

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

Richard Heede
Climate Accountability Institute
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Crude Oil & Natural Gas Liquids

Rank	Entity	Production less sequestration						Ancillary emissions from flaring, venting, field use, refining and processing, etc.							
		This study	Percent of CDIAC	Flaring CO2	Vented CO2	Fugitive methane	Fugitive methane	Total oil & NGL emissions	This study	Percent of CDIAC	Flaring CO2	Vented CO2	Fugitive methane	Fugitive methane	Total oil & NGL emissions
		MtCO2	Percent	MtCO2	MtCO2	MtCH4	MtCO2e	MtCO2e		MtCO2	MtCO2	MtCO2	MtCH4	MtCO2e	MtCO2e

IPCC values (28Dec12) kg CO2/tCO2 15.94 kg CO2/tCO2 3.833 kg CH4/tCO2 1.924 EPA kg CO2e/tCO2 53.86

IPCC values pasted: 15.19 3.651 10.080 212

CMIEs summed to 2017 y y y y y y y xCO2

Rank	Entity	y	y	y	y	y	y	y	y
1	China, PR (coal & cement only)	35,462	6.37%	565	136	68	1,910	38,073	
2	FSU (Former Soviet Union)	19,238	9.05%	803	193	97	2,712	54,069	
3	Saudi Aramco, Saudi Arabia	50,361	6.87%	610	147	74	2,060	41,058	
4	Chevron, USA	38,242	5.70%	506	122	61	1,709	34,066	
5	ExxonMobil, USA	31,729	5.05%	44	11	5	149	2,979	
6	Gazprom, Russia	2,775	5.00%	444	107	54	1,500	29,900	
7	BP, UK	27,849	4.16%	370	89	45	1,248	24,881	
8	Royal Dutch Shell, Netherlands (acq BG Feb16)	25,175	4.94%	438	105	53	1,481	29,514	
9	National Iranian Oil Co., Iran	27,490	3.11%	276	66	33	933	18,606	
10	Poland	17,330	1.81%	161	39	19	543	10,824	
11	Pemex, Mexico	10,082	2.28%	203	49	24	684	13,642	
12	Coal India, India	12,706	1.99%	176	42	21	595	11,868	
13	British Coal Corporation, UK	11,054	1.79%	159	38	19	536	10,681	
14	ConocoPhillips, USA	9,948	1.84%	163	39.2	20	551	10,991	
15	Russian Federation	10,238	2.14%	190	46	23	642	12,789	
16	Peabody Energy, USA	11,912	2.06%	182	44	22	616	12,286	
17	Petroleos de Venezuela, Venezuela	11,444	1.00%	89	21	11	300	5,976	
18	PetroChina (CNPC), China	5,566	0.27%	24	6	3	80	1,604	
19	Total, France	1,494	1.22%	108	26	13	364	7,264	
20	Abu Dhabi, United Arab Emirates	6,765	1.24%	110	26	13	371	7,405	
21	Kuwait Petroleum Corp., Kuwait	6,897	0.69%	61	15	7	206	4,112	
22	Iraq National Oil Company, Iraq	3,850	0.73%	65	16	8	218	4,351	
23	Sonatrach, Algeria	4,053	0.93%	82	20	10	278	5,541	
24	Anglo American, UK	5,161	1.16%	103	25	12	347	6,920	
25	Pertamina, Indonesia	6,445	0.60%	53	13	6	179	3,577	
26	Libya National Oil Corp., Libya	3,332	1.02%	90	22	11	305	6,085	
27	Petronas, Malaysia	5,667	0.68%	61	15	7	205	4,090	
28	Rosneft, Russian Federation	3,810	0.92%	81	20	10	275	5,474	
29	Arch Coal Company, USA	5,099	0.51%	45	11	5	151	3,018	
30	RWE, Germany	2,811	0.53%	47	11	6	158	3,141	
31	Rio Tinto, UK	2,925	0.58%	52	12	6	175	3,494	
32	Kazakhstan	3,254	0.48%	42	10	5	143	2,844	
33	Equinor, Norway	2,649	0.48%	42	10	5	143	2,844	
34	Lukoil, Russia	2,811	0.48%	42	10	5	143	2,844	
35	Anadarko, USA	2,811	0.48%	42	10	5	143	2,844	
36	Centura (AlphaNR, Massey), USA	2,925	0.53%	47	11	6	158	3,141	
37	Occidental, USA	2,925	0.58%	52	12	6	175	3,494	
38	Oil and Gas Corp., India	3,254	0.48%	42	10	5	143	2,844	
39	Repsol, Spain (acq Talisman May2015)	2,649	0.48%	42	10	5	143	2,844	
40	Ukraine	2,649	0.48%	42	10	5	143	2,844	
41	Glencore, Switzerland	2,649	0.48%	42	10	5	143	2,844	
42	Sasol, South Africa	2,649	0.48%	42	10	5	143	2,844	
43	North Korea	2,222	0.40%	35	9	4	120	2,386	
44	Egyptian General Petroleum, Egypt	2,267	0.41%	36	9	4	122	2,434	
45	Petroleum Development Oman, Oman	2,267	0.38%	34	8	4	115	2,285	
46	Marathon, USA	2,129	0.32%	28	7	3	95	1,901	
47	Petoro, Norway	1,771	0.46%	41	10	5	138	2,753	
48	Sinopec, China	2,564	0.41%	37	9	4	124	2,479	
49	CNOOC, PR China (acq Nexen Jan2013)	2,309	0.48%	42	10	5	142	2,840	
50	Yuko, Russia	2,645	0.31%	28	7	3	93	1,855	
51	LafargeHolcim, France	1,728	0.06%	6	1	1	19	373	
52	Hess, USA	347	0.45%	40	10	5	135	2,700	
53	TurkmenGaz, Turkmenistan	2,515	0.36%	32	8	4	108	2,162	
54	Sonangol, Angola	2,014	0.17%	15	4	2	50	993	
55	Singareni Collieries, India	925	0.30%	27	6	3	90	1,792	
56	Ecopetrol, Colombia	1,669	0.11%	10	2	1	33	651	
57	Novatek, Russian Federation	606	0.04%	3	1	0	11	220	
58	Cyprus Amx, USA	205	0.17%	15	4	2	51	1,022	
59	Novatek, Russian Federation	205	0.14%	12	3	1	41	810	
60	Canadian Natural Resources, Canada	952	0.26%	23	6	3	77	1,541	
61	Apache, USA	755	0.22%	19	5	2	65	1,295	
62	Murray Coal Corporation, USA	1,435	0.07%	6	1	1	20	393	
63	Exaro, South Africa	382	0.07%	6	1	1	21	410	
64	PetroEcuador	1,435	0.03%	3	1	0	10	201	
65	Kiewit Mining Group, USA	187	0.11%	10	2	1	33	666	
66	Syrian Petroleum, Syria	620	0.07%	6	2	1	21	428	
67	North American Coal, US	398	0.07%	6	2	1	21	428	
68	HeidelbergCement, Germany	398	0.08%	7	2	1	24	486	
69	Cloud Peak, USA	453	0.08%	7	2	1	24	471	
70	Vistra Luminant, USA	439	0.08%	7	2	1	24	471	
71	Bahrain Petroleum Corporation	366	0.04%	3	1	0	13	250	
72	EOG Resources, USA	382	0.04%	3	1	0	14	259	
73	RAG, Germany	187	0.06%	5	1	1	18	360	
74	Chesapeake, USA	187	0.07%	6	1	1	20	399	
75	Husky, Canada	620	0.06%	5	1	1	18	360	
76	Wintershall, Germany	398	0.04%	3	1	0	11	223	
77	UK Coal, UK	398	0.00%	0	0	0	1	22	
78	Inpex, Japan	453	0.04%	4	1	0	13	256	
79	YPF, Argentina	439	0.00%	0	0	0	1	27	
80	Cemex, Mexico	439	0.03%	3	1	0	9	174	
81	Woodside, Australia	233	0.01%	1	0	0	2	38	
82	Noble Energy, USA	251	0.01%	1	0	0	2	38	
83	OMV Group, Austria	336	0.01%	1	0	0	2	38	
84	Murphy Oil, USA	371	0.01%	1	0	0	2	38	
85	Polish Oil & Gas, Poland	340	0.01%	1	0	0	2	38	
86	Santos, Australia	208	0.01%	1	0	0	2	38	
87	Southwestern, USA	20	0.01%	1	0	0	2	38	
88	Taiheilyo, Japan	238	0.00%	0	0	0	1	27	
89	Pioneer, USA	25	0.00%	0	0	0	1	27	
90	EQT Corporation, USA	25	0.00%	0	0	0	1	27	
91	Obsidian, Canada	162	0.00%	0	0	0	1	27	
92	Antero, USA	35	0.00%	1	0	0	2	38	

Total CO2 & methane emissions	436,884	78.52%	6,966	1,674	840	23,530	469,054
	436,884	vertical check	1.59%	0.38%		5.39%	469,054
Oil & NGL CO2	436,884	This study, MtCO2					
Flaring CO2	7,242	This study, MtCO2					
Vented CO2	6,207	This study, MtCO2					
CDIAC emissions, MtCO2	556,431	CDIAC oil CO2	14,261	CDIAC Flaring CO2			
Percent this study of total CDIAC 1751-2010	78.5%	Percent of CDIAC	50.8%	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	Own fuel use	
MtCO2	Percent	MtCO2	MtCO2	MtCH4	MtCO2e	MtCO2	MtCO2e
	IPCC values (28Dec12)	1,736	28.53	9.878	276.6	57.28	EPA
		kg CO2/tCO2	kg CO2/tCO2	kg CH4/tCO2	kg CO2e/tCO2	kg CO2e/tCO2	
	IPCC values pasted:	1.525	25.08	3.708	77.9		
	28xCO2				28.0	xCO2	IPCC AR5 GWP 28xCO2

Rank Entity

CMEs summed to 2017

1	China, PR (coal & cement only)
2	FSU (Former Soviet Union)
3	Saudi Aramco, Saudi Arabia
4	Chevron, USA
5	ExxonMobil, USA
6	Gazprom, Russia
7	BP, UK
8	Royal Dutch Shell, Netherlands (acq BG Feb16)
9	National Iranian Oil Co., Iran
10	Poland
11	Pemex, Mexico
12	Coal India, India
13	British Coal Corporation, UK
14	ConocoPhillips, USA
15	Russian Federation
16	Peabody Energy, USA
17	Petroleos de Venezuela, Venezuela
18	PetroChina (CNPC), China
19	Total, France
20	Abu Dhabi, United Arab Emirates
21	Kuwait Petroleum Corp., Kuwait
22	Iraq National Oil Company, Iraq
23	Sonatrach, Algeria
24	BHP Billiton, Australia
25	CONSOL Energy, USA
26	Czechoslovakia
27	Petrobras, Brazil
28	Nigerian National Petroleum, Nigeria
29	Qatar Petroleum, Qatar
30	ENI, Italy
31	Anglo American, UK
32	Pertamina, Indonesia
33	Libya National Oil Corp., Libya
34	Petronas, Malaysia
35	Rosneft, Russian Federation
36	Arch Coal Company, USA
37	RWE, Germany
38	Rio Tinto, UK
39	Kazakhstan
40	Equinor, Norway
41	Lukoil, Russia
42	Anadarko, USA
43	Cortura (AlphaNR, Massey), USA
44	Occidental, USA
45	Oil and Gas Corp., India
46	Repsol, Spain (acq Talsman May2015)
47	Ukraine
48	Glencore, Switzerland
49	Sasol, South Africa
50	North Korea
51	Egyptian General Petroleum, Egypt
52	Petroleum Development Oman, Oman
53	Marathon, USA
54	Petoro, Norway
55	Sinopec, China
56	CNOOC, PR China (acq Nexen Jan2013)
57	Yukos, Russia
58	LafargeHolcim, France
59	Hess, USA
60	TurkmenGaz, Turkmenistan
61	Sonangol, Angola
62	Singareni Collieries, India
63	Ecopetrol, Colombia
64	Czech Republic
65	Devon Energy, USA
66	Suncor, Canada
67	EnCana, Canada
68	Westmoreland Mining, USA
69	Novatek, Russian Federation
70	Cyprus Amx, USA
71	Canadian Natural Resources, Canada
72	Apache, USA
73	Murray Coal Corporation, USA
74	Exaro, South Africa
75	PetroEcuador
76	Kiewit Mining Group, USA
77	Syrian Petroleum, Syria
78	North American Coal, US
79	HeidelbergCement, Germany
80	Cloud Peak, USA
81	Vistra Luminant, USA
82	Bahrain Petroleum Corporation
83	EOG Resources, USA
84	RAG, Germany
85	Chesapeake, USA
86	Husky, Canada
87	Wintershall, Germany
88	UK Coal, UK
89	Inpex, Japan
90	YPF, Argentina
91	Cemex, Mexico
92	Woodside, Australia
93	Noble Energy, USA
94	OMV Group, Austria
95	Murphy Oil, USA
96	Polish Oil & Gas, Poland
97	Santos, Australia
98	Southwestern, USA
99	Taiheyo, Japan
100	Pioneer, USA
101	EQT Corporation, USA
102	Obsidian, Canada
103	Antero, USA

y	y	10% of oil flaring	y	y	y	y	y
17,937	8.03%	31.1	511.80	177.18	4,961	1,027	24,468
4,003	1.79%	6.9	114.22	39.54	1,107	229	5,461
9,185	4.11%	15.9	262.09	90.73	2,541	526	12,530
12,246	5.48%	21.3	349.42	120.97	3,387	701	16,705
29,507	13.21%	51.2	841.93	291.47	8,161	1,690	40,251
6,683	2.99%	11.6	190.69	66.02	1,849	383	9,117
6,932	4.00%	15.5	254.85	88.23	2,470	511	12,184
5,704	2.53%	9.9	162.74	56.34	1,578	327	7,780
3,728	1.67%	6.5	106.38	36.83	1,031	213	5,086
5,881	2.63%	10.2	167.79	58.09	1,627	337	8,022
1,714	0.77%	3.0	48.92	16.94	474	98	2,339
2,759	1.24%	4.8	78.74	27.26	763	158	3,764
2,840	1.27%	4.9	81.02	28.05	785	163	3,874
2,092	0.94%	3.6	59.70	20.67	579	120	2,854
723	0.32%	1.3	20.62	7.14	200	41	986
285	0.13%	0.5	8.14	2.82	79	16	389
4,674	2.09%	8.1	133.36	46.17	1,293	268	6,375
659	0.29%	1.1	18.79	6.51	182	38	898
135	0.06%	0.2	3.85	1.33	37	8	184
1,108	0.50%	1.9	31.61	10.94	306	63	1,511
955	0.43%	1.7	27.25	9.43	264	55	1,303
2,915	1.30%	5.1	83.19	28.80	806	167	3,977
2,539	1.14%	4.4	72.46	25.09	702	145	3,464
1,482	0.66%	2.6	42.29	14.64	410	85	2,022
448	0.20%	0.8	12.79	4.43	124	26	611
2,844	1.27%	4.9	81.14	28.09	787	163	3,879
880	0.39%	1.5	25.12	8.70	244	50	1,201
1,631	0.73%	2.8	46.55	16.12	451	93	2,225
523	0.23%	0.9	14.93	5.17	145	30	714
1,784	0.80%	3.1	50.89	17.62	493	102	2,433
605	0.27%	1.0	17.26	5.98	167	35	825
1,299	0.58%	2.3	37.07	12.83	359	74	1,772
1,728	0.77%	3.0	49.31	17.07	478	99	2,357
64	0.03%	0.1	1.83	0.63	18	4	87
958	0.43%	1.7	27.34	9.47	265	55	1,307
867	0.39%	1.5	24.73	8.56	240	50	1,182
904	0.40%	1.6	25.79	8.93	250	52	1,233
1,112	0.50%	1.9	31.73	10.99	308	64	1,517
477	0.21%	0.8	13.60	4.71	132	27	650
425	0.19%	0.7	12.12	4.20	118	24	580
41	0.02%	0.1	1.18	0.41	11	2	56
685	0.31%	1.2	19.54	6.77	189	39	934
1,754	0.78%	3.0	50.04	17.32	485	100	2,392
25	0.01%	0.0	0.71	0.25	7	1	34
305	0.14%	0.5	8.69	3.01	84	17	415
1,083	0.48%	1.9	30.91	10.70	300	62	1,478
392	0.18%	0.7	11.18	3.87	108	22	534
1,180	0.53%	2.0	33.68	11.66	326	68	1,610
1,257	0.56%	2.2	35.87	12.42	348	72	1,715
547	0.24%	0.9	15.61	5.40	151	31	746
619	0.28%	1.1	17.67	6.12	171	35	845
12	0.01%	0.0	0.35	0.12	3	1	17
187	0.08%	0.3	5.33	1.85	52	11	255
668	0.30%	1.2	19.07	6.60	185	38	912
582	0.26%	1.0	16.61	5.75	161	33	794
683	0.31%	1.2	19.50	6.75	189	39	932
260	0.12%	0.5	7.41	2.56	72	15	354
368	0.16%	0.6	10.50	3.64	102	21	502
269	0.12%	0.5	7.67	2.66	74	15	367
270	0.12%	0.5	7.70	2.67	75	15	368
331	0.15%	0.6	9.44	3.27	91	19	451
315	0.14%	0.5	9.00	3.12	87	18	430
229	0.10%	0.4	6.55	2.27	63	13	313
172	0.08%	0.3	4.91	1.70	48	10	235
162	0.07%	0.3	4.63	1.60	45	9	222
235	0.11%	0.4	6.72	2.33	65	13	321
354	0.16%	0.6	10.09	3.49	98	20	482
159	0.07%	0.3	4.54	1.57	44	9	217
238	0.11%	0.4	6.79	2.35	66	14	325
118	0.05%	0.2	3.38	1.17	33	7	162
113	0.05%	0.2	3.23	1.12	31	6	154

Total CO2 & methane emissions	158,849	71.10%	276	4,533	1,569	43,937	9,096	216,690
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CMEs summed to 2017

This study, MtCO2	158,849	This study, MtCO2
CDIAC emissions, MtCO2	223,403	CDIAC gas CO2
Percent this study of total CDIAC 1751-2010	71.11%	Percent of CDIAC

Total Methane	119,514	This study, MtCO2e
CDIAC CH4, MtCO2e	176,132	CDIAC CH4, MtCO2e
Percent of CDIAC	67.85%	Percent of CDIAC

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

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Rank	Entity	Coal				Cement production	
		Coal CO2 emissions		Fugitive methane emissions		Calculating emissions	
		This study	Percent of CDIAC	Fugitive methane	Fugitive methane	Total coal emissions	Percent of CDIAC
		MtCO2	Percent	MtCH4	MtCO2e	MtCO2e	Percent

		IPCC values (22Dec12)		IPCC values pasted:		IPCC AR5 GWP 28xCO2		GWP 28xCO2	
		kg CH4/tCO2		kg CO2e/tCO2		28.0 xCO2			
				4.035		84.73			
		CMEs summed to 2017							
		y	y	y	y	y	y	y	y
1	China, PR (coal & cement only)	200,360	27.01%	808	22,635	222,994		17,411	45.26%
2	FSU (Former Soviet Union)	64,852	8.74%	262	7,326	72,179			
3	Saudi Aramco, Saudi Arabia								
4	Chevron, USA	1,086	0.15%	4	123	1,208			
5	EconMobil, USA	1,317	0.18%	5	149	1,466			
6	Gazprom, Russia								
7	BP, UK	918	0.12%	4	104	1,022			
8	Royal Dutch Shell, Netherlands (acq BG Feb16)	978	0.13%	4	111	1,089			
9	National Iranian Oil Co., Iran								
10	Poland	24,345	3.28%	98	2,750	27,096			
11	Pemex, Mexico								
12	Coal India, India	20,779	2.80%	84	2,347	23,126			
13	British Coal Corporation, UK	17,742	2.39%	72	2,004	19,746			
14	ConocoPhillips, USA								
15	Russian Federation	16,678	2.25%	67	1,884	18,562			
16	Peabody Energy, USA	14,509	1.96%	59	1,639	16,148			
17	Petroleos de Venezuela, Venezuela								
18	PetroChina (CNPC), China								
19	Total, France								
20	Abu Dhabi, United Arab Emirates								
21	Kuwait Petroleum Corp., Kuwait								
22	Iraq National Oil Company, Iraq								
23	Sonatrach, Algeria								
24	BHP Billiton, Australia	6,641	0.90%	27	750	7,391			
25	CONSOL Energy, USA	8,709	1.17%	35	984	9,693			
26	Czechoslovakia	8,634	1.16%	35	975	9,610			
27	Petrobras, Brazil								
28	Nigerian National Petroleum, Nigeria								
29	Qatar Petroleum, Qatar								
30	ENI, Italy								
31	Anglo American, UK	6,864	0.93%	28	775	7,639			
32	Pertamina, Indonesia								
33	Libya National Oil Corp., Libya								
34	Petronas, Malaysia								
35	Rosneft, Russian Federation								
36	Arch Coal Company, USA	6,439	0.87%	26	727	7,167			
37	RWE, Germany	6,425	0.87%	26	726	7,151			
38	Rio Tinto, UK	6,033	0.81%	24	682	6,714			
39	Kazakhstan	5,783	0.78%	23	653	6,436			
40	Equinor, Norway								
41	Lukoil, Russia								
42	Anadarko, USA	636	0.09%	3	72	708			
43	Contura (AlphaR, Massey), USA	5,309	0.72%	21	600	5,908			
44	Occidental, USA	1,725	0.23%	7	195	1,920			
45	Oil and Gas Corp., India								
46	Repsol, Spain (acq Talisman May2015)								
47	Ukraine	4,204	0.57%	17	475	4,679			
48	Glencore, Switzerland	4,203	0.57%	17	475	4,678			
49	Sasol, South Africa	3,922	0.53%	16	443	4,365			
50	North Korea	3,474	0.47%	14	392	3,866			
51	Egyptian General Petroleum, Egypt								
52	Petroleum Development Oman, Oman								
53	Marathon, USA								
54	Petoro, Norway								
55	Sinopec, China								
56	CNOOC, PR China (acq Nexen Jan2013)								
57	Yukos, Russia								
58	LafargeHolcim, France							2,823	7.34%
59	Hess, USA								
60	TurkmenGaz, Turkmenistan								
61	Sonangol, Angola								
62	Singarel Collieries, India	2,398	0.32%	10	271	2,668			
63	Ecopetrol, Colombia								
64	Czech Republic	2,308	0.31%	9	261	2,568			
65	Devon Energy, USA								
66	Suncor, Canada								
67	EnCana, Canada								
68	Westmoreland Mining, USA	1,975	0.27%	8	223	2,198			
69	Novatek, Russian Federation								
70	Cyprus Amx, USA	1,611	0.22%	7	182	1,793			
71	Canadian Natural Resources, Canada								
72	Apache, USA								
73	Murray Coal Corporation, USA	1,466	0.20%	6	166	1,631			
74	Exaro, South Africa	1,446	0.20%	6	163	1,610			
75	PetroEcuador								
76	Kiewit Mining Group, USA	1,395	0.19%	6	158	1,553			
77	Syrian Petroleum, Syria								
78	North American Coal, US	1,324	0.18%	5	150	1,473			
79	HeidelbergCement, Germany							1,452	3.77%
80	Cloud Peak, USA	1,208	0.16%	5	136	1,345			
81	Vistra Luminant, USA	1,186	0.16%	5	134	1,320			
82	Bahrain Petroleum Corporation								
83	EOG Resources, USA								
84	RAG, Germany	1,049	0.14%	4	119	1,168			
85	Chesapeake, USA								
86	Husky, Canada								
87	Wintershall, Germany								
88	UK Coal, UK	792	0.11%	3	90	882			
89	Inpex, Japan								
90	YPF, Argentina								
91	Cemex, Mexico							742	1.93%
92	Woodside, Australia								
93	Noble Energy, USA								
94	OMV Group, Austria								
95	Murphy Oil, USA								
96	Polish Oil & Gas, Poland								
97	Santos, Australia								
98	Southwestern, USA								
99	Taiheyo, Japan							502	1.31%
100	Pioneer, USA								
101	EQT Corporation, USA								
102	Obdilan, Canada								
103	Antero, USA								
Total CO2 & methane emissions		460,725	62.11%	1,859	52,048	512,772		22,930	59.61%

		Coal CO2		Coal Methane		Cement	
		This study, MtCO2	This study, MtCO2e	This study, MtCO2e	This study, MtCO2e	This study, MtCO2e	This study, MtCO2e
		460,725	741,737	52,048	105,214	22,930	38,469
		linked to SumCoal.xls	linked to SumCoal.xls	linked to CDIAC.xls	linked to CDIAC.xls	linked to SumCement.xls	linked to SumCement.xls
		62.1% Percent of CDIAC		49.5% Percent of CDIAC		59.6% Percent of CDIAC	

Table with columns AR, AS, AT, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BE, BF, BG, BH, BI, BJ

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

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Grand Total of emissions identified in this study

Summary table with columns: Total fuel and cement CO2 emissions, Emissions from flaring, venting, and fugitive methane, Total CO2 and methane. Sub-headers include This study, Percent of CDIAC, Flaring CO2, Vented CO2, Own fuel use, Fugitive methane, Total emissions, Percent of this study, % of CDIAC 1751-2016.

Summary table with columns: Scope 3, Scope 1, Scope 1, Scope 1, Scope 1, Scope 1 + Scope 3. Sub-headers include Top Twenty IOCs & SOEs, CNEs summed to 2017, Top Twenty IOCs & SOEs, 28.0 xCO2, GWP 28xCO2, Top Twenty IOCs & SOEs.

Main data table with columns: Rank, Entity, MtCO2, MTC, Percent of CDIAC, Percent, Flaring CO2 (MtCO2), Vented CO2 (MtCO2), Own fuel use (MtCO2), Fugitive methane (MtCH4), Fugitive methane (MtCO2e), Total emissions (MtCO2e), Percent of this study, % of CDIAC 1751-2016. Lists entities like China, Saudi Aramco, ExxonMobil, etc.

Summary table with columns: Total CO2 & methane emissions, Total CO2: fossil fuels (excl. cement, flaring & vented), Total CO2: fossil fuels, flaring, venting, cement, Total CO2 and methane. Includes sub-totals for This study, CDIAC emissions, and Percent of CDIAC.

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 × 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 ocoal, 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: AJ11**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 CH₄/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: BB128**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: BJ130**Comment:** Rick Heede: