the DOC arises solely from the cellulose and hemi-cellulose content of the waste. The LQM report states that "Cellulose and hemicellulose are known to make up approximately 91% of the degradable fraction, whilst other potential degradable fractions which may have a small contribution (such as proteins and lipids) are ignored." The proportion of cellulose and hemi-cellulose in each waste component and the degradability of these fractions were based on a study by Barlaz *et al.* (1997).

Each waste component (paper, food, etc) was assigned a DOC value based on the cellulose and hemi-cellulose content. The component was then split into four fractions: rapidly degrading, moderately degrading, slowly degrading and inert, each of which was assigned the appropriate degradation rate. For example, paper was assumed to be 25% moderately degrading and 75% slowly degrading. The DOC value for both components was assumed to be equal to the percentage by weight of cellulose and hemi-cellulose multiplied by a factor of 72/162 (to account for the carbon content). This was around 22% for household paper waste. Further details are provided in Annex 3, section A3.8.

The fraction of degradable organic carbon dissimilated (DOC_F) is also derived from an analysis of the laboratory study by Barlaz *et al.* (1997). It varies from 35% (newspaper) to 98% (white office paper) depending on the particular component in the waste. The majority of the waste components are between 50% and 64% degradable. The IPCC recommended range quoted in the guidance is 50-60%.

The fraction of CH_4 in landfill gas is generally taken to be 50%, which is in line with the Guidance. For old shallow sites it is taken to be 30% to reflect a higher degree of oxidation.

The fraction of methane recovered was derived from a survey of statistics on gas use for power generation, and a survey of installed flare capacity, assuming that flares operate at full capacity except for 15% downtime. In 2004 the estimates were that 32% of generated methane was utilised and 44% was flared. The estimates are not derived from metering data, as recommended by the Guidance, as such data were not readily available at the time of the study. Further details are provided in section A3.8 of the NIR.

The oxidation factor based on a model developed by LQM (2003) is no longer used to estimate the quantity of methane oxidised; the recommended IPCC Guidance value of 0.1 has been adopted. Recovered methane is subtracted before applying the oxidation factor. This is in line with the IPCC Guidance.

Emissions from electricity generation are considered under Power Stations and emissions from heat generation are included under Miscellaneous and are discussed in Appendix 1. The emissions of pollutants from the flare stacks were not estimated.

An estimate of NMVOC emissions from landfills was made using an emission factor of 0.01 t NMVOC/t methane produced which is equivalent to 5.65g NMVOC/m^3 landfill gas (Passant, 1993).

Neither the GHGI nor the NAEI reports carbon dioxide emissions from the anaerobic decay of landfilled waste since this is considered to be part of the carbon cycle and not a net source.

Uncertainties and time-series consistency

The Tier 1 uncertainty analysis in **Annex 7**, shown in **Table A7.5a** and **Table A7.5b**, provides estimates of uncertainty according to IPCC source category and gas. The uncertainty analysis presented in the initial 2006 NIR has not been updated to take into account the additional methane emissions from the Gibraltar inventory.

The estimates for all years have been calculated from the LQM model and thus the methodology is consistent throughout the time series. Estimates of waste composition and quantities have been taken from different sources – prior to 1995 they are from Brown *et al.* 1999, and after 1995 new estimates were made as part of the LQM study, based on more recent data. This has led to some discontinuity between the two sets of estimates – there is an increase in estimated MSW arisings from households from 25 million tonnes in 1994 to 28 million tonnes in 1995, against a background trend of an annual increase of around 1 million tonnes before and after 1995. Similarly this has led to a discontinuity in the estimates of industrial and commercial waste arising – from 108 million tonnes in 1995 to reach 169

million tonnes by 1999 (assuming a linear increase over this period), although the arisings are roughly constant in the years before 1995 and after 1999.

Source-specific QA/QC and verification

There are many uncertainties inherent in estimating methane emissions from landfill sites. The model is particularly sensitive to the values assumed for the degradable organic carbon (DOC) present in different fractions of waste, and the amount of this that is dissimilable, as well as to the oxidation factor. Both of these parameters are poorly understood, and field and experimental observations exhibit wide variation, so uncertainties are inevitably high, and the uncertainty estimates in **Annex 7** reflect this.

Source-specific recalculations

The methodology uses the basis of the LQM model applied in 2003 GHG inventory. There have, however, been changes that have had a significant affect on the methane emission values (Golder, 2005). The most important is the reassessment of the oxidation factor which has been aligned to the IPCC Guidelines. This review has increased the UK's methane emissions throughout the time series. Furthermore, the estimates for total waste arisings have been updated with real data where possible.

The preliminary IPCC Tier 2 Solid Waste Disposal from Land model has been made available to the UK for purposes of quality control. The model was used to compare emissions to the Golder (2005) model. A comparison of the results is shown in Table 8.1. Although the Golder model uses country specific DOC, DOC_F and K (half-life) values, the way they are implemented against rapidly-, moderately- and slowly-degrading fractions of waste means that they are capable of changing with time through each waste stream. Consequently they were difficult to apply to the IPCC model, and hence, IPCC default values were used. The activity data, the methane correction factor, the fraction of methane, the oxidation factor and the amount recovered were identical. The results in Table 8.1 show that the two models provide similar emissions through the time-series providing an additional degree of verification for the Solid Waste Disposal on Land emissions. Over the time-series the IPCC model predicts 1769 kt less methane emissions than the Golder (2005) model.

Table 8.1 Amount of methane generated compared with the IPCC Tier 2 model.

Year	Mass of waste landfilled (Mt)			Golder (2005) Methane emitted (kt)	IPCC Methane emitted (kt)
	MSW	C&I	Combined waste streams		
1990	18.19	81.83	100.02	2363	2432
1991	18.84	81.77	100.61	2329	2364
1992	19.47	81.72	101.19	2270	2275
1993	20.09	81.66	101.76	2212	2190
1994	20.71	81.61	102.32	2167	2121
1995	23.83	81.56	105.39	2099	2044
1996	24.76	78.17	102.93	2027	1979
1997	26.14	72.86	99.00	1866	1795
1998	25.94	65.63	91.57	1735	1628
1999	27.03	63.84	90.87	1577	1413
2000	27.54	62.05	89.59	1472	1262
2001	26.85	60.27	87.11	1277	1032
2002	27.17	58.48	85.64	1162	884
2003	26.39	58.48	84.87	1016	710
2004	25.47	58.48	83.94	943	615
Total	-	-	-	**26514**	**24745**

Table 8.2 Original and Revised time series for Methane from Landfill in the UK GHG inventory, 1990-2004

	kt CH_4	
Year	**original**	**revised**
1990	1814	2363
1991	1782	2329
1992	1737	2270
1993	1691	2212
1994	1664	2167
1995	1612	2099
1996	1560	2027
1997	1441	1866
1998	1344	1735
1999	1113	1577
2000	1066	1472
2001	884	1277
2002	808	1162
2003	716	1016
2004	666	943

The following text updates the UK NIR (2006) Annex 3, Section A3.8.1 – A3.8.2 inclusive.

A3.8 WASTE (CRF SECTOR 6)

A3.8.1 Solid Waste Disposal on Land (6A)

Degradable Organic Carbon (DOC) and Fraction Dissimilated (DOCF)
The UK does not use the IPCC default values for degradable organic carbon (DOC) and Fraction of DOC Dissimilated (DOC_F). The UK estimates are based on an emissions model maintained by LQM (2003) that uses updated degradable carbon input parameters with values based on well-documented US research for the USEPA's life-cycle programme. This has been adapted to UK conditions and incorporated into (1) the Environment Agency's WISARD life cycle assessment model (WS Atkins, 2000); (2) the HELGA framework model (Gregory et al., 1999) and (3) GasSim (Environment Agency, 2002).

Cellulose and hemi-cellulose are known to make up approximately 91% of the degradable fraction, whilst other potential degradable fractions which *may* have a small contribution (such as proteins and lipids) are ignored. The amount of degradable carbon that produces landfill gas is determined using the mass (expressed on a percentage dry weight basis) and degradability (expressed as a percentage decomposition) of cellulose and hemi-cellulose using data provided by Barlaz et al. (1997). The default input values for these parameters are provided in Tables A3.8.1a and A3.8.1b below for each of the waste fractions for both municipal (MSW) and commercial and industrial (C&I) waste categories, respectively. Also included are the proportions of individual waste streams that are considered to be rapidly, moderately or slowly degradable.

These data are used within the model to determine the amount of degradable carbon that decays at the relevant decay rate. This process requires complete disaggregation of the waste streams into their component parts, allocation of degradability and rate of decomposition to each component and application of the IPCC model approach at this disaggregated level.

Table 3.8.1a Waste degradable carbon model parameters for MSW waste

Waste category	Fraction				Moisture content	Cellulose	Hemi-cellulose	DOC	DOC	Decomposition (DOC_f)
	Readily Degradable	Moderately Degradable	Slowly Degradable	Inert	(%)	(% Dry waste)	(% Dry waste)	(% Dry waste)	(% Wet waste)	(%)
Paper and card	0	25	75	0	30	61.2	9.1	70.3	54.08	61.8
Dense plastics	0	0	0	100	5	0	0	0	0.00	0
Film plastics (until 1995)	0	0	0	100	30	0	0	0	0.00	0
Textiles	0	0	100	0	25	20	20	40	32.00	50
Misc. combustible (plus non-inert fines from 1995)	0	100	0	0	20	25	25	50	41.67	50
Misc. non-combustible (plus inert fines from 1995)	0	0	0	100	5	0	0	0	0.00	0
Putrescible	100	0	0	0	65	25.7	13	38.7	23.45	62
Composted putrescibles	0	50	50	0	30	0.7	0.7	1.4	1.08	57
Glass	0	0	0	100	5	0	0	0	0.00	0
Ferrous metal	0	0	0	100	5	0	0	0	0.00	0
Non-ferrous metal and Al cans	0	0	0	100	10	0	0	0	0.00	0
Non-inert fines	100	0	0	0	40	25	25	50	35.71	50
Inert fines	0	0	0	100	5	0	0	0	0.00	0

Notes:

1. DOC is Degradable Organic Carbon.

2. DOC_f is the portion of DOC that is converted to landfill gas.

Table 3.8.1b Waste degradable carbon model parameters for C & I waste

Waste category	Fraction				Moisture content	Cellulose	Hemi-cellulose	DOC	DOC	Decomposition (DOC_f)
	Readily Degradable	Moderately Degradable	Slowly Degradable	Inert	(%)	(% Dry waste)	(% Dry waste)	(% Dry waste)	(% Wet waste)	(%)
Commercial	15	57	15	13	37	76	8	84	61.31	85
Paper and card	0	25	75	0	30	87.4	8.4	95.8	73.69	98
General industrial waste	15	43	20	22	37	76	8	84	61.31	85
Food solids	79	10	0	11	65	55.4	7.2	62.6	37.94	76
Food effluent	50	5	0	45	65	55.4	7.2	62.6	37.94	76
Abattoir waste	78	10	0	12	65	55.4	7.2	62.6	37.94	76
Misc processes	0	5	5	90	20	10	10	20	16.67	50
Other waste	15	35	35	15	20	25	25	50	41.67	50
Power station ash	0	0	0	100	20	0	0	0	0.00	0
Blast furnace and steel slag	0	0	0	100	20	0	0	0	0.00	0
Construction/demolition	0	5	5	90	30	8.5	8.5	17	13.08	57
Sewage sludge	100	0	0	0	70	14	14	28	16.47	75

Notes:

1. DOC is Degradable Organic Carbon.

2. DOC_f is the portion of DOC that is converted to landfill gas.

A3.8.2 Flaring and Energy Recovery

Flaring and energy recovery constitutes the method likely to reduce methane emissions from landfills by the largest amount, and is probably the most readily auditable management method for achieving actual (as opposed to modelled) methane emissions reductions. This survey was carried out in 2002. As set out below, it is estimated that in 2004 69% of the total landfill gas generated in the UK was flared or utilised (Table 3.8.2).

A3.8.2.1 Gas Utilisation

The gas utilisation data is based on comparison of information from the trade association, the Renewables Energy Association, formerly Biogas Association (Gaynor Hartnell, Pers. Comm. 2002) and current DTI figures. In addition, LQM (2003) included data on utilisation prior to the first round of the Non Fossil Fuel Obligation (NFFO) contracts (Richards and Aitchison, 1990). The first four NFFO rounds (NFFO 1-4) and the Scottish Renewables Order (SRO) round are all assumed to be completed and operational schemes, since there are relatively few outstanding schemes still to be implemented. It is known that not all of the proposed early schemes were found to be economic, and no NI-NFFO (Northern Ireland-NFFO) schemes have progressed, so those known schemes have not been included in the total (Gaynor Hartnell, Pers. Comm. 2002).

This approach, comparing the trade association and Government data sources, provides a reasonable correlation, and so LQM is confident in the accuracy of its estimates of current installed capacity. The latest round of NFFO (NFFO 5) has been implemented in the forecasting model over the period 2000 – 2005, to give a reasonable lead in time for these new projects. Various industry sources have indicated in confidence that some of the proposed NFFO 5 projects are now also considered uneconomic under NFFO. Some of these have definitely been abandoned, some have been surrendered and re-started under the new renewables order, and others are likely to follow this route. These figures are likely to have only a small uncertainty, as they are directly derived from power generation figures supplied by the industry and the Department of Trade and Industry.

A3.8.2.2 Flaring

Information on flaring capacity was obtained through consultation with flare manufacturers. LQM (2003) collected information from all but one of the UK flare companies contacted. The data collected was divided into flares supplied for routine flaring and flares supplied as back-up to generation sets. The data produced demonstrates total flare capacity as opposed to the actual volumes of gas being flared in each year. There are difficulties in ascertaining the actual volumes of LFG burnt, as detailed records, if they exist at all, are held by individual site operators. It is rare to find a flare stack with a flow measurement.

The data relating to total flaring capacity and usage have a potentially large uncertainty. The data for flares sold solely for generation back-up purposes is believed to be fairly accurate. The operational capacity is derived by subtracting the back-up capacity from the total. LQM's total for generation back-up capacity remains at a fairly constant percentage of the installed generation capacity (around 60%), indicating that these figures are realistic. In the model, there is a further correction

factor used in arriving at the final volume of gas flared each year, to take account of maintenance downtime (15%). In addition, it is assumed that since 1984 (i.e. three years after the first flare was commissioned) 7% of capacity in any given year is treated as replacement. This effectively gives the flare an expected 15-year operational lifetime. In 1990, the methane captured equates to 11% of the total generated, rising to 69% in 2004 (Table 3.8.2).

The last input of gas utilisation data in the model is year 2005 and the last input of flare data is year 2002. Gas utilisation and flaring is assumed constant thereafter.

Table 3.8.2 Amount of methane generated, captured, oxidsed and emitted.

Year	Mass of waste landfilled (Mt)			Methane generated (kt)	Methane captured (kt)	Methane captured (%)	Residual methane oxidised (kt)	Residual methane oxidised (%)	Methane emitted (kt)
	MSW	C&I	Combined waste streams						
1990	18.19	81.83	100.02	2947	322	10.91	263	10	2363
1991	18.84	81.77	100.61	3024	436	14.43	259	10	2329
1992	19.47	81.72	101.19	3098	576	18.58	252	10	2270
1993	20.09	81.66	101.76	3170	712	22.47	246	10	2212
1994	20.71	81.61	102.32	3240	832	25.67	241	10	2167
1995	23.83	81.56	105.39	3294	962	29.20	233	10	2099
1996	24.76	78.17	102.93	3330	1077	32.36	225	10	2027
1997	26.14	72.86	99.00	3352	1279	38.15	207	10	1866
1998	25.94	65.63	91.57	3361	1433	42.65	193	10	1735
1999	27.03	63.84	90.87	3371	1620	48.04	175	10	1577
2000	27.54	62.05	89.59	3384	1749	51.68	164	10	1472
2001	26.85	60.27	87.11	3394	1975	58.19	142	10	1277
2002	27.17	58.48	85.64	3405	2114	62.09	129	10	1162
2003	26.39	58.48	84.87	3415	2287	66.96	113	10	1016
2004	25.47	58.48	83.94	3425	2377	69.40	105	10	943