

# Summary of CO2 & methane emissions from identified oil & NGL production

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Richard Heede  
Climate Accountability Institute  
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## Crude Oil & Natural Gas Liquids

Production less sequestration		Ancillary emissions from flaring, venting, field use, refining and processing, etc.				Total oil & NGL emissions MtCO2e
This study	Percent of CDIAC	Flaring CO2	Vented CO2	Fugitive methane	Fugitive methane	
MtCO2	Percent	MtCO2	MtCO2	MtCH4	MtCO2e	MtCO2e
	IPCC values (20Dec12)	15.94	3,833	1,924	40.39	
		kg CO2/tCO2	kg CO2/tCO2	kg CH4/tCO2	kg CO2e/tCO2	
	IPCC values pasted:	15.19	3,651	10,080	212	

Rank

Entity

	y	y	y	y	y	y	y	
1	Abu Dhabi, United Arab Emirates	8,562	1.69%	137	32.8	16	346	9,077
2	Alpha Natural Resources, USA							
3	Anadarko, USA	2,574	0.51%	41	10	5	104	2,728
4	Anglo American, UK							
5	Apache, USA	571	0.11%	9	2	1	23	606
6	Arch Coal Company, USA							
7	Bahrain Petroleum Corporation	339	0.07%	5	1	1	14	380
8	BG Group (British Gas) UK	363	0.07%	6	1	1	15	384
9	BHP Billiton, Australia	1,330	0.26%	21	5	3	54	1,410
10	BP, UK	26,727	5.27%	426	102	51	1,080	28,335
11	British Coal Corporation, UK							
12	Canadian Natural Resources, Canada	631	0.12%	10	2	1	25	669
13	Cemex, Mexico							
14	ChevronTexaco, USA	37,307	7.35%	595	143	72	1,507	39,552
15	China, PR (coal & cement only)							
16	CNOOC, PR China	1,733	0.34%	28	7	3	70	1,837
17	Coal India, India							
18	ConocoPhillips, USA	9,624	1.90%	153	37	19	389	10,203
19	CONSOL Energy, USA							
20	Cyprus Amax, USA							
21	Czech Republic							
22	Czechoslovakia							
23	Devon Energy, USA	724	0.14%	12	3	1	29	767
24	Ecopetrol, Colombia	1,683	0.33%	27	6	3	68	1,785
25	Egyptian General Petroleum, Egypt	2,040	0.40%	33	8	4	82	2,163
26	EnCana, Canada	542	0.11%	9	2	1	22	575
27	ENI, Italy	3,583	0.71%	57	14	7	145	3,799
28	ExxonMobil, USA	30,495	6.01%	486	117	59	1,232	32,330
29	FSU (Former Soviet Union)	35,462	6.99%	565	136	68	1,432	37,596
30	Gazprom, Russia	2,256	0.44%	36	9	4	91	2,392
31	HeidelbergCement, Germany							
32	Hess, USA	1,596	0.31%	25	6	3	64	1,692
33	Holcim, Switzerland							
34	Husky, Canada	494	0.10%	8	2	1	20	524
35	Iraq National Oil Company, Iraq	7,274	1.43%	116	28	14	294	7,712
36	Italcementi							
37	Kazakhstan							
38	Kiewit Mining Group, USA							
39	Kuwait Petroleum Corp., Kuwait	10,381	2.05%	166	40	20	419	11,006
40	Lafarge, France							
41	Libya National Oil Corp., Libya	6,062	1.19%	97	23	12	245	6,426
42	Lukoil, Russia	4,072	0.80%	65	16	8	164	4,317
43	Luminant / TXU, USA							
44	Marathon, USA	1,973	0.39%	31	8	4	80	2,092
45	Massey Energy Corporation, US							
46	Murphy Oil, USA	303	0.06%	5	1	1	12	322
47	Murray Coal Corporation, USA							
48	National Iranian Oil Co., Iran	24,754	4.88%	395	95	48	1,000	26,244
49	Nexen, Canada		0.00%	-	-	-	-	-
50	Nigerian National Petroleum, Nigeria	6,203	1.22%	99	24	12	251	6,576
51	North American Coal, US							
52	North Korea							
53	Occidental, USA	2,669	0.53%	43	10	5	108	2,829
54	Oil and Gas Corp., India	2,973	0.59%	47	11	6	120	3,152
55	OMV Group, Austria	248	0.05%	4	1	0	10	263
56	Peabody Energy, USA							
57	Pertamina, Indonesia	4,998	0.99%	80	19	10	202	5,299
58	PetroChina (CNPC), China	9,383	1.85%	150	36	18	379	9,948
59	Petrobras, Brazil	5,570	1.10%	89	21	11	225	5,905
60	Petroleos de Venezuela, Venezuela	11,079	2.18%	177	42	21	448	11,746
61	Pemex, Mexico	15,966	3.15%	255	61	31	645	16,926
62	Petroleum Development Oman, Oman	2,049	0.40%	33	8	4	83	2,172
63	Petronas, Malaysia	2,994	0.59%	48	11	6	121	3,174
64	Poland							
65	Polish Oil & Gas, Poland	326	0.06%	5	1	1	13	345
66	Qatar Petroleum, Qatar	2,653	0.52%	42	10	5	107	2,812
67	Repsol, Spain	2,000	0.39%	32	8	4	81	2,120
68	Rio Tinto, UK							
69	Rosneft, Russian Federation	3,420	0.67%	55	13	7	138	3,626
70	Royal Dutch Shell, The Netherlands & UK	21,839	4.30%	348	84	42	882	23,153
71	Ruhrkohle AG (RAG), Germany							
72	Russian Federation							
73	RWE, Germany							
74	Sasol, South Africa							
75	Saudi Aramco, Saudi Arabia	44,449	8.76%	709	170	85	1,795	47,124
76	Singareni Collieries, India							
77	Sinopec, China	1,677	0.33%	27	6	3	68	1,778
78	Sonangol, Angola	2,040	0.40%	33	8	4	82	2,162
79	Sonatrach, Algeria	4,953	0.98%	79	19	10	200	5,251
80	Statoil, Norway	3,259	0.64%	52	12	6	132	3,455
81	Suncor, Canada	1,076	0.21%	17	4	2	43	1,140
82	Syrian Petroleum, Syria	1,195	0.24%	19	5	2	48	1,267
83	Taiheyo, Japan							
84	Talisman, Canada	510	0.10%	8	2	1	21	540
85	Total, France	9,286	1.83%	148	36	18	375	9,844
86	UK Coal, UK							
87	Ukraine							
88	Westmoreland Mining, USA							
89	Xstrata, Switzerland							
90	Yukos, Russia	2,645	0.52%	42	10	5	107	2,804
<b>Total CO2 &amp; methane emissions</b>		<b>388,912</b>	<b>76.65%</b>	<b>6,201</b>	<b>1,491</b>	<b>748</b>	<b>15,710</b>	<b>412,313</b>
		388,912	vertical check	1.59%	0.38%		4.04%	412,313

This study, MtCO2	388,912	This study, MtCO2	6,431	This study, MtCO2	5,272	This study, MtCO2
CDIAC emissions, MtCO2	507,408	CDIAC oil CO2	13,096	CDIAC Flaring CO2	13,096	CDIAC Flaring CO2
Percent this study of total CDIAC 1751-2010	76.6%	Percent of CDIAC	49.1%	Percent of CDIAC	na	Percent of CDIAC

# Summary of CO2 & methane emissions from identified natural gas production

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## Natural Gas

Production less sequestration	Ancillary emissions from flaring, venting, own use of fuels, and fugitive methane						Total natural gas emissions
	This study	Percent of CDIAC	Flaring CO2	Vented CO2	Fugitive methane	Fugitive methane	
MtCO2	Percent	MtCO2	MtCO2	MtCH4	MtCO2e	MtCO2	MtCO2e
	IPCC values (28Dec12)	1,736	28.53	9,878	207.4	57.26	EPA
	kg CO2/tCO2		kg CO2/tCO2	kg CH4/tCO2	kg CO2e/tCO2	kg CO2e/tCO2	IPCC SAR GWP 21xCO2
	IPCC values pasted:	1.525	25.08	3.708	77.9		

Rank Entity

	y	y	10% of oil flaring	y	y	y	y	y
1 Abu Dhabi, United Arab Emirates	1,602	0.82%	2.8	45.70	15.82	332	92	2,074
2 Alpha Natural Resources, USA								
3 Anadarko, USA	1,621	0.83%	2.8	46.25	16.01	336	93	2,099
4 Anglo American, UK								
5 Apache, USA	526	0.27%	0.9	15.02	5.20	109	30	682
6 Arch Coal Company, USA								
7 Bahrain Petroleum Corporation	511	0.26%	0.9	14.59	5.05	106	29	662
8 BG Group (British Gas) UK	1,116	0.57%	1.9	31.84	11.02	232	64	1,445
9 BHP Billiton, Australia	493	0.25%	0.9	14.06	4.87	102	28	638
10 BP, UK	6,116	3.12%	10.6	174.50	60.41	1,269	350	7,920
11 British Coal Corporation, UK								
12 Canadian Natural Resources, Canada	416	0.21%	0.7	11.88	4.11	86	24	539
13 Cemex, Mexico								
14 ChevronTexaco, USA	8,762	4.47%	15.2	250.00	86.55	1,818	502	11,346
15 China, PR (coal & cement only)								
16 CNOOC, PR China	284	0.14%	0.5	8.10	2.80	59	16	368
17 Coal India, India								
18 ConocoPhillips, USA	5,676	2.90%	9.9	161.95	56.07	1,177	325	7,350
19 CONSOL Energy, USA	62	0.03%	0.1	1.77	0.61	13	4	80
20 Cyprus Amax, USA								
21 Czech Republic								
22 Czechoslovakia								
23 Devon Energy, USA	963	0.49%	1.7	27.49	9.52	200	55	1,248
24 Ecopetrol, Colombia	245	0.13%	0.4	7.00	2.42	51	14	318
25 Egyptian General Petroleum, Egypt	764	0.39%	1.3	21.81	7.55	159	44	990
26 EnCana, Canada	1,054	0.54%	1.8	30.08	10.41	219	60	1,365
27 ENI, Italy	2,189	1.12%	3.8	62.46	21.62	454	125	2,835
28 ExxonMobil, USA	11,427	5.84%	19.8	326.05	112.88	2,370	654	14,797
29 FSU (Former Soviet Union)	17,937	9.16%	31.1	511.80	177.18	3,721	1,027	23,227
30 Gazprom, Russia	26,262	13.41%	45.6	749.35	259.42	5,448	1,504	34,009
31 HeidelbergCement, Germany								
32 Hess, USA	643	0.33%	1.1	18.35	6.35	133	37	833
33 Holicim, Switzerland								
34 Husky, Canada	213	0.11%	0.4	6.07	2.10	44	12	276
35 Iraq National Oil Company, Iraq	162	0.08%	0.3	4.61	1.60	34	9	209
36 Italcementi								
37 Kazakhstan								
38 Kiewit Mining Group, USA								
39 Kuwait Petroleum Corp., Kuwait	537	0.27%	0.9	15.31	5.30	111	31	695
40 Lafarge, France								
41 Libya National Oil Corp., Libya	443	0.23%	0.8	12.65	4.38	92	25	574
42 Lukoil, Russia	327	0.17%	0.6	9.33	3.23	68	19	423
43 Luminant / TXU, USA								
44 Marathon, USA	842	0.43%	1.5	24.01	8.31	175	48	1,090
45 Massey Energy Corporation, US	140	0.07%	0.2	4.00	1.38	29	8	181
46 Murphy Oil, USA								
47 Murray Coal Corporation, USA								
48 National Iranian Oil Co., Iran	4,181	2.13%	7.3	119.29	41.30	867	239	5,414
49 Nexen, Canada	-	0.00%	-	-	-	-	-	-
50 Nigerian National Petroleum, Nigeria	620	0.32%	1.1	17.70	6.13	129	36	803
51 North American Coal, US								
52 North Korea								
53 Occidental, USA	534	0.27%	0.9	15.24	5.28	111	31	692
54 Oil and Gas Corp., India	1,122	0.57%	1.9	32.02	11.09	233	64	1,453
55 OMV Group, Austria	161	0.08%	0.3	4.59	1.59	33	9	208
56 Peabody Energy, USA								
57 Pertamina, Indonesia	1,336	0.68%	2.3	38.11	13.20	277	76	1,730
58 PetroChina (CNPC), China	1,720	0.88%	3.0	49.08	16.99	357	98	2,227
59 Petrobras, Brazil	865	0.44%	1.5	24.69	8.55	180	50	1,121
60 Petroleos de Venezuela, Venezuela	1,561	0.80%	2.7	44.53	15.42	324	89	2,021
61 Pemex, Mexico	3,734	1.91%	6.5	106.55	36.89	775	214	4,836
62 Petroleum Development Oman, Oman	679	0.35%	1.2	19.37	6.71	141	39	879
63 Petronas, Malaysia	2,327	1.19%	4.0	66.39	22.99	483	133	3,013
64 Poland								
65 Polish Oil & Gas, Poland	128	0.07%	0.2	3.66	1.27	27	7	166
66 Qatar Petroleum, Qatar	1,536	0.78%	2.7	43.82	15.17	319	88	1,989
67 Repsol, Spain	1,084	0.55%	1.9	30.94	10.71	225	62	1,404
68 Rio Tinto, UK								
69 Rosneft, Russian Federation	407	0.21%	0.7	11.62	4.02	84	23	527
70 Royal Dutch Shell, The Netherlands & UK	6,963	3.56%	12.1	198.69	68.79	1,445	399	9,017
71 Ruhrkohle AG (RAG), Germany								
72 Russian Federation								
73 RWE, Germany								
74 Sasol, South Africa	36	0.02%	0.1	1.02	0.35	7	2	46
75 Saudi Aramco, Saudi Arabia	3,337	1.70%	5.8	95.21	32.96	692	191	4,321
76 Singareni Collieries, India								
77 Sinopec, China	239	0.12%	0.4	6.81	2.36	49	14	309
78 Sonangol, Angola	22	0.01%	0.0	0.63	0.22	5	1	28
79 Sonatrach, Algeria	3,930	2.01%	6.8	112.13	38.82	815	225	5,089
80 Statoil, Norway	1,273	0.65%	2.2	36.34	12.58	264	73	1,649
81 Suncor, Canada	390	0.20%	0.7	11.12	3.85	81	22	505
82 Syrian Petroleum, Syria	171	0.09%	0.3	4.87	1.69	35	10	221
83 Taiheyo, Japan								
84 Talisman, Canada	437	0.22%	0.8	12.46	4.32	91	25	566
85 Total, France	2,348	1.20%	4.1	66.99	23.19	487	134	3,040
86 UK Coal, UK								
87 Ukraine								
88 Westmoreland Mining, USA								
89 Xstrata, Switzerland								
90 Yukos, Russia	41	0.02%	0.1	1.18	0.41	9	2	54

Total CO2 & methane emissions	132,514	67.67%	230	3,781	1,309	27,489	7,588	171,602
	132,514 vertical check		0.17%	2.85%		20.74%		171,602 ver

This study, MtCO2	132,514	This study, MtCO2	75,448	This study, MtCO2e	
CDIAC emissions, MtCO2	195,831	CDIAC gas CO2	122,687	CDIAC CH4, MtCO2e	
Percent this study of total CDIAC 1751-2010	67.7%	Percent of CDIAC	61.50%	Percent of CDIAC	

# Summary of CO2 & methane emissions from identified coal and cement production

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Coal				
Coal CO2 emissions		Fugitive methane emissions		Total coal emissions
This study	Percent of CDIAC	Fugitive methane	Fugitive methane	
MtCO2	Percent	MtCH4	MtCO2e	MtCO2e
IPCC values (22Dec12)		4,035	84.73	
		kg CH4/tCO2	kg CO2e/tCO2	
IPCC values pasted:		4,035	84.73	IPCC SAR GWP 21xCO2

Cement production	
Calculating emissions	
Cement	Percent of CDIAC
MtCO2	Percent

Rank

Entity

1	Abu Dhabi, United Arab Emirates
2	Alpha Natural Resources, USA
3	Anadarko, USA
4	Anglo American, UK
5	Apache, USA
6	Arch Coal Company, USA
7	Bahrain Petroleum Corporation
8	BG Group (British Gas) UK
9	BHP Billiton, Australia
10	BP, UK
11	British Coal Corporation, UK
12	Canadian Natural Resources, Canada
13	Cemex, Mexico
14	ChevronTexaco, USA
15	China, PR (coal & cement only)
16	CNOOC, PR China
17	Coal India, India
18	ConocoPhillips, USA
19	CONSOL Energy, USA
20	Cyprus Amax, USA
21	Czech Republic
22	Czechoslovakia
23	Devon Energy, USA
24	Ecopetrol, Colombia
25	Egyptian General Petroleum, Egypt
26	EnCana, Canada
27	ENI, Italy
28	ExxonMobil, USA
29	FSU (Former Soviet Union)
30	Gazprom, Russia
31	HeidelbergCement, Germany
32	Hess, USA
33	Holcim, Switzerland
34	Husky, Canada
35	Iraq National Oil Company, Iraq
36	Italcementi
37	Kazakhstan
38	Kiewit Mining Group, USA
39	Kuwait Petroleum Corp., Kuwait
40	Lafarge, France
41	Libya National Oil Corp., Libya
42	Lukoil, Russia
43	Luminant / TXU, USA
44	Marathon, USA
45	Massey Energy Corporation, US
46	Murphy Oil, USA
47	Murray Coal Corporation, USA
48	National Iranian Oil Co., Iran
49	Nexen, Canada
50	Nigerian National Petroleum, Nigeria
51	North American Coal, US
52	North Korea
53	Occidental, USA
54	Oil and Gas Corp., India
55	OMV Group, Austria
56	Peabody Energy, USA
57	Pertamina, Indonesia
58	PetroChina (CNPC), China
59	Petrobras, Brazil
60	Petroleos de Venezuela, Venezuela
61	Pemex, Mexico
62	Petroleum Development Oman, Oman
63	Petronas, Malaysia
64	Poland
65	Polish Oil & Gas, Poland
66	Qatar Petroleum, Qatar
67	Repsol, Spain
68	Rio Tinto, UK
69	Rosneft, Russian Federation
70	Royal Dutch Shell, The Netherlands & UK
71	Ruhrkohle AG (RAG), Germany
72	Russian Federation
73	RWE, Germany
74	Sasol, South Africa
75	Saudi Aramco, Saudi Arabia
76	Singareni Collieries, India
77	Sinopec, China
78	Sonangol, Angola
79	Sonatrach, Algeria
80	Statoil, Norway
81	Suncor, Canada
82	Syrian Petroleum, Syria
83	Taiheiyu, Japan
84	Talisman, Canada
85	Total, France
86	UK Coal, UK
87	Ukraine
88	Westmoreland Mining, USA
89	Xstrata, Switzerland
90	Yukos, Russia

y	y	y	y	y
4,468	0.65%	18	379	4,847
636	0.09%	3	54	690
6,894	1.00%	28	584	7,478
6,238	0.91%	25	528	6,766
6,086	0.88%	25	516	6,601
918	0.13%	4	78	996
17,742	2.58%	72	1,503	19,245
1,243	0.18%	5	105	1,349
142,634	20.73%	575	12,085	154,719
16,677	2.42%	67	1,413	18,090
8,457	1.23%	34	717	9,174
1,611	0.23%	7	137	1,748
2,254	0.33%	9	191	2,445
7,041	1.02%	28	597	7,638
1,317	0.19%	5	112	1,429
63,480	9.23%	256	5,378	68,858
5,112	0.74%	21	433	5,545
1,315	0.19%	5	111	1,427
1,070	0.16%	4	91	1,161
-	0.00%	-	-	-
1,001	0.15%	4	85	1,085
1,183	0.17%	5	100	1,283
2,828	0.41%	11	240	3,067
1,725	0.25%	7	146	1,871
12,785	1.86%	52	1,083	13,869
26,237	3.81%	106	2,223	28,460
5,760	0.84%	23	488	6,248
1,049	0.15%	4	89	1,138
12,551	1.82%	51	1,063	13,614
5,967	0.87%	24	506	6,472
3,530	0.51%	14	299	3,829
2,014	0.29%	8	171	2,184
778	0.11%	3	66	844
3,585	0.52%	14	304	3,888
1,514	0.22%	6	128	1,642
2,929	0.43%	12	248	3,177
380,629	55.32%	1,536	32,250	412,878

y	y
630	1.65%
12,500	32.64%
677	1.77%
1,197	3.12%
544	1.42%
1,232	3.22%
427	1.12%
17,207	44.93%

Total CO2 & methane emissions

380,629 vertical check 55.32% 1,536 32,250 412,878 vertical

17,207 vertical check 44.93%

This study, MtCO2
688,027
CDIAC emissions, MtCO2
1,253
Percent this study of total CDIAC 1751-2010
55.3%

Coal CO2
380,629 This study, MtCO2e
688,027 CDIAC coal CO2
55.3% Percent of CDIAC

Coal Methane
32,250 This study, MtCO2e
76,269 CDIAC CH4, MtCO2e
42.3% Percent of CDIAC

Cement
17,207 This study, MtCO2e
38,299 CDIAC cement CO2
44.9% Percent of CDIAC

# Summary of CO2 & methane emissions from identified fossil fuel & cement production

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## Grand Total of emissions identified in this study

Rank	Entity	Total fuel and cement CO2 emissions			Emissions from flaring, venting, and fugitive methane					Total CO2 and methane		
		This study	This study	Percent of CDIAC	Flaring CO2	Vented CO2	Own fuel use	Fugitive methane	Fugitive methane	Total emissions	Percent of this study	% of CDIAC 1751-2013
		MtCO2	MtC	Percent	MtCO2	MtCO2	MtCO2	MtCH4	MtCO2e	MtCO2e	Percent	Percent

	y	y	y	y	y	y	y	y	y	y	y	y
1	Abu Dhabi, United Arab Emirates	10,163	2,774	0.73%	139	79	92	32	678	11,151	1.10%	0.71%
2	Alpha Natural Resources, USA	4,468	1,219	0.32%				18	379	4,847	0.48%	0.31%
3	Anadarko, USA	4,831	1,318	0.35%	44	56	93	24	494	5,517	0.54%	0.35%
4	Anglo American, UK	6,894	1,881	0.50%				28	584	7,478	0.74%	0.48%
5	Apache, USA	1,098	300	0.08%	10	17	30	6	132	1,287	0.13%	0.08%
6	Arch Coal Company, USA	6,238	1,702	0.45%				25	528	6,766	0.67%	0.43%
7	Bahrain Petroleum Corporation	851	232	0.06%	6	16	29	6	120	1,022	0.10%	0.07%
8	BG Group (British Gas) UK	1,479	404	0.11%	8	33	64	9	246	1,850	0.18%	0.12%
9	BHP Billiton, Australia	7,908	2,158	0.57%	22	19	28	32	672	8,649	0.85%	0.55%
10	BP, UK	33,761	9,214	2.43%	437	277	350	116	2,426	37,251	3.67%	2.38%
11	British Coal Corporation, UK	17,742	4,842	1.28%				72	1,503	19,245	1.90%	1.23%
12	Canadian Natural Resources, Canada	1,047	286	0.08%	11	14	24	5	112	1,208	0.12%	0.08%
13	Cemex, Mexico	630	172	0.05%				7	129	630	0.06%	0.04%
14	ChevronTexaco, USA	47,312	12,912	3.40%	610	393	502	163	3,430	52,247	5.15%	3.34%
15	China, PR (coal & cement only)	155,134	42,338	11.15%				575	12,085	167,219	16.49%	10.68%
16	CNOOC, PR China	2,017	550	0.14%	28	15	16	6	129	2,205	0.22%	0.14%
17	Coal India, India	16,677	4,551	1.20%				67	1,413	18,090	1.78%	1.16%
18	ConocoPhillips, USA	15,300	4,176	1.10%	163	199	325	75	1,566	17,553	1.73%	1.12%
19	CONSOL energy, USA	8,519	2,325	0.61%	0	2	4	35	729	9,254	0.91%	0.59%
20	Cyprus Amax, USA	1,611	440	0.12%				7	137	1,748	0.17%	0.11%
21	Czech Republic	2,254	615	0.16%				9	191	2,445	0.24%	0.16%
22	Czechoslovakia	7,041	1,942	0.51%				28	597	7,638	0.75%	0.49%
23	Devon Energy, USA	1,687	460	0.12%	13	30	55	11	229	2,015	0.20%	0.13%
24	Ecopetrol, Colombia	1,929	526	0.14%	27	13	14	6	119	2,102	0.21%	0.13%
25	Egyptian General Petroleum, Egypt	2,805	765	0.20%	34	30	44	11	241	3,153	0.31%	0.20%
26	EnCana, Canada	1,597	436	0.11%	10	32	60	11	241	1,940	0.19%	0.12%
27	ENI, Italy	5,772	1,575	0.41%	61	76	125	29	599	6,634	0.65%	0.42%
28	ExxonMobil, USA	43,239	11,801	3.11%	506	443	654	177	3,714	48,557	4.79%	3.10%
29	FSU (Former Soviet Union)	116,879	31,898	8.40%	597	648	1,027	502	10,532	129,682	12.79%	8.28%
30	Gazprom, Russia	28,518	7,783	2.05%	82	758	1,504	264	5,539	36,400	3.59%	2.33%
31	HeidelbergCement, Germany	677	185	0.05%						677	0.07%	0.04%
32	Hess, USA	2,239	611	0.16%	27	24	37	9	198	2,525	0.25%	0.16%
33	Holcim, Switzerland	1,197	327	0.09%						1,197	0.12%	0.08%
34	Husky, Canada	707	193	0.05%						707	0.07%	0.05%
35	Iraq National Oil Company, Iraq	7,436	2,029	0.53%	8	8	12	3	64	7,921	0.78%	0.51%
36	Italcementi	544	148	0.04%	116	32	9	16	327	544	0.05%	0.03%
37	Kazakhstan	5,112	1,395	0.37%				21	433	5,545	0.55%	0.35%
38	Kiewit Mining Group, USA	1,315	359	0.09%				5	111	1,427	0.14%	0.09%
39	Kuwait Petroleum Corp., Kuwait	10,917	2,980	0.78%	166	55	31	25	531	11,700	1.15%	0.75%
40	Lafarge, France	1,232	336	0.09%						1,232	0.12%	0.08%
41	Libya National Oil Corp., Libya	6,505	1,775	0.47%	97	36	25	16	337	7,000	0.69%	0.45%
42	Lukoil, Russia	4,399	1,200	0.32%	65	25	19	11	232	4,740	0.47%	0.30%
43	Luminant / TXU, USA	1,070	292	0.08%				4	91	1,161	0.11%	0.07%
44	Marathon, USA	2,815	768	0.20%	33	32	48	12	254	3,182	0.31%	0.20%
45	Massey Energy Corporation, US			0.00%							0.00%	0.00%
46	Murphy Oil, USA	443	121	0.03%	5	5	8	2	41	503	0.05%	0.03%
47	Murray Coal Corporation, USA	1,001	273	0.07%				4	85	1,085	0.11%	0.07%
48	National Iranian Oil Co., Iran	28,935	7,897	2.08%	402	214	239	89	1,867	31,658	3.12%	2.02%
49	Nexen, Canada			0.00%							0.00%	0.00%
50	Nigerian National Petroleum, Nigeria	8,623	1,862	0.49%	100	41	36	18	379	7,380	0.73%	0.47%
51	North American Coal, US	1,183	323	0.08%				5	100	1,283	0.13%	0.08%
52	North Korea	2,828	772	0.20%				11	240	3,067	0.30%	0.20%
53	Occidental, USA	4,928	1,345	0.35%	43	25	31	17	365	5,392	0.53%	0.34%
54	Oil and Gas Corp., India	4,095	1,118	0.29%	49	43	64	17	353	4,605	0.45%	0.29%
55	OMV Group, Austria	409	112	0.03%	4	6	9	2	43	471	0.05%	0.03%
56	Peabody Energy, USA	12,785	3,489	0.92%				52	1,083	13,869	1.37%	0.89%
57	Pertamina, Indonesia	6,334	1,729	0.46%	82	57	76	23	479	7,029	0.69%	0.45%
58	PetroChina (CNPC), China	11,103	3,030	0.80%	153	85	98	35	736	12,175	1.20%	0.78%
59	Petrobras, Brazil	6,435	1,756	0.46%	90	46	50	19	404	7,026	0.69%	0.45%
60	Petroleos de Venezuela, Venezuela	12,640	3,450	0.91%	179	87	89	37	771	13,767	1.36%	0.88%
61	Pernex, Mexico	19,700	5,376	1.42%	261	168	214	68	1,420	21,762	2.15%	1.39%
62	Petroleum Development Oman, Oman	2,728	744	0.20%	34	27	39	11	224	3,052	0.30%	0.19%
63	Petronas, Malaysia	5,321	1,452	0.38%	52	78	133	29	604	6,188	0.61%	0.40%
64	Poland	26,237	7,160	1.89%				106	2,223	28,460	2.81%	1.82%
65	Polish Oil & Gas, Poland	454	124	0.03%	5	5	7	2	40	511	0.05%	0.03%
66	Qatar Petroleum, Qatar	4,188	1,143	0.30%	45	54	88	20	426	4,801	0.47%	0.31%
67	Repsol, Spain	3,084	842	0.22%	34	39	62	15	306	3,524	0.35%	0.23%
68	Rio Tinto, UK	5,760	1,572	0.41%				23	488	6,248	0.62%	0.40%
69	Rosneft, Russian Federation	3,827	1,044	0.28%	55	25	23	11	223	4,153	0.41%	0.27%
70	Royal Dutch Shell, The Netherlands & UK	28,802	7,861	2.07%	360	282	399	111	2,327	32,171	3.17%	2.06%
71	Ruhrkohle AG (RAG), Germany	1,049	286	0.08%				4	89	1,138	0.11%	0.07%
72	Russian Federation	12,551	3,425	0.90%				51	1,063	13,614	1.34%	0.87%
73	RWE, Germany	5,967	1,628	0.43%				24	506	6,472	0.64%	0.41%
74	Sasol, South Africa	3,566	973	0.26%	0	1	2	15	306	3,875	0.38%	0.25%
75	Saudi Aramco, Saudi Arabia	47,786	13,041	3.43%	715	266	191	118	2,488	51,445	5.07%	3.29%
76	Singareni Collieries, India	2,014	550	0.14%				8	171	2,184	0.22%	0.14%
77	Sinopec, China	1,915	523	0.14%	27	13	14	6	117	2,087	0.21%	0.13%
78	Sonangol, Angola	2,062	563	0.15%	33	8	1	4	87	2,191	0.22%	0.14%
79	Sonatrach, Algeria	8,882	2,424	0.64%	86	131	225	48	1,015	10,340	1.02%	0.66%
80	Statoll, Norway	4,532	1,237	0.33%	54	49	73	19	396	5,104	0.50%	0.33%
81	Suncor, Canada	1,465	400	0.11%	18	15	22	6	124	1,645	0.16%	0.11%
82	Syrian Petroleum, Syria	1,366	373	0.10%	19	9	10	4	84	1,488	0.15%	0.10%
83	Taiheivo, Japan	427	117	0.03%						427	0.04%	0.03%
84	Talisman, Canada	947	258	0.07%						947	0.09%	0.07%
85	Total, France	11,633	3,175	0.84%	152	103	134	41	862	12,884	1.27%	0.82%
86	UK Coal, UK	778	212	0.06%				3	66	844	0.08%	0.05%
87	Ukraine	3,585	978	0.26%				14	304	3,888	0.38%	0.25%
88	Westmoreland Mining, USA	1,514	413	0.11%				6	128	1,642	0.16%	0.10%
89	Xstrata, Switzerland	2,929	799	0.21%				12	248	3,177	0.31%	0.20%
90	Yukos, Russia	2,686	733	0.19%	42	11	2	5	115	2,858	0.28%	0.18%

<b>Total CO2 &amp; methane emissions</b>	<b>919,261</b>	<b>250,877</b>	<b>66.1%</b>	<b>6,431</b>	<b>5,272</b>	<b>7,588</b>	<b>3,593</b>	<b>75,448</b>	<b>1,014,001</b>	<b>100.0%</b>	<b>64.8%</b>
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	Total CO2: fossil fuels (excl. cement, flaring & vented)	Total CO2: fossil fuels, flaring, venting, cement	Total CO2 and methane
This study, MtCO2	902,054	938,552	1,014,001
CDIAC emissions, MtCO2	1,391,266	1,442,661	1,565,348
Percent this study of total CDIAC 1751-2010	64.84%	65.06%	64.78%

**Cell:** M9

**Comment:** Rick Heede:

This section sums emissions from combustion of produced crude oil and NGLs reported by identified oil and gas companies (including national oil and gas companies). Non-fuel uses of gas are accounted for, and IPCC coefficients are applied to net production and combustion. Emissions of CO2 from company energy use, vented CO2, flaring, and methane sources are also detailed below and in related worksheets. See production worksheets ("OilGasAdnoc-Encana.xls", "OilGasENI-NorskHydro.xls", "OilGasOxy-Shell.xls", and "OilGasSaudi-Yukos.xls") and production and emissions sums in "SumOil.xls" and "SumGas.xls" and "AncillaryCH4&CO2.xls" for production data, emissions estimates, results, and methodological discussion.

**Cell:** AA9

**Comment:** Rick Heede:

This section sums emissions from combustion of produced natural gas reported by identified oil and gas companies (including national oil and gas companies). Non-fuel uses of gas are accounted for, and IPCC coefficients are applied to net production and combustion. Emissions of CO2 from company energy use, vented CO2, flaring, and methane sources are also detailed below and in related worksheets. See production worksheets ("OilGasAdnoc-Encana.xls", "OilGasENI-NorskHydro.xls", "OilGasOxy-Shell.xls", and "OilGasSaudi-Yukos.xls") and production and emissions sums in "SumOil.xls" and "SumGas.xls" and "AncillaryCH4&CO2.xls" for production data, emissions estimates, results, and methodological discussion.

**Cell:** AL9

**Comment:** Rick Heede:

See production worksheets ("CoalAngloNorthAmerican.xls" and "CoalPeabodyXstrata.xls") and production and emissions sums in "SumCoal.xls" and "AncillaryCH4&CO2.xls" for production data, emissions estimates, results, and methodological discussion.

**Cell:** AP9

**Comment:** Rick Heede:

CMS methodology and results are shown in the worksheets "Cement.xls" and "SumCement.xls". CMS has included the largest six cement manufacturers plus PR China in an industry with relatively few large multinational companies meeting the threshold of > 10 MtC per year, hence our total is a fraction of CDIAC's estimated emissions of CO2 (the CDIAC estimates start in 1928). Most of this project's emissions estimates start in ~1990.

**Cell:** B19

**Comment:** Rick Heede:

This section sums all emissions from identified producers of crude oil (including NGLs), natural gas, coal, and cement manufacturing. Emissions are estimated from primary production data, and account for net non-fuel uses and other factors discussed throughout this assemblage of ~one hundred worksheets. This summary table also sums CO2 emissions from flaring, CO2 emissions from direct venting. CMS also sums emissions of methane associated with primary production and flaring in oil, gas, and coal operations, converts methane gas to CO2-equivalent (at IPCC SAR value of 21 x CO2). The table sums all emissions sources for each entity, and ranks total emissions in tonnes CO2e and as a percent of total identified emissions. Finally, all estimates are compared to global industrial emissions of CO2 and methane from the CDIAC database of CO2 emissions by fuel, cement, flaring, and methane from coal, oil, and natural gas operations.

**Cell:** H11

**Comment:** Rick Heede:

Flaring rates are calculated in the worksheet "AncillaryCH4&CO2.xls".

In brief, flaring rate is computed for kg CO2 of flared associated gas per kg CO2 from oil combustion and is based on World Bank Global Gas Flaring Reduction data estimated from satellite reconnaissance. See the "Flaring and Venting" worksheet in the AncillaryCO2CH4.xls workbook.

**Cell:** I11

**Comment:** Rick Heede:

Recent data from the US EPA on venting from petroleum systems is used to compute vented CO2 as a function of CO2 from the combustion of oil and NGLs. See "Flaring and Venting" worksheet in AncillaryCH4&CO2.xls for details. CO2 vented from petroleum operations is small compared to CO2 venting from natural gas operations.

**Cell:** J11

**Comment:** Rick Heede:

The US EPA (2012) Draft Inventory of U.S Emissions and Sinks 2010 data on methane emissions from petroleum systems were used to develop a fugitive methane rate as a function of oil & NGL production and combustion (in kg CH4 per tonne CO2 from combusted liquids).

See "Oil and Gas ancillary CH4" worksheet in AncillaryCH4&CO2.xls for details.

**Cell:** L11

**Comment:** Rick Heede:

The IPCC Second Assessment Report (SAR) GWP value for methane -- 21xCO2 -- is used throughout.

**Cell:** V11

**Comment:** Rick Heede:

CMS reviews numerous estimates of flaring emissions in the oil and gas industries in the worksheets in "AncillaryCH4&CO2.xls". CMS allocates flaring to both oil and gas production, with the preponderance (90 percent) to oil operations and 10 percent to gas operations to account for flaring at natural gas production, field processing, and processing plants.

See "Flaring and Venting" worksheet in the "AncillaryCH4&CO2.xls" workbook for details.

**Cell:** W11

**Comment:** Rick Heede:

Recent US EPA (2012) estimates of CO2 vented from natural gas systems -- chiefly Acid Gas Removal vents at processing plants to meet market specifications -- as a function of CO2 from combusted natural gas in the U.S. 1990-2010. This factor is applied to global natural gas operations, though the CO2 content of raw produced gas varies widely from region to region.

See the "Flaring & Venting" worksheet in "AncillaryCH4&CO2.xls" for details.

**Cell:** X11

**Comment:** Rick Heede:

The US EPA (2006) Global Mitigation of Non-CO2 Gases data on methane emissions from natural gas systems were used to develop a fugitive methane rate as a function of natural gas production and combustion (in kg CH4 per tonne CO2 from combusted natural gas).

See "Oil and Gas ancillary CH4" worksheet in AncillaryCH4&CO2.xls for details.

**Cell:** Y11

**Comment:** Rick Heede:

The IPCC Second Assessment Report (SAR) GWP value for methane -- 21xCO2 -- is used throughout.

**Cell:** A111

**Comment:** Rick Heede:

Stern and Kaufmann (1998) data on methane rates from coal mining were averaged with US EPA (2011) Global Anthropogenic Non-CO2 Greenhouse Gas Emissions and converted to a fugitive methane rate per tonne of CO2 from coal combustion: kg CH2/tCO2. See the "Coal ancillary CH4" worksheet in AncillaryCO2CH4.xls for details on the methodology.

**Cell:** AK11

**Comment:** Rick Heede:

The IPCC Second Assessment Report (SAR) GWP value for methane -- 21xCO2 -- is used throughout.

**Cell:** B12

**Comment:** Rick Heede:

Alphabetical rank.

**Cell:** Z13

**Comment:** Rick Heede:

25Nov14: This value modified from previous 59.24 kgCO2/tCO2 to 57.26 kgCO2/tCO2 upon modifying the methane data in AncillaryCH4&CO2 worksheet. This reduced total Own Fuel Use from 7,850 MtCO2 to 7,588 MtCO2 (net minus 262 MtCO2).

**Cell:** BB115

**Comment:** Rick Heede (29 March 2012):

The CDIAC industrial carbon emissions worksheet rounds each fuel column independently, and the sum shown here is 1 MtC (and 3.7 MtCO2) higher than CDIAC's own sum. We do not correct this so as to not throw off the percentages calculated here.

**Cell:** B117

**Comment:** Rick Heede:

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