

Appendix 3

International Shipping and Aviation

International Shipping and Aviation: Emission Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007

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 1990-2008 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 28% in 2006), only 3% of international flight emissions are allocated to Scotland. England, meanwhile, accounts for 96% of international aviation emissions in 2006. 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 following two tables. 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	DA	UNITS	EMISSION YEARS											
			1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Carbon dioxide	England	ktCO2	4188	4207	5800	4111	3626	4154	3473	3422	3885	3931	4674	4742
	Scotland	ktCO2	1545	1552	1968	1495	1303	1403	1171	1022	1132	1091	1185	1212
	Wales	ktCO2	696	699	886	650	578	620	498	486	616	594	661	673
	N Ireland	ktCO2	248	249	317	245	214	240	205	203	240	241	286	284
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
	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
	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
	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
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
	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
	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
	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
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
	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
	Wales	ktCO2e	702	705	893	656	583	625	503	490	621	599	667	678
	N Ireland	ktCO2e	250	251	319	247	216	242	206	205	242	243	288	286
	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

Table A3.3.2 International Aviation Emissions: England, Scotland, Wales and Northern Ireland

GAS	DA	UNITS	EMISSION YEARS											
			1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Carbon dioxide	England	ktCO2	15,205	19,527	24,519	26,613	29,367	28,613	28,117	28,747	31,386	33,768	34,200	33,505
	Scotland	ktCO2	394	482	585	674	712	726	707	755	917	1,054	1,132	1,138
	Wales	ktCO2	49	77	84	88	110	107	96	114	113	114	138	124
	N Ireland	ktCO2	49	74	96	103	110	104	81	92	110	149	171	197
	UK	ktCO2	15,697	20,160	25,285	27,478	30,300	29,550	29,000	29,708	32,526	35,086	35,642	34,963
Methane	England	ktCO2e	6.20	3.83	3.63	3.23	2.75	2.20	1.99	1.96	1.86	1.94	1.88	1.73
	Scotland	ktCO2e	0.28	0.21	0.20	0.18	0.18	0.19	0.18	0.17	0.17	0.17	0.19	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
	N Ireland	ktCO2e	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	UK	ktCO2e	6.51	4.06	3.85	3.44	2.95	2.40	2.18	2.15	2.04	2.13	2.08	1.93
Nitrous Oxide	England	ktCO2e	149.7	192.2	241.3	261.9	289.0	281.6	276.7	282.9	308.9	332.4	336.6	329.8
	Scotland	ktCO2e	3.9	4.7	5.8	6.6	7.0	7.1	7.0	7.4	9.0	10.4	11.1	11.2
	Wales	ktCO2e	0.5	0.8	0.8	0.9	1.1	1.0	0.9	1.1	1.1	1.1	1.4	1.2
	N Ireland	ktCO2e	0.5	0.7	0.9	1.0	1.1	1.0	0.8	0.9	1.1	1.5	1.7	1.9
	UK	ktCO2e	154.5	198.4	248.9	270.5	298.2	290.8	285.4	292.4	320.1	345.3	350.8	344.1
All GHGs	England	ktCO2e	15,361	19,723	24,764	26,878	29,659	28,897	28,396	29,032	31,697	34,102	34,539	33,836
	Scotland	ktCO2e	398	487	591	681	720	733	714	763	926	1,065	1,143	1,149
	Wales	ktCO2e	49	78	85	88	111	108	97	115	114	116	140	125
	N Ireland	ktCO2e	49	75	97	104	111	105	81	93	111	151	173	199
	UK	ktCO2e	15,858	20,363	25,538	27,752	30,601	29,843	29,288	30,003	32,849	35,433	35,995	35,309