

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Summary of emissions from identified coal production											
2		Richard Heede Climate Mitigation Services 22-May-13											
3		Copyright Climate Mitigation Services											
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Emission factor
tCO2/tonne
2,129
1,203
1,814
2,439
2,622
2,665

Tonnes CO2 per tonne coal (tCO2/t)	thermal coal = average utility coal
	lignite, brown, or soft coal
	sub-bituminous coal
	bituminous coal
	anthracite
	metallurgical

Thermal	Lignite	Sub-bituminous	Bituminous	Anthracite	Metallurgical	Total	linked?
Percent	Percent	Percent	Percent	Percent	Percent	Percent	

1	26.0%					74.0%	100%	Yes
2	76.8%					23.2%	100%	Yes
3	100.0%						100%	Yes
4				100.0%			100%	Yes
5	100.0%						100%	Yes
6	71.1%				28.9%		100%	Yes
7		4.0%	76.7%		19.3%		100%	Yes
8		6.6%	93.4%				100%	Yes
9				97.4%	2.6%		100%	Yes
10				92.3%	7.7%		100%	Yes
11	100.0%	assumed thermal					100%	Yes
12		48.4%	51.6%				100%	Yes
13		78.0%		22.0%			100%	Yes
14	100.0%						100%	Yes
15		21.9%		68.5%	9.6%		100%	Yes
16		4.1%		95.9%	0.0%		100%	Yes
17	100.0%						100%	Yes
18		5.9%	94.1%				100%	Yes
19		100.0%					100%	Yes
20				72.9%	27.1%		100%	Yes
21				100.0%			100%	Yes
22		100.0%					100%	Yes
23		23.3%		75.0%	1.7%		100%	Yes
24				69.0%	31.0%		100%	Yes
25	96.9%				3.1%		100%	Yes
26				100.0%			100%	Yes
27		30.5%		69.5%	0.0%		100%	Yes
28			65.4%	31.3%	3.3%		100%	Yes
29		68.5%			31.5%		100%	Yes
30		31.3%		64.4%	4.3%		100%	Yes
31		89.1%		10.9%			100%	Yes
32				100.0%			100%	Yes
33		6.6%	93.4%				100%	Yes
34				100.0%			100%	Yes
35		1.8%		77.3%	20.9%		100%	Yes
36		34.0%	66.0%				100%	Yes
37				84.4%	15.6%		100%	Yes

Emissions from identified coal prod'n (MtCO2/yr)
Emissions from identified coal prod'n (MtC/yr)
CDIAC coal emissions (MtCO2/yr) 1751-2008
CDIAC coal emissions (MtC/yr) 1751-2008
Percent of total CDIAC coal emissions identified

Converted to CO2:	4,595
CDIAC sum 1751-1849:	1,254

	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	Summary of emissions from identified coal production																						
2	Richard Heede Climate Mitigation Services 22-May-13																						
3	1850s											1860s											
4	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	
5	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	
6	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	
7	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	
8	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	
9	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	
10	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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98	198	198	209	216	253	260	278	282	286	304	333	348	352	377	410	436	447	476	491	520	535	572	
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	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	<div style="background-color: yellow; padding: 5px; display: inline-block;">Summary of emissions from identified coal production</div> Richard Heede Climate Mitigation Services 22-May-13																								
2																									
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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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96	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	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
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	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	
1																										
2	Summary of emissions from identified coal production																									
3																										
4	Richard Heede																									
5	Climate Mitigation Services																									
6	[22-May-13]																									
7																										
8	1900s										1910s										1910s					
9	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	
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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96	2	2	2	12	13	14	15	14	14	14	14	14	14	14	14	14	30	30	29	29	29	28	28	28	30	
97																										
98	1.557	1.645	1.799	1.887	1.946	1.990	2.173	2.188	2.330	2.492	2.748	2.616	2.737	2.851	2.902	3.056	3.279	2.931	2.873	3.085	3.265	3.199	2.693	3.089	2.598	
99																										
100	425	449	491	515	531	543	593	597	636	680	750	714	747	778	792	834	895	800	784	842	891	873	735	843	709	
101																										
102		2.3%	2.4%	2.5%	2.5%	2.4%	2.3%	2.1%	1.9%	1.9%	1.9%	1.8%	1.7%	1.6%	3.4%	3.7%	3.8%	3.5%	3.2%	3.3%	3.8%	3.3%	3.3%	4.3%		
103																										
104																										
105																										
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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	Summary of emissions from identified coal production																								
2	Richard Heede Climate Mitigation Services [22-May-13]																								
3																									
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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	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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66																									
67																									
68																									
69																									
70																									
71																									
72	60	61	62	64	65	66	68	69	70	71	72	73	74	75	76	78	79	86	93	100	107	114	121	128	135
73																									
74																									
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85																									
86																									
87																									
88																									
89	6	6	5	5	5	5	5	5	5	4	5	5	5	5	5	6	6	6	6	6	7	7	7	7	8
90																									
91																									
92																									
93	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
94																									
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	DO	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	Richard Heede Climate Mitigation Services 22-May-13																								
3																									
4																									
5																									
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	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
16																									
17																									
18																									
19																									
20																									
21																									
22	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
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																									
29																									
30																									
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
33																									
34																									
35																									
36																									
37																									
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
39	<--- bituminous bituminous & metallurgical ---->																								
40																									
41																									
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																									
50																									
51																									
52																									
53	6	6	7	7	7	7	7	7	7	8	8	8	8	8	8	9	9	9	9	9	10	10	10	10	11
54																									
55																									
56																									
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58																									
59																									
60																									
61																									
62																									
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																									
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																									
75																									
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83																									
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																									
86																									
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																									
104																									
105																									
106																									

	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY
1	Summary of emissions from identified coal production																Carbon coefficient	2.129	Million tonnes CO2 / million tonnes of coal	
2																				
3																			(average utility coal, USA)	
4																	dataset marker	Richard Heede	Climate Mitigation Services	
5																			Copyright Climate Mitigation Services	
6																			22-May-13	
7																			Y sums verified, linked to columns D-J and rows 11-16.	
8	1990s					2000s										Sum to 2010		Coal		
9	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Million tonnes CO2				
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	thermal coal = average utility coal		Tonnes CO2 per tonne produced (tCO2/t)		
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	lignite, brown, or soft coal		Tonnes CO2 per tonne produced (tCO2/t)		
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	sub-bituminous coal		Tonnes CO2 per tonne produced (tCO2/t)		
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	bituminous coal		Tonnes CO2 per tonne produced (tCO2/t)		
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	anthracite		Tonnes CO2 per tonne produced (tCO2/t)		
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	metallurgical		Tonnes CO2 per tonne produced (tCO2/t)		
16																	Sum to 2010			
17																	1,981		Alpha Natural Resources, USA	
18																	6,676		Anglo American, UK	
19																	5,428		Arch Coal Company, USA	
20																	17,742		British Coal Corporation	
21																	918		BP Coal, UK	
22																	5,355		BHP Billiton, Australia	
23																	105,961		China, Peoples Republic	
24																	14,282		Coal India, India	
25																	-		ConocoPhillips (see CONSOL Energy)	
26																	8,342		CONSOL Energy, USA	
27																	1,611		Cyprus Amax, USA	
28																	6,773		Czechoslovakia	
29																	1,844		Czech Republic + Slovakia	
30																	1,317		Exxon Mobil	
31																	63,480		FSU (Former Soviet Union)	
32																	4,095		Kazakhstan	
33																	636		Kerr-McGee Coal (Anadarko), USA	
34																	1,194		Klewit Mining Group, USA	
35																	967		Luminant, USA	
36																	2,027		Massey Energy Corporation	
37																	734		Murray Coal Corporation, USA	
38																	1,088		North American Coal Corp., USA	
39																	2,583		North Korea	
40																	1,725		Occidental, USA	
41																	11,461		Peabody Energy, USA	
42																	1,229		Pittsburgh & Midway Coal (Chevron)	
43																	24,661		Poland	
44																	5,495		Rio Tinto, Australia	
45																	1,049		Ruhrkohle AG (RAG), Germany	
46																	10,365		Russian Federation (not including FSU)	
47																	6,309		RWE, Germany	
48																	3,241		Sasol, South Africa	
49																	1,735		Singareni Collieries Company, India	
50																	732		UK Coal, UK	
51																	3,107		Ukraine	
52																	1,411		Westmoreland Coal, USA	
53																	2,049		Xstrata, Switzerland	
54																	329,604		sum check	
55																	329,604		Emissions from identified prod'n (MtCO2/yr)	
56																	89,953		Emissions from identified prod'n (MtC/yr)	
57																	642,500		CDIAC coal emissions (MtCO2/yr) 1751-2010	
58																	175,346		CDIAC coal emissions (MtC/yr) 1751-2010	
59																	51.3%		Percent of total CDIAC coal emissions identified	
60																	Total emissions from identified coal producers through 2010 (million tonnes CO2)		329,604	

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 10^9 joules." CMS factor of 21 million Btu per short ton = 23.15 million Btu/tonne, and the CDIAC datum (29.31 10^9 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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