

Table AC.1 Emissions from Fossil Fuel Burning and Cement Manufacturing

Source: Carbon Dioxide Information Analysis Center

	Carbon Dioxide (CO ₂) Emissions (000 metric tons)								Per Capita CO ₂ Emissions (kg) 1996	CO ₂ Emitted Per Million Int\$ (PPP) of Gross Domestic Product (a) (metric tons)		Signatory to the Kyoto Protocol 1999 (Yes/No)
	Solid Fuels 1996	Liquid Fuels 1996	Gaseous Fuels 1996	Gas Flaring 1996	Cement Manufacturing 1996	Total 1990	Total 1996	Total Contribution Since 1950		1990	1996	
WORLD	9,013,440	9,497,088	4,382,144	245,488	740,128	22,361,392	23,881,952	718,514,064	4,157	X	X	X
ASIA (EXCL. MIDDLE EAST)	4,251,273	2,201,364	555,697	10,936	423,960	5,194,233	7,452,030	145,131,386	2,296	X	X	X
Armenia	15	1,528	2,015	0	141	X	3,697	130,452	b	1,037	X	425
Azerbaijan	15	18,166	11,736	0	100	X	30,019	1,637,062	b	3,945	X	2,621
Bangladesh	0	8,537	14,279	0	142	15,359	22,959	269,033		190	189	187
Bhutan	62	121	0	0	80	128	260	2,015		137	X	X
Cambodia	0	498	0	0	0	451	498	14,759		49	56	37
China	2,597,109	483,740	38,520	0	244,169	2,401,741	3,363,541	57,580,606		2,729	1,523	949
Georgia	509	645	1,762	0	50	X	2,968	503,077	b	572	X	308
India	677,411	229,213	50,230	2,549	37,981	675,261	997,385	15,516,498		1,050	710	652
Indonesia	42,026	108,290	74,643	7,641	12,458	165,210	245,056	3,538,050		1,223	447	365
Japan	341,239	651,020	128,321	0	47,086	1,070,665	1,167,666	31,157,964		9,284	463	389
Kazakhstan	122,968	31,913	17,715	0	1,246	X	173,846	10,119,364	b	10,577	X	3,134
Korea, Dem People's Rep	234,741	11,113	0	0	8,471	244,634	254,326	4,954,149		11,249	X	X
Korea, Rep	125,459	229,436	24,596	0	28,570	241,179	408,060	4,988,074		8,999	X	X
Kyrgyzstan	1,905	1,957	2,023	0	249	X	6,134	401,943	b	1,335	X	X
Lao People's Dem Rep	4	330	0	0	5	231	337	9,413		69	X	X
Malaysia	6,698	64,354	36,252	6	6,147	55,279	119,069	1,185,652	e	5,794	637	725
Mongolia	7,159	1,667	0	0	53	9,981	8,882	219,349		3,560	2,751	2,368
Myanmar	169	3,851	3,026	15	252	4,148	7,310	177,209		168	X	X
Nepal	132	1,312	0	0	171	630	1,612	21,160		74	42	69
Pakistan	9,358	49,904	30,638	0	4,435	67,872	94,333	1,188,653		674	516	468
Philippines	6,046	51,215	0	0	5,980	44,305	63,241	1,228,649		905	246	256
Singapore	117	64,076	0	0	1,644	41,920	65,835	981,736		19,505	958	801
Sri Lanka	4	6,625	0	0	451	3,855	7,079	155,068		391	137	163
Tajikistan	267	3,422	2,132	0	25	X	5,844	700,550	b	1,001	X	898
Thailand	45,932	117,658	24,329	0	17,441	95,740	205,360	1,899,256		3,471	433	501
Turkmenistan	264	13,015	20,738	0	225	X	34,244	1,219,985	b	8,240	X	3,623
Uzbekistan	3,158	19,427	69,902	0	2,492	X	94,978	3,772,482	b	4,157	X	1,656
Viet Nam	14,777	16,821	15	X	2,840	22,464	37,644	766,842	f	501	X	318
EUROPE	2,131,682	2,076,872	1,768,290	50,808	128,310	X	6,124,896	264,991,558	8,414	X	X	X
Albania	147	1,649	44	0	100	8,380	1,942	164,854		616	1,225	255
Austria	12,835	29,037	15,436	0	1,993	57,393	59,302	2,130,213		7,364	422	334
Belarus	5,382	30,686	24,945	0	731	X	61,742	3,241,636	b	5,949	X	1,380
Belgium	31,888	43,118	27,040	0	3,986	97,437	106,032	4,923,287		10,489	538	467
Bosnia and Herzegovina	942	1,583	484	0	100	X	3,111	X		909	X	X
Bulgaria	28,748	14,770	10,710	0	1,046	75,339	55,271	2,537,228		6,543	1,920	1,539
Croatia	458	11,205	4,961	0	918	X	17,543	X		3,909	X	770
Czech Rep	88,431	18,518	17,257	0	2,497	X	126,701	6,499,129	b	12,282	X	X
Denmark	23,512	23,336	8,035	372	1,310	50,724	56,561	2,244,068		10,792	560	467
Estonia	12,241	2,627	1,323	0	199	X	16,389	742,658	b	11,180	X	2,378
Finland	28,488	23,424	6,789	0	472	51,072	59,174	1,658,982		11,544	605	600
France	62,185	214,868	74,801	0	9,966	353,184	361,820	16,826,436		6,211	348	286
Germany	350,956	322,066	167,350	919	19,932	X	861,223	42,689,711	g	10,514	X	499
Greece	35,215	39,311	110	3	5,980	72,199	80,615	1,712,436		7,655	714	617
Hungary	17,067	17,617	23,402	0	1,383	64,120	59,470	2,868,938		5,834	955	848
Iceland	242	1,913	0	0	40	2,019	2,195	70,547		8,099	431	370
Ireland	12,025	16,067	6,068	0	747	29,847	34,907	959,653		9,606	731	505
Italy	42,821	238,043	105,421	0	16,942	398,852	403,231	12,319,486		7,029	427	349
Latvia	967	6,379	1,799	0	134	X	9,281	454,055	b	3,714	X	1,015
Lithuania	967	8,116	4,466	0	299	X	13,850	733,527	b	3,728	X	932
Macedonia, FYR	8,028	4,411	0	0	274	X	12,714	X		6,438	X	2,006
Moldova, Rep	2,466	2,876	6,723	0	35	X	12,099	742,909	b	2,765	X	X
Netherlands	35,021	32,796	85,302	399	1,644	138,891	155,163	5,192,482		9,984	578	484
Norway	3,807	20,819	7,357	34,232	797	47,669	67,015	1,787,369		15,327	670	640
Poland	280,761	47,251	21,852	0	6,916	347,585	356,782	14,369,915		9,229	1,947	1,506
Portugal	12,879	30,920	0	0	4,136	42,327	47,932	996,652		4,862	405	351
Romania	40,330	35,537	40,000	0	3,417	155,071	119,282	5,528,382		5,270	1,610	1,142
Russian Federation	484,546	338,865	732,393	9,859	13,853	X	1,579,514	68,412,659	b	10,681	X	X
Slovakia	19,489	7,878	11,036	0	1,246	X	3,964	1,967,818	b	7,389	X	X
Slovenia	3,257	7,786	1,502	0	498	X	13,040	X		6,537	X	575
Spain	69,843	130,328	19,767	12	12,536	211,710	232,484	6,183,432		5,872	442	382
Sweden	11,564	39,688	1,667	0	1,219	48,537	54,139	2,797,548		6,130	336	311
Switzerland	550	36,046	5,437	0	2,193	42,689	44,224	1,525,906		6,144	281	250
Ukraine	184,112	51,197	159,494	0	2,492	X	397,291	21,708,318	b	7,751	X	3,441
United Kingdom	169,427	207,983	168,778	5,013	5,780	563,281	556,983	27,167,794		9,532	606	472
Yugoslavia	23,831	6,126	5,141	0	1,099	X	36,197	3,299,234	h	3,413	X	X
MIDDLE EAST & N. AFRICA	104,241	765,021	399,574	72,170	67,379	1,057,086	1,408,390	24,846,874	3,792	X	X	X
Afghanistan	11	780	308	11	58	2,620	1,176	68,000		58	X	X
Algeria	3,188	22,651	50,567	14,400	3,488	80,443	94,297	1,725,913		3,283	755	728
Egypt	3,419	57,778	27,707	0	8,969	75,434	97,873	1,856,890		1,541	X	X
Iran, Islamic Rep	3,873	153,936	77,549	23,082	8,222	212,354	266,662	5,056,708		4,201	X	X
Iraq	0	84,023	6,221	96	1,046	49,262	91,387	1,493,703		4,435	X	X
Israel	21,068	28,847	26	0	2,392	34,628	52,329	907,258		9,145	557	503
Jordan	0	11,989	0	0	1,744	10,182	13,733	203,696		2,313	1,142	908
Kuwait	0	23,145	17,463	986	997	42,206	42,590	981,102		25,257	2,614	X
Lebanon	542	11,879	0	0	1,744	9,094	14,165	263,654		4,594	855	597
Libyan Arab Jamahiriya	15	25,348	9,966	3,482	1,769	37,772	40,579	855,830		7,978	X	X
Morocco	6,225	18,426	40	0	3,189	23,486	27,879	558,859		1,055	345	301
Oman	0	4,752	9,065	726	598	11,538	15,143	228,051		6,791	831	X
Saudi Arabia	0	156,343	79,351	23,948	8,191	177,096	267,831	4,107,234		14,225	1,168	1,338
Syrian Arab Rep	11	32,782	5,016	4,437	2,043	35,845	44,290	738,717		3,040	X	X
Tunisia	238	9,167	4,250	254	2,276	13,260	16,184	318,035		1,782	428	364
Turkey	65,600	80,901	15,649	0	16,195	143,819	178,342	3,212,251		2,861	554	474
United Arab Emirates	0	21,460	56,645	750	2,990	58,433	81,843	1,202,675		36,220	1,534	X
Yemen	0	16,488	0	0	518	9,603	17,008	247,111	i	1,085	X	X

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	Solid Fuels 1996	Liquid Fuels 1996	Gaseous Fuels 1996	Gas Flaring 1996	Cement Manufacturing 1996	Total	Total	Total		1990	1996		1996
						1990	1996	Contribution Since 1950					
SUB-SAHARAN AFRICA	268,395	170,270	14,070	54,136	12,685	466,991	519,548	12,928,091	894	X	X	X	
Angola	0	2,151	344	2,465	149	4,650	5,108	145,552	450	291	288	N	
Benin	0	465	0	0	189	564	656	14,762	120	122	94	N	
Botswana	6,383	12,579	4	9	691	2,415	19,665	51,505	13,035	337	1,778	N	
Burkina Faso	0	967	0	0	0	1,008	967	14,682	90	146	96	N	
Burundi	18	202	0	0	0	194	220	3,975	35	46	54	N	
Cameroon	4	3,213	0	0	299	1,488	3,517	86,507	260	65	139	N	
Central African Rep	0	234	0	0	0	198	234	5,866	70	X	X	N	
Chad	0	99	0	0	0	143	99	5,027	14	35	15	N	
Congo	0	4,741	7	167	50	2,037	4,961	40,161	1,884	X	X	N	
Congo, Dem Rep	854	1,436	0	0	5	4,096	2,294	142,475	49	X	X	N	
Côte d'Ivoire	0	12,817	0	0	249	9,907	13,066	185,109	946	X	X	N	
Equatorial Guinea	0	143	0	0	0	117	143	2,862	349	X	X	N	
Eritrea	X	X	X	X	X	X	X	X	X	X	X	N	
Ethiopia	0	3,048	0	0	320	2,964	3,367	66,509	59	144	117	N	
Gabon	0	2,041	1,587	0	65	6,112	3,690	135,432	3,333	1,019	437	N	
Gambia	0	216	0	0	0	191	216	4,481	188	X	X	N	
Ghana	7	3,342	0	0	698	3,539	4,045	109,271	223	187	142	N	
Guinea	0	1,092	0	0	0	1,011	1,092	32,445	150	126	88	N	
Guinea-Bissau	0	231	0	0	0	209	231	4,477	208	X	X	N	
Kenya	267	5,760	0	0	747	5,822	6,775	180,020	243	228	203	N	
Lesotho	X	X	X	X	X	X	X	X	X	X	X	N	
Liberia	0	326	0	0	0	465	326	33,189	148	X	X	N	
Madagascar	44	1,121	0	0	30	945	1,198	37,860	84	87	94	N	
Malawi	44	616	0	0	70	601	733	18,184	75	127	105	N	
Mali	0	462	0	0	10	421	473	12,025	46	81	66	Y	
Mauritania	15	2,876	0	0	60	2,634	2,950	40,648	1,232	943	720	N	
Mozambique	158	821	0	0	15	997	997	89,149	56	132	91	N	
Namibia	X	X	X	X	X	X	X	X	X	X	X	N	
Niger	458	649	0	0	15	1,048	1,121	20,863	119	162	139	Y	
Nigeria	150	21,596	8,596	51,494	1,495	88,665	83,330	1,944,327	822	1,196	802	N	
Rwanda	0	484	0	2	5	528	491	9,167	90	96	105	N	
Senegal	0	2,770	0	0	294	2,895	3,063	76,142	358	263	211	N	
Sierra Leone	0	447	0	0	0	333	447	19,844	104	128	182	N	
Somalia	0	0	0	0	15	18	15	13,747	2	X	X	N	
South Africa	227,707	56,821	3,532	0	4,684	291,108	292,746	8,541,575	7,678	1,236	986	N	
Sudan	0	3,283	0	0	189	3,459	3,473	137,001	128	148	83	N	
Tanzania, United Rep	15	2,030	0	0	399	2,272	2,444	61,694	80	166	146	N	
Togo	0	575	0	0	174	689	751	17,023	180	140	121	N	
Uganda	0	986	0	0	50	846	1,033	32,837	53	67	46	N	
Zambia	773	1,499	0	0	174	2,444	2,444	111,151	291	344	277	Y	
Zimbabwe	13,623	4,217	0	0	573	16,646	18,412	369,232	1,667	818	705	N	
NORTH AMERICA	2,012,492	2,279,862	1,354,255	18,726	45,005	5,233,610	5,710,344	200,969,374	19,074	X	X	X	
Canada	94,927	148,293	156,434	4,190	5,506	409,628	409,353	14,855,347	13,669	790	622	Y	
United States	1,917,565	2,131,569	1,197,820	14,535	39,499	4,823,982	5,300,991	186,114,027	19,674	858	706	Y	
C. AMERICA & CARIBBEAN	20,196	367,202	81,885	6,560	16,832	411,973	499,033	11,518,037	3,078	X	X	X	
Belize	0	355	0	0	0	311	355	7,478	1,624	469	368	N	
Costa Rica	0	4,192	0	0	493	2,917	4,683	85,756	1,282	188	209	Y	
Cuba	509	29,854	84	0	724	31,818	31,170	1,018,401	2,829	X	X	Y	
Dominican Rep	341	11,805	0	0	747	9,435	12,890	237,779	1,619	X	X	Y	
El Salvador	0	3,572	0	0	472	2,616	4,045	82,535	699	254	245	Y d	
Guatemala	0	6,210	22	0	543	5,086	6,775	138,961	661	181	163	Y d	
Haiti	0	1,048	0	0	25	993	1,070	25,238	139	107	114	N	
Honduras	0	3,550	0	0	479	2,590	4,027	72,591	692	268	315	Y	
Jamaica	169	9,603	0	0	277	7,958	10,050	234,650	4,029	1,069	1,113	X c,d	
Mexico	17,910	248,104	67,165	3,549	11,376	294,974	348,106	7,760,957	3,754	525	470	Y	
Nicaragua	0	2,686	0	0	174	2,601	2,862	70,015	629	455	322	Y	
Panama	150	6,240	174	0	174	3,129	6,679	129,933	2,495	259	357	Y d	
Trinidad and Tobago	0	4,536	14,385	3,010	307	16,924	22,237	489,957	17,508	2,521	2,570	Y d	
SOUTH AMERICA	73,514	460,568	143,413	24,600	33,789	572,181	735,885	17,875,788	2,260	X	X	X	
Argentina	3,019	63,853	54,502	5,929	2,550	109,729	129,852	3,853,154	3,687	519	381	Y	
Bolivia	0	4,639	3,239	1,759	465	5,500	10,102	159,637	1,330	377	468	Y	
Brazil	44,642	197,585	10,622	3,284	17,240	202,612	273,371	5,706,610	1,692	273	266	Y	
Chile	11,439	31,573	3,635	321	1,811	36,263	48,779	1,076,150	3,383	383	278	Y	
Colombia	11,871	38,901	9,658	719	4,159	55,850	65,307	1,589,993	1,662	313	246	N	
Ecuador	0	20,918	1,271	960	1,334	16,569	24,487	421,888	2,093	408	428	Y	
Guyana	0	953	0	0	0	1,132	953	51,915	1,138	848	379	N	
Paraguay	0	3,386	0	0	309	2,261	3,697	53,960	746	163	204	Y d	
Peru	1,447	22,416	352	43	1,917	22,175	26,176	771,034	1,093	357	244	Y	
Suriname	0	2,074	0	0	25	1,810	2,099	63,647	5,115	X	X	N	
Uruguay	4	5,298	0	0	341	3,909	5,643	217,601	1,741	200	196	Y	
Venezuela	1,092	68,055	60,134	11,584	3,638	113,569	144,501	3,897,477	6,477	798	765	N	
OCEANIA	198,424	92,047	48,061	0	3,833	295,524	342,360	8,582,495	11,842	X	X	X	
Australia	192,774	72,723	37,897	0	3,239	266,010	306,633	7,622,743	16,902	1,011	820	N	
Fiji	59	660	0	0	46	813	762	23,058	981	326	230	Y d	
New Zealand	5,141	14,110	10,003	0	498	23,596	29,752	791,083	7,997	508	463	Y	
Papua New Guinea	4	2,246	161	0	0	2,429	2,407	56,202	547	X	X	Y	
Solomon Islands	0	161	0	0	0	161	161	3,488	412	263	171	Y	

Notes: Negative values are shown in parentheses. "0" is either zero or less than one-half the unit of measure. a. Gross domestic product figures are calculated using purchasing power parity (PPP) and are in current international dollars. b. Data are estimated for the countries of the former Soviet Union and former Czechoslovakia before 1992. (See technical notes for further explanation.) c. Country went straight to ratification. d. Country has ratified the Kyoto Protocol. e. Includes Singapore until 1957. f. Data before 1970 refer to the Democratic Republic of Viet Nam and South Viet Nam. g. Data before 1991 refer to the Democratic Republic of Germany and the Federal Republic of Germany. h. Data include Bosnia and Herzegovina, Croatia, Macedonia (FYR), Slovenia, Yugoslavia, and the former Socialist Federal Republic of Yugoslavia. i. Data before 1991 refer to the People's Democratic Republic of Yemen and the Republic of Yemen.

Table AC.1 Emissions from Fossil Fuel Burning and Cement Manufacturing

Source: All fossil fuel carbon dioxide emissions data: Carbon Dioxide Information Analysis Center (CDIAC), Global, Regional, and National Annual CO₂ Emissions from Fossil-Fuel Burning, Hydraulic Cement Production, and Gas Flaring: 1751–1996, ORNL/CDIAC-25, NDP-030 (Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1999). Data are available online at: <http://cdiac.esd.ornl.gov/ftp/ndp030/>. Gross domestic product at purchasing power parity in current international dollars: World Bank, World Development Indicators 1999, on CD-ROM (Development Data Group, World Bank, Washington, D.C., 1999). Population figures for per capita calculations: United Nations (U.N.) Population Division, Annual Populations 1950–2050 (The 1998 Revision), on diskette (U.N., New York, 1999). Kyoto Protocol data: U.N. Framework Convention on Climate Change (an Internet-accessible numerical database) available online at: <http://www.unfccc.de/>.

Carbon dioxide (CO₂) emissions are often calculated and reported in terms of their content of elemental carbon. For this table, their values were converted to the actual mass of CO₂ by multiplying the carbon mass by 3.664 (the ratio of the mass of CO₂ to that of carbon).

These data from CDIAC represent a complete harmonized global dataset of CO₂ emissions. However, individual country estimates, based on more detailed information and a country-specific methodology, could differ. Guidelines were developed to assist in the preparation of national greenhouse gases inventories. The Intergovernmental Panel on Climate Change (IPCC) accepted these guidelines at its Twelfth Session in Mexico City on September 11–13, 1996. The guidelines were published in Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, Cambridge, England, 1997). Such data are currently available for an increasing number of countries, but long time series are rare. Methods used by CDIAC have the advantage of calculating CO₂ emissions from a single common dataset available for all countries.

Solid fuels, liquid fuels, and gaseous fuels are primarily, but not exclusively, coals, petroleum products, and natural gas, respectively. Gas flaring is the practice of burning off gas released in the process of petroleum extraction, a practice that is declining. During cement manufacturing, cement is calcined to produce calcium oxide. In the process, 0.498 metric ton of CO₂ is released for each ton of cement produced. Total emissions for 1990 and 1996 consist of the sum of the CO₂ produced during the consumption of solid, liquid, and gaseous fuels, and from gas flaring and the manufacture of cement. However, these estimates do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport. For more information, please see the World Resources 2000–01 Database CD-ROM or the original source for data on emissions from bunker fuels.

CDIAC annually calculates emissions of CO₂ from the burning of fossil fuels and the manufacture of cement for most of the countries of the world. CDIAC calculates emissions from data on the net apparent consumption of fossil fuels (based on the World Energy Data Set maintained by the U.N. Statistical Division) and from data on world cement manufacturing (based on the Cement Manufacturing Data Set maintained by the U.S. Geological Survey). Emissions are calculated using conversion factors based on global average fuel chemistry and oxidation rates.

Total contribution since 1950 represents total carbon dioxide emitted from 1950 to 1996, excluding bunker fuels. For the independent republics of the former Soviet Union, CO₂ emissions from 1950 to 1991 are estimates based on each country's post-1991 share of all emissions from the entire former Soviet Union. Total 1992 CO₂ emissions for the former Soviet Union were 3,289,909 tons; the share of that total was then calculated for each of the former Soviet republics. For example, Kazakhstan's

Table AC.1 Emissions from Fossil Fuel Burning and Cement Manufacturing

emissions in 1992 were calculated to be 8.90 percent of the total carbon emitted from the former Soviet Union. The same approach was used for the other former Soviet republics. Therefore, the total contributions for the former Soviet republics from 1950 to 1991 should be taken only as rough approximations. An equivalent method was used to calculate historical estimates for the former Czechoslovakia.

Per capita carbon emissions are calculated using 1996 CO₂ emissions and the 1996 population estimates from the U.N. Population Division (medium-case scenario).

The carbon dioxide intensity of a country's economic output is expressed as CO₂ emitted per million international dollars (PPP) of gross domestic product in metric tons. Gross domestic product (GDP) measures the final output of goods and services produced by the domestic economy. The international dollar values, which are different from U.S. dollar values, are obtained using special conversion factors designed to equalize the purchasing powers of different currencies. This conversion factor, the purchasing power parity (PPP), is defined as the number of units of a country's currency that are required to buy the same amounts of goods and services in the domestic market as \$1 would buy in the United States. The computation involves deriving implicit quantities from national account expenditure data and specially collected price data, and then revaluing the implicit quantities in each country at a single set of average prices. Because the same international price averages are used for every country, cross-country comparisons reflect differences in quantities of goods and services free of price-level differences. This procedure is designed to bring cross-country comparisons in line with cross-time real-value comparisons that are based on constant price series. PPP estimates tend to lower per capita GDPs in industrialized countries and raise per capita GDPs in developing countries.

Information concerning whether a country is a signatory and whether they have ratified the Kyoto Protocol is current through October 1999. The Kyoto Protocol attempts to place legally binding limits on greenhouse gas emissions (carbon dioxide [CO₂], methane [CH₄], nitrous oxide [N₂O], hydrofluorocarbons [HFCs], perfluorocarbons [PFCs], and sulfur hexafluoride [SF₆]) from developed countries. By signing the treaty, a state recognizes the authentic text, intends to complete the procedures for becoming legally bound by it, and is committed not to act against the treaty's objectives before ratification. Ratification (or its alternatives of acceptance, approval, or accession) binds the state to observe the treaty. Depending on a country's system of governance, signing the treaty may be simply an executive decision while ratification may require legislative approval. Quantitative obligations by developed countries will be based on the base year of 1990. For further information about the Kyoto Protocol, please refer to the information available online at: <http://www.unfccc.de/resource/convkp.html>.