

Appendix 3

International Shipping and Aviation

International Shipping and Aviation: Emission Estimates for England, Scotland, Wales and Northern Ireland, 1990-2008

A3.1 Background

There is growing interest in the methods that could be used to allocate emissions from international shipping and aviation sources to the constituent countries of the UK. This is particularly important for Scotland, as it has chosen to include emissions from these sources within the emission reduction targets that have been established under the recent Climate Change (Scotland) Act 2009. At a UK level, emissions from shipping and aviation are estimated but are not included in national totals. The emissions are reported as memo items.

Therefore, AEA have analysed the available data to provide the estimates outlined below, which have been derived by estimating the DA share of the UK-level GHG emission estimates from international shipping and international aviation.

Emissions from these two transport sources include the GHGs:

- carbon dioxide (CO₂)
- methane (CH₄)
- nitrous oxide (N₂O)

In accordance with international inventory protocol, the emissions from international shipping and aviation are not included in national totals, but rather are reported as separate memo items to the national inventories. Hence we have maintained this approach here, with separate reporting of these memo items to the inventories for England, Scotland, Wales and Northern Ireland.

The emission estimates presented below for international shipping are regarded as preliminary, as there is limited data availability for regional marine shipping fuel use. It should also be noted that there is research ongoing in the shipping sector, to derive improved emission estimates for the national and international shipping GHG emissions at UK level, following a recent study into shipping movements around the UK (Entec, 2008). It is anticipated that this study will lead to a revision of the UK emissions from both national and international shipping sources within the 1990-2009 UK GHG inventory. Once this work is complete, the analysis of data for England, Scotland, Wales and Northern Ireland will need to be re-examined.

The estimates of emissions from international aviation, presented below, are associated with low uncertainty. The emission estimates are based on a database of UK flight movements and detailed calculations of emissions from different phases of flights (take off, cruise, landing cycles).

A3.2 Emission Estimation Methodology

A3.2.1 International Shipping: Allocation of UK emissions across England, Scotland, Wales and Northern Ireland

Estimates of fuel used by international shipping are provided for the UK within the annual DECC publication, the Digest of United Kingdom Energy Statistics (DUKES), with annual data reported for gas oil and fuel oil estimates in the category "Marine bunkers". No equivalent DA-specific data have been found. There is no agreed international protocol that defines how a sub-country split should be made. So, to provide an indicative allocation of the international shipping emissions by DA, the UK data has been allocated across England, Scotland, Wales and Northern Ireland based on annual port

movement data available taken from the DfT annual publication "Maritime Statistics", Table 1.1: All ports traffic (kt). These data do not discriminate between domestic and international shipping and hence are used to disaggregate both UK domestic and international shipping emissions.

No detailed dataset of shipping movements is currently available, and hence emissions are assigned based on the assumption that the total mass of port traffic per DA is a representative proxy to estimate shipping fuel sales and use in the ports and waters around the DAs. Note that the sum of the DA shipping emission allocations are constrained by the UK fuel use data for the sector; this method of estimation is therefore consistent with the principles of international inventory guidance, whereby emissions are allocated to the country (here, the UK) at point of fuel sale.

A3.2.2 International Aviation: Allocation of UK emissions across England, Scotland, Wales and Northern Ireland

Emission estimates for both domestic and international aviation are constrained at UK level by the fuel use data reported within the annual publication of DUKES. Annual aviation fuel sales in the UK therefore define the overall aviation emissions, in accordance with UNFCCC, UNECE and IPCC inventory guidance.

Data for total aviation fuel use from UK airports are provided within the annual DUKES publication. No equivalent DA-specific fuel use data have been found. The split of domestic and international aviation fuel use at UK level is based on analysis of a CAA database of flight details, which comprises both domestic and international flights. To provide a split of the UK international aviation emissions across England, Scotland, Wales and Northern Ireland, this detailed database of all flights (including details of airport of origin, destination, fuel type, plane type and engine type) has been used. There is no agreed international protocol that defines how a sub-country split should be made (the DA GHG inventories are not currently required for any mandatory international reporting mechanisms) and the protocol adopted in the DA data disaggregation method assumes that all emissions from a flight originating in a DA is allocated to that DA. (e.g. for a flight from Glasgow to Paris, all emissions from that flight, e.g. take-off, cruise and landing cycles, are assigned to Scotland).

Note on Aviation Emission Estimates and the Impact of Hub Airports

The aviation emission estimates at DA level are, as indicated above, based on a detailed database of flight information. Emissions have been assigned to the DAs based on the protocol that the total emissions (take-off, cruise and landing cycles) from flights originating in a DA are assigned to that DA. This methodology has been chosen as it is consistent with international guidance for GHG inventories, i.e. it follows the principle that the emissions are allocated to the country of origin of the aviation fuel sales. In the absence of aviation fuel sales data by DA, the DA aviation fuel sales are estimated assuming that fuel sales for a given flight are at the origin airport. In these circumstances, the impact of hub airports may play a significant role in influencing the emission totals presented here. It is notable, for example, that whilst Scotland has a high percentage of domestic flight emissions (around 29% in 2008), only 3.2% of international flight emissions are allocated to Scotland. England, meanwhile, accounts for nearly 96% of international aviation emissions in 2008. This reflects the dominance of the London airports as international aviation route hubs.

Examples

For a passenger taking a flight that originates in Glasgow, on to Dubai and then onwards to Australia, only the emissions from the Glasgow to Dubai leg will be used in the DA allocation method (noting that emissions in total are aligned with aviation fuel sales in the UK), and the emissions will be assigned to Scotland.

For a passenger taking flights from Glasgow to London and then on to Paris, the Glasgow to London leg would be classed as a domestic flight and the London to Paris leg would be international. In these circumstances, Scotland is assigned emissions from the domestic leg, whilst England is assigned emissions from the international leg.

A3.3 Results

The estimates of emissions from international shipping and aviation are presented in the tables below. The emissions are presented as kilotonnes CO₂-equivalent. There are emissions of CO₂, CH₄ and N₂O from both shipping and aviation but CO₂ dominates the emissions from both sources on a GWP basis.

Please note these estimates are indicative only, and the methods for estimating emissions will be kept under review. The estimates of emissions from international aviation are associated with low uncertainty. The estimates from shipping are associated with a much higher uncertainty, and research continues to derive improved emission estimates for the national and international shipping GHG emissions at UK and DA level.

Table A3.3.1 International Shipping Emissions: England, Scotland, Wales and Northern Ireland

Gas	Country	Units	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Carbon dioxide	England	ktCO2	4,188	4,207	5,800	4,111	3,626	4,154	3,473	3,422	3,885	3,931	4,674	4,742	5,128
	Scotland	ktCO2	1,545	1,552	1,968	1,495	1,303	1,403	1,171	1,022	1,132	1,091	1,185	1,212	1,278
	Wales	ktCO2	696	699	886	650	578	620	498	486	616	594	661	673	739
	N Ireland	ktCO2	248	249	317	245	214	240	205	203	240	241	286	284	312
Methane	England	ktCO2e	1.4	1.4	1.9	1.3	1.2	1.4	1.1	1.1	1.3	1.3	1.5	1.6	1.7
	Scotland	ktCO2e	0.5	0.5	0.6	0.5	0.4	0.5	0.4	0.3	0.4	0.4	0.4	0.4	0.4
	Wales	ktCO2e	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	N Ireland	ktCO2e	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nitrous oxide	England	ktCO2e	32.6	32.8	45.1	31.9	28.1	32.2	26.9	26.5	30.0	30.4	36.1	36.6	39.5
	Scotland	ktCO2e	12.0	12.1	15.3	11.6	10.1	10.9	9.1	7.9	8.8	8.4	9.2	9.4	9.9
	Wales	ktCO2e	5.4	5.5	6.9	5.0	4.5	4.8	3.9	3.8	4.8	4.6	5.1	5.2	5.7
	N Ireland	ktCO2e	1.9	1.9	2.5	1.9	1.7	1.9	1.6	1.6	1.9	1.9	2.2	2.2	2.4
All GHGs	England	ktCO2e	4,222	4,241	5,847	4,144	3,655	4,187	3,501	3,450	3,916	3,963	4,711	4,781	5,170
	Scotland	ktCO2e	1,557	1,564	1,984	1,507	1,313	1,414	1,180	1,030	1,142	1,100	1,195	1,221	1,288
	Wales	ktCO2e	702	705	893	656	583	625	503	490	621	599	667	678	745
	N Ireland	ktCO2e	250	251	319	247	216	242	206	205	242	243	288	286	314
	UK	ktCO2e	6,731	6,761	9,044	6,554	5,767	6,469	5,390	5,175	5,920	5,905	6,861	6,966	7,517

Table A3.3.2 International Shipping Fuel Use Estimates: England, Scotland, Wales and Northern Ireland

	DA	UNITS	EMISSION YEARS												
			1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fuel Use	England	Mt	1.32	1.32	1.82	1.29	1.13	1.30	1.08	0.99	1.18	1.20	1.43	1.44	1.59
	Scotland	Mt	0.49	0.49	0.62	0.47	0.41	0.44	0.37	0.30	0.34	0.33	0.36	0.37	0.40
	Wales	Mt	0.22	0.22	0.28	0.20	0.18	0.19	0.16	0.14	0.19	0.18	0.20	0.20	0.23
	N Ireland	Mt	0.08	0.08	0.10	0.08	0.07	0.07	0.06	0.06	0.07	0.07	0.09	0.09	0.10
	UK	Mt	2.10	2.11	2.81	2.03	1.79	2.01	1.67	1.49	1.78	1.78	2.08	2.10	2.32

Table A3.3.3 International Aviation Emissions: England, Scotland, Wales and Northern Ireland

Gas	Country	Units	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Carbon dioxide	England	ktCO2	15,071	19,404	24,340	26,398	29,131	28,366	27,910	28,504	31,202	33,723	34,053	33,850	32,675
	Scotland	ktCO2	417	513	622	715	755	769	749	813	955	1,113	1,185	1,226	1,074
	Wales	ktCO2	54	86	94	98	123	119	107	124	122	122	143	127	114
	N Ireland	ktCO2	56	84	110	118	125	119	92	103	120	159	176	206	231
	UK	ktCO2	15,599	20,088	25,165	27,329	30,135	29,372	28,858	29,545	32,399	35,118	35,558	35,408	34,094
Methane	England	ktCO2e	5.85	3.89	3.84	3.36	2.82	2.21	2.05	1.99	1.88	1.97	1.95	1.85	1.75
	Scotland	ktCO2e	0.28	0.22	0.22	0.20	0.20	0.20	0.20	0.18	0.17	0.18	0.20	0.20	0.18
	Wales	ktCO2e	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	N Ireland	ktCO2e	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	UK	ktCO2e	6.16	4.14	4.09	3.58	3.04	2.43	2.26	2.19	2.07	2.17	2.17	2.07	1.95
Nitrous Oxide	England	ktCO2e	148.3	191.0	239.6	259.8	286.7	279.2	274.7	280.5	307.1	331.9	335.2	333.2	321.6
	Scotland	ktCO2e	4.1	5.0	6.1	7.0	7.4	7.6	7.4	8.0	9.4	11.0	11.7	12.1	10.6
	Wales	ktCO2e	0.5	0.8	0.9	1.0	1.2	1.2	1.1	1.2	1.2	1.2	1.4	1.2	1.1
	N Ireland	ktCO2e	0.5	0.8	1.1	1.2	1.2	1.2	0.9	1.0	1.2	1.6	1.7	2.0	2.3
	UK	ktCO2e	153.5	197.7	247.7	269.0	296.6	289.1	284.0	290.8	318.9	345.6	350.0	348.5	335.6
All GHGs	England	ktCO2e	15,226	19,599	24,583	26,661	29,421	28,647	28,187	28,787	31,511	34,057	34,390	34,185	32,998
	Scotland	ktCO2e	422	518	628	722	763	777	757	821	965	1,125	1,196	1,238	1,085
	Wales	ktCO2e	55	87	95	99	124	120	108	125	123	123	145	128	115
	N Ireland	ktCO2e	56	85	111	119	126	120	93	104	121	161	178	208	234
	UK	ktCO2e	15,759	20,289	25,417	27,601	30,435	29,664	29,145	29,838	32,720	35,466	35,910	35,759	34,432

Table A3.3.4 International Aviation Fuel Use Estimates: England, Scotland, Wales and Northern Ireland

	DA	UNITS	EMISSION YEARS												
			1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Fuel use	England	Mt	4.79	6.16	7.73	8.38	9.25	9.01	8.86	9.05	9.91	10.71	10.81	10.75	10.37
	Scotland	Mt	0.13	0.16	0.20	0.23	0.24	0.24	0.24	0.26	0.30	0.35	0.38	0.39	0.34
	Wales	Mt	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.04	0.04
	N Ireland	Mt	0.02	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.04	0.05	0.06	0.07	0.07
	UK	Mt	4.95	6.38	7.99	8.68	9.57	9.33	9.16	9.38	10.29	11.15	11.29	11.24	10.82