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[illegible]

	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	
1	Summary of emissions from identified coal production																									
2																										
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7																										
8	1870s								1880s										1890s							
9	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	
10	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	
11	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	
12	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	
13	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	
14	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	
15	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	
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38	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	
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90	0.9	1.0	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	
91																										
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94	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	6	6	6	6	6	7	
95																										
96	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	
97																										
98	634	671	634	685	696	704	711	758	854	876	923	986	993	1,000	1,008	1,052	1,162	1,165	1,264	1,319	1,330	1,312	1,363	1,440	1,484	
99																										
100	173	183	173	187	190	192	194	207	233	239	252	269	271	273	275	287	317	318	345	360	363	358	372	393	405	
101																										
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1	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI		
2	Summary of emissions from identified coal production																										
3	Richard Heede																										
4	Climate Mitigation Services																										
5	22-May-13																										
6																											
7				1900s											1910s												
8	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921		
9	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129		
10	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203		
11	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814		
12	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439		
13	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622		
14	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665		
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	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH
1																									
2	Summary of emissions from identified coal production																								
3																									
4	Richard Heede																								
5	Climate Mitigation Services																								
6	22-May-13																								
7																									
8	1920s								1930s										1940s						
9	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946
10	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	
11	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	
12	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	
13	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	
14	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	
15	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	
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47	28	35	43	50	58	65	72	80	87	110	154	190	243	238	276	277	290	360	431	485	540	304	277	320	352
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93																									
94	121	130	140	150	159	169	176	183	189	212	256	291	349	344	386	391	457	536	614	678	742	515	504	574	636
95																									
96	33	36	38	41	43	46	48	50	52	58	70	80	95	94	105	107	125	146	168	185	202	141	137	157	174
97																									
98	2,712	3,096	3,063	3,085	3,100	3,316	3,261	3,470	3,159	2,781	2,473	2,594	2,840	2,972	3,272	3,448	3,224	3,364	3,726	3,822	3,895	4,001	3,836	3,005	3,206
99																									
100	740	845	836	842	846	905	890	947	862	759	675	708	775	811	893	941	880	918	1,017	1,043	1,063	1,092	1,047	820	875
101																									
102	4.5%	4.2%	4.6%	4.8%	5.1%	5.1%	5.4%	5.3%	6.0%	7.6%	10.3%	11.2%	12.3%	11.6%	11.8%	11.3%	14.2%	15.9%	16.5%	17.7%	19.0%	12.9%	13.1%	19.1%	19.8%
103																									
104																									
105																									
106																									

	DI	DJ	DK	DL	DM	DN	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG		
1	Summary of emissions from identified coal production																									
2																										
3	Richard Heede																									
4	Climate Mitigation Services																									
5	[22-May-13]																									
6																										
7																										
8	1940s			1950s										1960s												
9	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	
10																										
11	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	2.129	
12	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	
13	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	1.814	
14	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439	
15	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	2.622	
16	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	2.665	
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21	23	24	25	25	24	26	27	27	28	29	29	31	31	32	33	33	33	34	42	40	38	33	27	30	32	
22																										
23																										
24																										
25																										
26	488	504	520	536	538	541	544	546	549	535	521	507	494	480	474	469	464	458	453	433	413	393	373	353	344	
27																										
28														8	7	8	9	10	12	19	20	19	23	23	20	
29																										
30									6	6	7	7	8	8	8	10	10	11	12	14	14	14	16	16	17	
31																										
32	45	62	79	95	112	128	214	299	385	470	255	641	726	812	485	485	529	565	582	635	441	582	702	906	912	
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38	42	44	46	49	51	53	57	62	66	77	82	86	91	96	100	105	110	115	119	124	129	133	136	143	122	
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42	33	32	31	33	43	52	62	71	81	90	100	109	119	128	139	147	154	158	153	153	148	153	162	167	172	
43																										
44																										
45																										
46																										
47																										
48	382	448	516	599	614	656	772	880	942	1,034	1,116	1,194	1,220	1,237	1,231	1,247	1,282	1,335	1,393	1,411	1,435	1,434	1,289	1,278	1,318	
49																										
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51																										
52																										
53	6	6	7	7	7	7	7	7	7	8	8	8	8	8	9	9	9	9	9	10	10	10	10	10	11	
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62				2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	10	10	11	9	
63																										
64																										
65																										
66	9	11	13	15	18	13	13	16	19	22	25	28	31	34	37	41	44	47	50	53	56	59	69	68	52	
67																										
68	7	10	13	16	26	21	16	18	22	42	45	43	50	56	58	64	76	91	95	105	109	112	116	132	109	
69																										
70																		18	20	20	20	20	17	17	16	
71																										
72	142	150	158	166	173	180	187	193	200	207	214	221	228	235	241	249	265	284	292	302	305	321	342	356	371	
73																										
74																3	3	3	4	4	5	6	6	6	6	6
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81																				107	112	111	120	124	126	122
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83							0	1	3	3	4	5	5	5	6	6	6	6	7	8	9	10	9	10	10	
84	5	5	5	5	5	6	6	6	6	6	7	7	8	8	9	10	10	10	11	11	11	11	12	10	9	
85																										
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87																										
88																										
89																										
90	8	8	8	8	9	9	9	9	9	10	10	10	10	11	11	11	11	11	12	12	12	12	17	17	12	
91																										
92																										
93																										
94	1,191	1,303	1,420	1,556	1,622	1,695	1,916	2,139	2,327	2,543	2,426	2,902	3,032	3,162	2,855	2,900	3,019	3,150	3,375	3,472	3,290	3,452	3,482	3,708	3,695	
95																										
96	325	356	388	425	443	462	523	584	635	694	662	792	828	863	779	791	824	860	921	947	898	942	950	1,012	1,008	
97																										
98	3,635	3,719	3,518	3,921	4,137	4,100	4,122	4,089	4,426	4,665	4,796	4,895	5,064	5,167	4,943	4,950	5,115	5,258	5,350	5,416	5,306	5,306	5,445	5,701	5,712	
99																										
100	992	1,015	960	1,070	1,129	1,119	1,125	1,116	1,208	1,273	1,309	1,336	1,382	1,410	1,349	1,351	1,396	1,435	1,460	1,478	1,448	1,448	1,486	1,556	1,559	
101																										
102	32.8%	35.0%	40.4%	39.7%	39.2%	41.3%	46.5%	52.3%	52.6%	54.5%	50.6%	59.3%	59.9%	61.2%	57.8%	58.6%	59.0%	59.9%	63.1%	64.1%	62.0%	65.1%	64.0%	65.0%	64.7%	
103																										
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Cell: FS2

Comment: Rick Heede:

We have calculated carbon coefficients for various coal ranks in the attached worksheet ("Coal C Coefficients") and here apply the coefficient for "average utility coal," which comprises the bulk of the coal mined by the identified coal operators. Where information on coal types and ranks is available in company annual reports, each coal rank and amounts produced are listed in separate columns, permitting more precise estimation of the amount of carbon dioxide emitted by the coal's combustion. EPA (2011) "Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2010," Annex B, Table B2 and Annex 4 (IPCC Reference Approach for Estimating CO2 Emissions from Fossil Fuel Combustion: Tables 4-2 and 4-4. Also see citations and calculations at "Coal Carbon Coefficients" worksheet.

Cell: L18

Comment: Rick Heede:

Are the coal-type percentages linked to each entity's worksheet? And verified?

Cell: EJ22

Comment: Rick Heede:

Since Anglo apparently started mining metallurgical coal in 1974, CMS applies the average metallurgical to thermal coal factor to 1974-2004 only; prior years are applied the thermal coal factor.

Cell: FX28

Comment: Rick Heede:

BP's share of the acquired ARCO coal interests are allocated to Arch Coal, which acquired ARCO's coal operations in 1998. CSM has attributed Sohio (Amoco) coal production from 1960 to 1979 and BP coal from 1979 to 1989 (partial production histories).

Cell: FX34

Comment: Rick Heede:

Preliminary estimate based on attributing 88 percent of India's total coal production to Coal India Ltd (CIL) and 8 percent to Singareni Collieries. See each worksheet for details.

Cell: FX36

Comment: Rick Heede:

Conoco acquired Consolidation Coal Company in 1966, DuPont acquired an ownership interest in Conoco in 1981, Rheinbraun acquired Consolidation Group from DuPont in 1998. Renamed CONSOL Energy in 1999.

CMS attributes all coal production from 1864 to 2008 to CONSOL Energy.

Cell: FX38

Comment: Rick Heede (Feb10):

CONSOL Energy produces bituminous coal and coal-bed methane (CBM). CONSOL Energy has its roots in Consolidation Coal Company (established in 1864 in Cumberland, MD). Consolidation Coal merged with Pittsburgh Coal in 1945, and was acquired by Continental Oil Company (Conoco) in 1966, which was itself acquired by DuPont in 1981. Sold to Rheinbraun/RWE in 1998. Renamed CONSOL Energy in 1999.

CMS attributes all historical production to CONSOL Energy, and removes attribution to Conoco and DuPont 1966-1998.

Note: CONSOL Energy estimates total coal production 1864-1964 at ~ 1 billion tons, whereas our estimate for the same period is 1.19 billion tons -- due to necessity of interpolating between known production in years 1864-1865, 1900, 1903, 1927, 1933-1935, 1952, and 1968. See CONSOL worksheet for details.

Cell: FX92

Comment: Rick Heede:

Xstrata plc's acquisition of Glencore International AG's Australian and South African coal business in March 2002 and its acquisition of M.I.M. Holdings in June 2003. Today Xstrata Coal has interests in over thirty coal mines located in Australia and South Africa and employs around 10,000 people, including contractors.

Cell: FX98

Comment: Rick Heede:

CDIAC data in million tonnes of carbon converted to CO2, which is 3.664191 times Carbon if carbon and oxygen isotopes are accounted for, per Kevin Baumert May05, then at World resources Institute: CO2 conversion is, precisely: C=12.0107 + O=15.9994 x 2 = 44.0095/12.0107 = 3.664191.

Cell: FT100

Comment: Rick Heede:

Updated with CDIAC emissions for solid fuels to 2010 in December 2011.

Cell: FX100

Comment: Rick Heede:

From the associated "Methods" paper: CDIAC's emissions are estimated for each fuel using the following formula: CO2 = (P) (FO) (C).

From primary and secondary solid fuel production and trade⁵
CO2s = CO2 emissions in 106 metric tons of carbon
Ps = annual production or consumption in 106 tons coal equivalent⁶
FOs = 0.982 ± 2%
Cs = carbon content in tons C per ton coal equivalent = 0.746 ± 2%.

While there is, as Marland et al point out, a strong correlation between heat rate and carbon content and the "C content is quite constant when production is in units of tonnes coal equivalent where 1 tonne coal equivalent is defined as 29.31 10⁹ joules." CMS factor of 21 million Btu per short ton = 23.15 million Btu/tonne, and the CDIAC datum (29.31 10⁹ joules/tonne) = 27.78 million Btu/tonne.

CDIAC uses average carbon content of 74.6 percent per tonne of coal equivalent, whereas CMS uses an average factor of 60.1 percent for utility coal per tonne (albeit not the same equiv tonne used by CDIAC; the average utility coal factor CMS applies to coal production when coal rank is not specified).

If we "upgrade" CMS's "average utility coal" to CDIAC's coal equivalent, the CMS carbon factor per tonne of coal becomes 27.78/23.15 = 1.20; 1.20 times the CMS carbon content per tonne of average utility coal = 601.4 tonne carbon per tonne of coal times 1.2 = 721.7 kgC/tonne, or 0.7217. Compare CDIAC's carbon factor of 0.746 ± 2%, which is 3.4 percent higher than the adjusted CMS factor. In practice, however, for the companies and countries listed in the coal production sheet, and applying the coal ranks when known (and thus a higher proportion of lignite than higher-grade coals on a tonnage basis), the AVERAGE coal contains 0.5733 tonne carbon per tonne produced (20July06: 72,724 million tonnes C / 126,862 million tonnes coal produced = 0.5733). (Note: this is prior to any application of oxidation rate and non-fuel uses.) In sum, CMS may be underestimating the emissions of carbon dioxide by (0.746 - 0.573)/0.573 = 0.302, or 30.2 percent relative to the CDIAC data.

Now, let's compare the annual CDIAC carbon data with EIA's global coal production data as follows:

1990: CDIAC estimates 2,378 million tonnes carbon (MtC) vs EIA coal production of 4,851 million tonnes of coal: 0.4902 tC/tonne coal;

2000: CDIAC estimates 2,214 million tonnes carbon (MtC) vs EIA coal production of 4,473 million tonnes of coal: 0.4950 tC/tonne coal.

In other words, curious results compared to the CDIAC factors discussed above, even though the FO (fuel oxidation rate) factor is not applied to 1990 and 2000; the FO would reduce the carbon emitted from a tonne of coal by 1.8 percent.

Applying CDIAC's formula of CO2 = (P) (FO) (C) without making any adjustment for CDIAC's coal equivalent or fuel oxidation rate for 2000 coal production: CO2 = (4,473 million tonnes of coal produced) * 0.982 * 0.746 = 3,277 million tonnes of carbon; in contrast, CDIAC's estimated emissions = 2,214 MtC. The EIA data includes lignite, sub-bituminous, bituminous, and anthracite coal.

CMS has not resolved this apparent discrepancy between CDIAC emissions estimates from combustion of solid fuels and the EIA coal production data.

Source: Marland, Gregg, Tom Boden, & R. J. Andres (~2005) "Global, Regional, and National Fossil Fuel CO2 Emissions," Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, US DOE, http://cdiac.esd.ornl.gov/trends/emis/em_cont.htm

Boden, T.A., G. Marland, and R.J. Andres. 2009. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001.

Jan10: CMS added CDIAC extrapolations for coal emissions from their dataset "Preliminary 2007-08 Global & National Estimates by Extrapolation" (undated) to the main file cited above.

Cell: FX102

Comment: Rick Heede:

Of CDIAC estimated emissions of carbon dioxide from combustion of coal worldwide 1751-2004, CMS has identified (at this writing, 26Nov06) 47.5 percent from the production of coal by identified producers from 1990 to 2004. Note that CMS has differentiated emissions by rank of coal produced, when company or country production data makes this possible to do.

Cell: FX105

Comment: Rick Heede:

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