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

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17-Oct-20

Crude Oil & Natural Gas Liquids

			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
	Rank	Entity	MtCO2	Percent	MtCO2	MtCO2	MtCH4		MtCO2e	MtCO2e
				IPCC values (28Dec12)	15.94	3.833	1.924	EPA	40.39	
					kg CO2/tCO2	kg CO2/tCO2	kg CH4/tCO2		kg CO2e/tCO2	
				IPCC values pasted:	15.19	3.651	10.080		212	
			CMEs summed to 2018						28.0 xCO2	GWP
			y	y	y	y	y		y	y
	1	Abu Dhabi, United Arab Emirates	10,712	1.89%	171	41.1	21		577	11,501
	2	Alliance Resource Partners, USA								
	3	Anadarko, USA	2,877	0.51%	46	11	6		155	3,089
	4	Anglo American, UK								
	5	Antero, USA	53	0.01%	1	0	0		3	57
	6	Apache, USA	796	0.14%	13	3	2		43	855
	7	Arch Coal Company, USA								
	8	Bahrain Petroleum Corporation	373	0.07%	6	1	1		20	401
	9	BHP Billiton, Australia	1,526	0.27%	24	6	3		82	1,639
	10	BP, UK	28,146	4.97%	449	108	54		1,516	30,219
	11	British Coal Corporation, UK								
	12	Canadian Natural Resources, Canada	1,063	0.19%	17	4	2		57	1,141
	13	Cemex, Mexico								
	14	Chesapeake, USA	206	0.04%	3	1	0		11	222
	15	Chevron, USA	38,484	6.80%	614	147	74		2,073	41,317
	16	China, PR (coal & cement only)								
	17	Cloud Peak, USA								
	18	CNOOC, PR China (acq Nexen Jan2013)	2,452	0.43%	39	9	5		132	2,632
	19	Coal India, India								
	20	ConocoPhillips, USA	10,193	1.80%	163	39	20		549	10,944
	21	CONSOL Energy, USA								
	22	Contura (AlphaNR, Massey), USA								
	23	Cyprus Amax, USA								
	24	Czech Republic								
	25	Czechoslovakia								
	26	Devon Energy, USA	973	0.17%	16	4	2		52	1,044
	27	Ecopetrol, Colombia	2,094	0.37%	33	8	4		113	2,248
	28	Egyptian General Petroleum, Egypt	2,268	0.40%	36	9	4		122	2,435
	29	EnCana, Canada	629	0.11%	10	2	1		34	675
	30	ENI, Italy	4,173	0.74%	67	16	8		225	4,480
	31	EOG Resources, USA	452	0.08%	7	2	1		24	485
	32	EQT Corporation, USA	31	0.01%	0	0	0		2	33
	33	Equinor, Norway	3,945	0.70%	63	15	8		212	4,236
	34	Exxaro, South Africa								
	35	ExxonMobil, USA	32,037	5.66%	511	123	62		1,725	34,396
	36	FSU (Former Soviet Union)	35,462	6.27%	565	136	68		1,910	38,073
	37	Gazprom, Russia	2,937	0.52%	47	11	6		158	3,153
	38	Glencore, Switzerland								
	39	HeidelbergCement, Germany (acq Italcementi)								
	40	Hess, USA	1,753	0.31%	28	7	3		94	1,882
	41	Husky, Canada	649	0.11%	10	2	1		35	697
	42	Inpex, Japan	497	0.09%	8	2	1		27	534
	43	Iraq National Oil Company, Iraq	11,946	2.11%	190	46	23		643	12,825
	44	Kazakhstan								
	45	Kiewit Mining Group, USA								
	46	Kuwait Petroleum Corp., Kuwait	12,283	2.17%	196	47	24		662	13,187
	47	LafargeHolcim, France								
	48	Libya National Oil Corp., Libya	6,547	1.16%	104	25	13		353	7,029
	49	Lukoil, Russia	5,336	0.94%	85	20	10		287	5,729
	50	Marathon, USA	2,166	0.38%	35	8	4		117	2,326
	51	Murphy Oil, USA	385	0.07%	6	1	1		21	413
	52	Murray Coal Corporation, USA								
	53	National Iranian Oil Co., Iran	28,095	4.96%	448	108	54		1,513	30,164
	54	Nigerian National Petroleum, Nigeria	7,064	1.25%	113	27	14		380	7,584
	55	Noble Energy, USA	278	0.05%	4	1	1		15	298
	56	North American Coal, US								
	57	North Korea								
	58	Novatek, Russian Federation	237	0.04%	4	1	0		13	254
	59	Obsidian, Canada	164	0.03%	3	1	0		9	176
	60	Occidental, USA	2,996	0.53%	48	11	6		161	3,216
	61	Oil and Gas Corp., India	3,323	0.59%	53	13	6		179	3,568
	62	OMV Group, Austria	360	0.06%	6	1	1		19	387
	63	Peabody Energy, USA								
	64	Pertamina, Indonesia	5,214	0.92%	83	20	10		281	5,598
	65	Petoro, Norway	1,821	0.32%	29	7	4		98	1,955
	66	PetroChina (CNPC), China	11,357	2.01%	181	44	22		612	12,193
	67	Petrobras, Brazil	7,050	1.25%	112	27	14		380	7,569
	68	Petroleos de Venezuela, Venezuela	12,911	2.28%	206	49	25		695	13,862
	69	Pemex, Mexico	17,611	3.11%	281	67	34		948	18,908
	70	Petroleum Development Oman, Oman	2,322	0.41%	37	9	4		125	2,493
	71	PetroEcuador	1,506	0.27%	24	6	3		81	1,616
	72	Petronas, Malaysia	3,412	0.60%	54	13	7		184	3,664
	73	Pioneer, USA	273	0.05%	4	1	1		15	293
	74	Poland								
	75	Polish Oil & Gas, Poland	344	0.06%	5	1	1		19	369
	76	PTTEP, Thailand	193	0.03%	3	1	0		10	207
	77	Qatar Petroleum, Qatar	3,914	0.69%	62	15	8		211	4,202
	78	Repsol, Spain (acq Talisman May2015)	2,684	0.47%	43	10	5		145	2,882
	79	Rio Tinto, UK								
	80	Rosneft, Russian Federation	6,294	1.11%	100	24	12		339	6,758
	81	Royal Dutch Shell, Netherlands (acq BG Feb16)	23,419	4.14%	373	90	45		1,261	25,144
	82	RAG, Germany								
	83	Russian Federation								
	84	RWE, Germany								
	85	Santos, Australia	220	0.04%	4	1	0		12	236
	86	Sasol, South Africa								
	87	Saudi Aramco, Saudi Arabia	51,938	9.18%	828	199	100		2,797	55,763
	88	Singareni Collieries, India								
	89	Sinopec, China	2,672	0.47%	43	10	5		144	2,868
	90	Sonangol, Angola	2,630	0.46%	42	10	5		142	2,823
	91	Sonatrach, Algeria	5,707	1.01%	91	22	11		307	6,127
	92	Southwestern, USA	29	0.01%	0	0	0		2	31
	93	Suncor, Canada	1,767	0.31%	28	7	3		95	1,897
	94	Syrian Petroleum, Syria	1,208	0.21%	19	5	2		65	1,297
	95	Taiheiyo, Japan								
	96	Teck Resources, Canada								
	97	Total, France	10,161	1.80%	162	39	20		547	10,909
	98	TurkmenGaz, Turkmenistan	369	0.07%	6	1	1		20	397
	99	UK Coal, UK								
	100	Ukraine								
	101	Vale, Brazil								
	102	Vistra Luminant, USA								
	103	Westmoreland Mining, USA								
	104	Whitehaven Coal, Australia								
	105	Wintershall, Germany	418	0.07%	7	2	1		23	449
	106	Woodside, Australia	238	0.04%	4	1	0		13	256
	107	YPF, Argentina	475	0.08%	8	2	1		26	510
	108	Yukos, Russia	2,645	0.47%	42	10	5		142	2,840
		Total CO2 & methane emissions	446,764	78.94%	7,123	1,712	859		24,062	479,662
			446,764 vertical check		1.59%	0.38%			5.39%	479,662
			CMEs summed to 2018							

	Oil & NGL CO2		Flaring CO2		Oil-related Methane	
This study, MtCO2	446,764	This study, MtCO2	7,408	This study, MtCO2	24,062	This study, MtCO2e
					CDIAC-EDGAR methane 1860-2013	
CDIAC emissions, MtCO2	565,950	CDIAC oil CO2	16,105	CDIAC Flaring CO2	32,337	CDIAC CH4, MtCO2e
	linked to SumOil.xls		linked to CDIAC Global 1751-2018.xls		linked to Ancillary "General Non-CO2 data" (CDIAC & EDGAR 1860-2	
Percent this study of total CDIAC 1751-2010	78.9%	Percent of CDIAC	46.0%	Percent of CDIAC	74.41%	Percent of CDIAC

Summary of CO2 & methane emissions from identified natural gas production

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Natural Gas

Rank	Entity	Production less sequestration: This study MtCO2	Production less sequestration: Percent of CDIAC Percent	Ancillary emissions from flaring, venting, own use of fuels, and fugitive methane: Flaring CO2 MtCO2	Vented CO2 MtCO2	Fugitive methane MtCH4	Fugitive methane MtCO2e	Own fuel use MtCO2	Total natural gas emissions 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 values pasted:	1.525	25.08	3.708	77.9		
28xCO2		CMEs summed to 2018					28.0	xCO2	IPCC AR5 GWP 28xCO2
		y	y	10% of oil flaring	y	y	y		y
1	Abu Dhabi, United Arab Emirates	2,226	0.97%	3.9	63.53	21.99	616	127	3,037
2	Alliance Resource Partners, USA								
3	Anadarko, USA	1,804	0.78%	3.1	51.48	17.82	499	103	2,461
4	Anglo American, UK								
5	Antero, USA	151	0.07%	0.3	4.31	1.49	42	9	206
6	Apache, USA	638	0.28%	1.1	18.21	6.30	177	37	871
7	Arch Coal Company, USA								
8	Bahrain Petroleum Corporation	696	0.30%	1.2	19.87	6.88	193	40	950
9	BHP Billiton, Australia	693	0.30%	1.2	19.76	6.84	192	40	945
10	BP, UK	6,852	2.98%	11.9	195.51	67.69	1,895	392	9,347
11	British Coal Corporation, UK								
12	Canadian Natural Resources, Canada	577	0.25%	1.0	16.47	5.70	160	33	787
13	Cemex, Mexico								
14	Chesapeake, USA	728	0.32%	1.3	20.77	7.19	201	42	993
15	Chevron, USA	9,320	4.05%	16.2	265.92	92.06	2,578	534	12,713
16	China, PR (coal & cement only)								
17	Cloud Peak, USA								
18	CNOOC, PR China (acq Nexen Jan2013)	453	0.20%	0.8	12.93	4.48	125	26	618
19	Coal India, India								
20	ConocoPhillips, USA	5,935	2.58%	10.3	169.34	58.62	1,641	340	8,096
21	CONSOL Energy, USA	160	0.07%	0.3	4.56	1.58	44	9	218
22	Contura (AlphaNR, Massey), USA								
23	Cyprus Amax, USA								
24	Czech Republic								
25	Czechoslovakia								
26	Devon Energy, USA	1,105	0.48%	1.9	31.52	10.91	306	63	1,507
27	Ecopetrol, Colombia	319	0.14%	0.6	9.09	3.15	88	18	435
28	Egyptian General Petroleum, Egypt	1,015	0.44%	1.8	28.95	10.02	281	58	1,384
29	EnCana, Canada	1,203	0.52%	2.1	34.33	11.88	333	69	1,641
30	ENI, Italy	2,630	1.14%	4.6	75.04	25.98	727	151	3,587
31	EOG Resources, USA	606	0.26%	1.1	17.29	5.98	168	35	826
32	EQT Corporation, USA	312	0.14%	0.5	8.91	3.08	86	18	426
33	Equinor, Norway	1,736	0.75%	3.0	49.53	17.15	480	99	2,368
34	Exxaro, South Africa								
35	ExxonMobil, USA	12,429	5.40%	21.6	354.65	122.78	3,438	712	16,955
36	FSU (Former Soviet Union)	17,937	7.80%	31.1	511.80	177.18	4,961	1,027	24,468
37	Gazprom, Russia	30,498	13.26%	52.9	870.23	301.27	8,436	1,746	41,604
38	Glencore, Switzerland								
39	HeidelbergCement, Germany								
40	Hess, USA	696	0.30%	1.2	19.85	6.87	192	40	949
41	Husky, Canada	270	0.12%	0.5	7.69	2.66	75	15	368
42	Inpex, Japan	282	0.12%	0.5	8.03	2.78	78	16	384
43	Iraq National Oil Company, Iraq	305	0.13%	0.5	8.70	3.01	84	17	416
44	Kazakhstan								
45	Kiewit Mining Group, USA								
46	Kuwait Petroleum Corp., Kuwait	756	0.33%	1.3	21.57	7.47	209	43	1,031
47	LafargeHolcim, France								
48	Libya National Oil Corp., Libya	460	0.20%	0.8	13.14	4.55	127	26	628
49	Lukoil, Russia	586	0.25%	1.0	16.73	5.79	162	34	800
50	Marathon, USA	921	0.40%	1.6	26.27	9.09	255	53	1,256
51	Murphy Oil, USA	180	0.08%	0.3	5.14	1.78	50	10	246
52	Murray Coal Corporation, USA								
53	National Iranian Oil Co., Iran	6,155	2.68%	10.7	175.64	60.81	1,703	352	8,397
54	Nigerian National Petroleum, Nigeria	1,048	0.46%	1.8	29.90	10.35	290	60	1,429
55	Noble Energy, USA	333	0.14%	0.6	9.51	3.29	92	19	455
56	North American Coal, US								
57	North Korea								
58	Novatek, Russian Federation	1,387	0.60%	2.4	39.57	13.70	384	79	1,892
59	Obsidian, Canada	120	0.05%	0.2	3.41	1.18	33	7	163
60	Occidental, USA	621	0.27%	1.1	17.73	6.14	172	36	848
61	Oil and Gas Corp., India	1,346	0.59%	2.3	38.40	13.29	372	77	1,836
62	OMV Group, Austria	257	0.11%	0.4	7.34	2.54	71	15	351
63	Peabody Energy, USA								
64	Pertamina, Indonesia	1,542	0.67%	2.7	44.00	15.23	426	88	2,103
65	Petoro, Norway	1,190	0.52%	2.1	33.96	11.76	329	68	1,623
66	PetroChina (CNPC), China	3,169	1.38%	5.5	90.41	31.30	876	181	4,322
67	Petrobras, Brazil	1,166	0.51%	2.0	33.27	11.52	323	67	1,591
68	Petroleos de Venezuela, Venezuela	1,761	0.77%	3.1	50.25	17.40	487	101	2,403
69	Pemex, Mexico	3,786	1.65%	6.6	108.02	37.40	1,047	217	5,164
70	Petroleum Development Oman, Oman	911	0.40%	1.6	26.00	9.00	252	52	1,243
71	PetroEcuador	13	0.01%	0.0	0.37	0.13	4	1	18
72	Petronas, Malaysia	2,972	1.29%	5.2	84.79	29.35	822	170	4,054
73	Pioneer, USA	167	0.07%	0.3	4.76	1.65	46	10	228
74	Poland								
75	Polish Oil & Gas, Poland	171	0.07%	0.3	4.88	1.69	47	10	233
76	PTTEP, Thailand	378	0.16%	0.7	10.77	3.73	104	22	515
77	Qatar Petroleum, Qatar	2,435	1.06%	4.2	69.48	24.05	674	139	3,322
78	Repsol, Spain (acq Talisman May2015)	1,781	0.77%	3.1	50.83	17.60	493	102	2,430
79	Rio Tinto, UK								
80	Rosneft, Russian Federation	1,007	0.44%	1.7	28.74	9.95	279	58	1,374
81	Royal Dutch Shell, Netherlands (acq BG Feb16)	9,142	3.97%	15.9	260.87	90.31	2,529	524	12,471
82	RAG, Germany								
83	Russian Federation								
84	RWE, Germany								
85	Santos, Australia	244	0.11%	0.4	6.95	2.41	67	14	332
86	Sasol, South Africa	71	0.03%	0.1	2.04	0.70	20	4	97
87	Saudi Aramco, Saudi Arabia	4,140	1.80%	7.2	118.12	40.89	1,145	237	5,647
88	Singareni Collieries, India								
89	Sinopec, China	529	0.23%	0.9	15.09	5.22	146	30	721
90	Sonangol, Angola	28	0.01%	0.0	0.80	0.28	8	2	38
91	Sonatrach, Algeria	4,855	2.11%	8.4	138.52	47.96	1,343	278	6,622
92	Southwestern, USA	397	0.17%	0.7	11.32	3.92	110	23	541
93	Suncor, Canada	392	0.17%	0.7	11.18	3.87	108	22	534
94	Syrian Petroleum, Syria	191	0.08%	0.3	5.45	1.89	53	11	260
95	Taiheiyo, Japan								
96	Teck Resources, Canada								
97	Total, France	2,968	1.29%	5.2	84.70	29.32	821	170	4,049
98	TurkmenGaz, Turkmenistan	1,846	0.80%	3.2	52.68	18.24	511	106	2,519
99	UK Coal, UK								
100	Ukraine								
101	Vale, Brazil								
102	Vistra Luminant, USA								
103	Westmoreland Mining, USA								
104	Whitehaven Coal, Australia								
105	Wintershall, Germany	406	0.18%	0.7	11.57	4.01	112	23	553
106	Woodside, Australia	353	0.15%	0.6	10.08	3.49	98	20	482
107	YPF, Argentina	295	0.13%	0.5	8.41	2.91	82	17	402
108	Yukos, Russia	41	0.02%	0.1	1.18	0.41	11	2	56
	Total CO2 & methane emissions V	164,091	71.33%	285	4,682	1,621	45,386	9,397	223,840 y
		164,091	vertical check	0.17%	2.85%		27.66%		223,840 vert

CMEs summed to 2018

		Natural Gas CO2		Vented CO2		Gas-related Methane	
This study, MtCO2	V	164,091	This study, MtCO2	6,394	This study, MtCO2	45,386	This study, MtCO2e V
						CDIAC-EDGAR methane 1860-2018	
CDIAC emissions, MtCO2	V	230,034	CDIAC gas CO2	CDIAC incl. in gas CO2	CDIAC Flaring CO2	73,818	CDIAC CH4, MtCO2e V
2018)		linked to SumGas.xls				linked to Ancillary "General Non-CO2 data" (CDIAC & EDGAR	1860
Percent this study of total CDIAC 1751-2010	V	71.3%	Percent of CDIAC	na	Percent of CDIAC	61.48%	Percent of CDIAC V

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

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Rank	Entity	Coal: This study MtCO2	Coal: Percent of CDIAC	Coal: Fugitive methane MtCH4	Coal: Fugitive methane MtCO2e	Coal: Total coal emissions MtCO2e	Cement production: Calcining emissions Cement MtCO2	Cement production: Percent of CDIAC Percent
			IPCC values (22Dec12)	4.035	84.73			
				kg CH4/tCO2	kg CO2e/tCO2			
			IPCC values pasted:	4.035	84.73	IPCC AR5 GWP 28xCO2		
		CMEs summed to 2018			28.0	xCO2	GWP 28xCO2	
		y	y	y	y	y	y	y
1	Abu Dhabi, United Arab Emirates							
2	Alliance Resource Partners, USA	1,300	0.17%	5	147	1,447		
3	Anadarko, USA	636	0.08%	3	72	708		
4	Anglo American, UK	6,975	0.92%	28	788	7,763		
5	Antero, USA							
6	Apache, USA							
7	Arch Coal Company, USA	6,608	0.87%	27	746	7,354		
8	Bahrain Petroleum Corporation							
9	BHP Billiton, Australia	6,807	0.89%	27	769	7,576		
10	BP, UK	918	0.12%	4	104	1,022		
11	British Coal Corporation, UK	17,742	2.33%	72	2,004	19,746		
12	Canadian Natural Resources, Canada							
13	Cemex, Mexico						770	1.93%
14	Chesapeake, USA							
15	Chevron, USA	1,086	0.14%	4	123	1,208		
16	China, PR (coal & cement only)	209,346	27.52%	845	23,650	232,995	18,650	46.72%
17	Cloud Peak, USA	1,290	0.17%	5	146	1,436		
18	CNOOC, PR China (acq Nexen Jan2013)							
19	Coal India, India	21,870	2.87%	88	2,471	24,341		
20	ConocoPhillips, USA							
21	CONSOL Energy, USA	8,725	1.15%	35	986	9,710		
22	Contura (AlphaNR, Massey), USA	5,348	0.70%	22	604	5,953		
23	Cyprus Amax, USA	1,611	0.21%	7	182	1,793		
24	Czech Republic	2,370	0.31%	10	268	2,638		
25	Czechoslovakia	8,634	1.13%	35	975	9,610		
26	Devon Energy, USA							
27	Ecopetrol, Colombia							
28	Egyptian General Petroleum, Egypt							
29	EnCana, Canada							
30	ENI, Italy							
31	EOG Resources, USA							
32	EQT Corporation, USA							
33	Equinor, Norway							
34	Exxaro, South Africa	1,552	0.20%	6	175	1,727		
35	ExxonMobil, USA	1,317	0.17%	5	149	1,466		
36	FSU (Former Soviet Union)	64,852	8.52%	262	7,326	72,179		
37	Gazprom, Russia							
38	Glencore, Switzerland	4,521	0.59%	18	511	5,032		
39	HeidelbergCement, Germany						1,502	3.76%
40	Hess, USA							
41	Husky, Canada							
42	Inpex, Japan							
43	Iraq National Oil Company, Iraq							
44	Kazakhstan	6,061	0.80%	24	685	6,745		
45	Kiewit Mining Group, USA	1,425	0.19%	6	161	1,586		
46	Kuwait Petroleum Corp., Kuwait							
47	LafargeHolcim, France						2,907	7.28%
48	Libya National Oil Corp., Libya							
49	Lukoil, Russia							
50	Marathon, USA							
51	Murphy Oil, USA							
52	Murray Coal Corporation, USA	1,568	0.21%	6	177	1,746		
53	National Iranian Oil Co., Iran							
54	Nigerian National Petroleum, Nigeria							
55	Noble Energy, USA							
56	North American Coal, US	1,366	0.18%	6	154	1,520		
57	North Korea	3,527	0.46%	14	398	3,926		
58	Novatek, Russian Federation							
59	Obsidian, Canada							
60	Occidental, USA	1,725	0.23%	7	195	1,920		
61	Oil and Gas Corp., India							
62	OMV Group, Austria							
63	Peabody Energy, USA	14,867	1.95%	60	1,680	16,547		
64	Pertamina, Indonesia							
65	Petoro, Norway							
66	PetroChina (CNPC), China							
67	Petrobras, Brazil							
68	Petroleos de Venezuela, Venezuela							
69	Pemex, Mexico							
70	Petroleum Development Oman, Oman							
71	PetroEcuador							
72	Petronas, Malaysia							
73	Pioneer, USA							
74	Poland	24,576	3.23%	99	2,776	27,353		
75	Polish Oil & Gas, Poland							
76	PTTEP, Thailand							
77	Qatar Petroleum, Qatar							
78	Repsol, Spain (acq Talisman May2015)							
79	Rio Tinto, UK	6,089	0.80%	25	688	6,777		
80	Rosneft, Russian Federation							
81	Royal Dutch Shell, Netherlands (acq BG Feb16)	978	0.13%	4	111	1,089		
82	RAG, Germany	1,049	0.14%	4	119	1,168		
83	Russian Federation	17,659	2.32%	71	1,995	19,654		
84	RWE, Germany	6,531	0.86%	26	738	7,268		
85	Santos, Australia							
86	Sasol, South Africa	4,013	0.53%	16	453	4,466		
87	Saudi Aramco, Saudi Arabia							
88	Singareni Collieries, India	2,513	0.33%	10	284	2,797		
89	Sinopec, China							
90	Sonangol, Angola							
91	Sonatrach, Algeria							
92	Southwestern, USA							
93	Suncor, Canada							
94	Syrian Petroleum, Syria							
95	Talhelyo, Japan						518	1.30%
96	Teck Resources, Canada	910	0.12%	4	103	1,013		
97	Total, France							
98	TurkmenGaz, Turkmenistan							
99	UK Coal, UK	792	0.10%	3	90	882		
100	Ukraine	4,292	0.56%	17	485	4,777		
101	Vale, Brazil	226	0.03%	1	25	251		
102	Vistra Luminant, USA	1,201	0.16%	5	136	1,337		
103	Westmoreland Mining, USA	2,028	0.27%	8	229	2,257		
104	Whitehaven Coal, Australia	232	0.03%	1	26	258		
105	Wintershall, Germany							
106	Woodside, Australia							
107	YPF, Argentina							
108	Yukos, Russia							
	Total CO2 & methane emissions	V 477,139	62.71%	1,925	53,902.02	531,041	V 24,348	60.99% y
	ical check	477,139	vertical check			531,041	vertical	24,348 vertical check
		CMEs summed to 2018						CMEs summed to 2018

	Coal CO2		Coal-related Methane		Cement	
This study, MtCO2	V 477,139	This study, MtCO2e	53,902	This study, MtCO2e	V V 24,348	This study, MtCO2e
			Coal methane - verified			
CDIAC emissions, MtCO2	V 760,840	CDIAC coal CO2	89,037	CDIAC CH4, MtCO2e	V V 39,922	CDIAC cement CO2
-2018)	linked to SumCoal.xls		linked to AncillaryCH4&CO2.xls		linked to SumCement..xls	
Percent this study of total CDIAC 1751-2010	V 62.7%	Percent of CDIAC	60.5%	Percent of CDIAC	V V 61.0%	Percent of CDIAC

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

Richard Heede
Climate Accountability Institute

17-Oct-20

Grand Total of emissions identified in this study

Rank	Entity	Total fuel and cement CO2 emissions: This study MtCO2	This study MtC	Percent of CDIAC	Emissions from flaring, venting, and fugitive methane: Flaring CO2	Vented CO2	Own fuel use	Fugitive methane MtCH4	Fugitive methane MtCO2e	Total CO2 and methane: Total emissions MtCO2e	Percent of this study	% of CDIAC 1751-2013
								28.0 xCO2	GWP 28xCO2			
		y	y	y	y	y	y	y	y	y	y	y
1	Abu Dhabi, United Arab Emirates	12,938	3,531	0.83%	175	105	127	43	1,193	14,538	1.15%	0.80%
2	Alliance Resource Partners, USA	1,300	355	0.08%				5	147	1,447	0.11%	0.08%
3	Anadarko, USA	5,318	1,451	0.34%	49	63	103	26	726	6,258	0.50%	0.35%
4	Anglo American, UK	6,975	1,904	0.45%				28	788	7,763	0.62%	0.43%
5	Antero, USA	204	56	0.01%	1	5	9	2	45	263	0.02%	0.01%
6	Apache, USA	1,434	391	0.09%	14	21	37	8	219	1,725	0.14%	0.10%
7	Arch Coal Company, USA	6,608	1,803	0.42%				27	746	7,354	0.58%	0.41%
8	Bahrain Petroleum Corporation	1,070	292	0.07%	7	21	40	8	213	1,351	0.11%	0.07%
9	BHP Billiton, Australia	9,026	2,463	0.58%	26	26	40	37	1,043	10,159	0.81%	0.56%
10	BP, UK	35,917	9,802	2.31%	461	303	392	126	3,515	40,588	3.22%	2.24%
11	British Coal Corporation, UK	17,742	4,842	1.14%				72	2,004	19,746	1.57%	1.09%
12	Canadian Natural Resources, Canada	1,640	448	0.11%	18	21	33	8	217	1,929	0.15%	0.11%
13	Cemex, Mexico	770	210	0.05%						770	0.06%	0.04%
14	Chesapeake, USA	934	255	0.06%	5	22	42	8	212	1,214	0.10%	0.07%
15	Chevron, USA	48,889	13,342	3.14%	630	413	534	170	4,773	55,239	4.39%	3.06%
16	China, PR (coal & cement only)	227,996	62,223	14.64%				845	23,650	251,645	19.99%	13.92%
17	Cloud Peak, USA	1,290	352	0.08%				5	146	1,436	0.11%	0.08%
18	CNOOC, PR China (acq Nexen Jan2013)	2,905	793	0.19%	40	22	26	9	257	3,250	0.26%	0.18%
19	Coal India, India	21,870	5,969	1.40%				88	2,471	24,341	1.93%	1.35%
20	ConocoPhillips, USA	16,128	4,401	1.04%	173	208	340	78	2,190	19,039	1.51%	1.05%
21	CONSOL Energy, USA	8,885	2,425	0.57%	0	5	9	37	1,030	9,929	0.79%	0.55%
22	Contura (AlphaNR, Massey), USA	5,348	1,460	0.34%				22	604	5,953	0.47%	0.33%
23	Cyprus Amax, USA	1,611	440	0.10%				7	182	1,793	0.14%	0.10%
24	Czech Republic	2,370	647	0.15%				10	268	2,638	0.21%	0.15%
25	Czechoslovakia	8,634	2,356	0.55%				35	975	9,610	0.76%	0.53%
26	Devon Energy, USA	2,077	567	0.13%	17	35	63	13	358	2,551	0.20%	0.14%
27	Ecopetrol, Colombia	2,413	659	0.15%	34	17	18	7	201	2,683	0.21%	0.15%
28	Egyptian General Petroleum, Egypt	3,283	896	0.21%	38	38	58	14	403	3,819	0.30%	0.21%
29	EnCana, Canada	1,832	500	0.12%	12	37	69	13	367	2,316	0.18%	0.13%
30	ENI, Italy	6,803	1,857	0.44%	71	91	151	34	952	8,067	0.64%	0.45%
31	EOG Resources, USA	1,058	289	0.07%	8	19	35	7	192	1,311	0.10%	0.07%
32	EQT Corporation, USA	343	94	0.02%	1	9	18	3	88	459	0.04%	0.03%
33	Equinor, Norway	5,681	1,550	0.36%	66	65	99	25	693	6,604	0.52%	0.37%
34	Exxaro, South Africa	1,552	424	0.10%				6	175	1,727	0.14%	0.10%
35	ExxonMobil, USA	45,783	12,495	2.94%	532	477	712	190	5,312	52,817	4.20%	2.92%
36	FSU (Former Soviet Union)	118,251	32,272	7.60%	597	648	1,027	507	14,197	134,720	10.70%	7.45%
37	Gazprom, Russia	33,435	9,125	2.15%	100	881	1,746	307	8,594	44,757	3.56%	2.48%
38	Glencore, Switzerland	4,521	1,234	0.29%				18	511	5,032	0.40%	0.28%
39	HeidelbergCement, Germany	1,502	410	0.10%						1,502	0.12%	0.08%
40	Hess, USA	2,449	668	0.16%	29	27	40	10	287	2,831	0.22%	0.16%
41	Husky, Canada	919	251	0.06%	11	10	15	4	110	1,065	0.08%	0.06%
42	Inpex, Japan	779	213	0.05%	8	10	16	4	105	918	0.07%	0.05%
43	Iraq National Oil Company, Iraq	12,251	3,343	0.79%	191	54	17	26	728	13,241	1.05%	0.73%
44	Kazakhstan	6,061	1,654	0.39%				24	685	6,745	0.54%	0.37%
45	Kiewit Mining Group, USA	1,425	389	0.09%				6	161	1,586	0.13%	0.09%
46	Kuwait Petroleum Corp., Kuwait	13,039	3,558	0.84%	197	69	43	31	871	14,218	1.13%	0.79%
47	LafargeHolcim, France	2,907	793	0.19%						2,907	0.23%	0.16%
48	Libya National Oil Corp., Libya	7,008	1,912	0.45%	105	38	26	17	480	7,657	0.61%	0.42%
49	Lukoil, Russia	5,923	1,616	0.38%	86	37	34	16	450	6,529	0.52%	0.36%
50	Marathon, USA	3,087	842	0.20%	36	35	53	13	371	3,581	0.28%	0.20%
51	Murphy Oil, USA	565	154	0.04%	6	7	10	3	71	659	0.05%	0.04%
52	Murray Coal Corporation, USA	1,568	428	0.10%				6	177	1,746	0.14%	0.10%
53	National Iranian Oil Co., Iran	34,250	9,347	2.20%	459	283	352	115	3,216	38,561	3.06%	2.13%
54	Nigerian National Petroleum, Nigeria	8,112	2,214	0.52%	114	57	60	24	670	9,014	0.72%	0.50%
55	Noble Energy, USA	611	167	0.04%	5	11	19	4	107	753	0.06%	0.04%
56	North American Coal, US	1,366	373	0.09%				6	154	1,520	0.12%	0.08%
57	North Korea	3,527	963	0.23%				14	398	3,926	0.31%	0.22%
58	Novatek, Russian Federation	1,623	443	0.10%	6	40	79	14	396	2,146	0.17%	0.12%
59	Obsidian, Canada	284	77	0.02%	3	4	7	1	42	340	0.03%	0.02%
60	Occidental, USA	5,342	1,458	0.34%	49	29	36	19	528	5,984	0.48%	0.33%
61	Oil and Gas Corp., India	4,669	1,274	0.30%	55	51	77	20	551	5,404	0.43%	0.30%
62	OMV Group, Austria	617	169	0.04%	6	9	15	3	91	738	0.06%	0.04%
63	Peabody Energy, USA	14,867	4,057	0.95%				60	1,680	16,547	1.31%	0.92%
64	Pertamina, Indonesia	6,756	1,844	0.43%	86	64	88	25	707	7,702	0.61%	0.43%
65	Petoro, Norway	3,011	822	0.19%	31	41	68	15	427	3,578	0.28%	0.20%
66	PetroChina (CNPC), China	14,525	3,964	0.93%	187	134	181	53	1,488	16,515	1.31%	0.91%
67	Petrobras, Brazil	8,216	2,242	0.53%	114	60	67	25	702	9,160	0.73%	0.51%
68	Petroleos de Venezuela, Venezuela	14,672	4,004	0.94%	209	100	101	42	1,183	16,264	1.29%	0.90%
69	Pemex, Mexico	21,397	5,839	1.37%	287	176	217	71	1,996	24,072	1.91%	1.33%
70	Petroleum Development Oman, Oman	3,233	882	0.21%	39	35	52	13	377	3,736	0.30%	0.21%
71	PetroEcuador	1,518	414	0.10%	24	6	1	3	85	1,634	0.13%	0.09%
72	Petronas, Malaysia	6,384	1,742	0.41%	60	98	170	36	1,006	7,717	0.61%	0.43%
73	Pioneer, USA	440	120	0.03%	5	6	10	2	61	520	0.04%	0.03%
74	Poland	24,576	6,707	1.58%				99	2,776	27,353	2.17%	1.51%
75	Polish Oil & Gas, Poland	515	140	0.03%	6	6	10	2	66	602	0.05%	0.03%
76	PTTEP, Thailand	571	156	0.04%	4	12	22	4	115	722	0.06%	0.04%
77	Qatar Petroleum, Qatar	6,349	1,733	0.41%	67	84	139	32	884	7,523	0.60%	0.42%
78	Repsol, Spain (acq Talisman May2015)	4,466	1,219	0.29%	46	61	102	23	637	5,312	0.42%	0.29%
79	Rio Tinto, UK	6,089	1,662	0.39%				25	688	6,777	0.54%	0.37%
80	Rosneft, Russian Federation	7,302	1,993	0.47%	102	53	58	22	618	8,132	0.65%	0.45%
81	Royal Dutch Shell, Netherlands (acq BG Feb16)	33,540	9,153	2.15%	389	351	524	139	3,901	38,704	3.07%	2.14%
82	RAG, Germany	1,049	286	0.07%				4	119	1,168	0.09%	0.06%
83	Russian Federation	17,659	4,819	1.13%				71	1,995	19,654	1.56%	1.09%
84	RWE, Germany	6,531	1,782	0.42%				26	738	7,268	0.58%	0.40%
85	Santos, Australia	464	127	0.03%	4	8	14	3	79	569	0.05%	0.03%
86	Sasol, South Africa	4,084	1,115	0.26%	0	2	4	17	473	4,564	0.36%	0.25%
87	Saudi Aramco, Saudi Arabia	56,078	15,304	3.60%	835	317	237	141	3,942	61,410	4.88%	3.40%
88	Singareni Collieries, India	2,513	686	0.16%				10	284	2,797	0.22%	0.15%
89	Sinopec, China	3,201	873	0.21%	44	25	30	10	290	3,590	0.29%	0.20%
90	Sonangol, Angola	2,657	725	0.17%	42	11	2	5	149	2,861	0.23%	0.16%
91	Sonatrach, Algeria	10,561	2,882	0.68%	99	160	278	59	1,650	12,749	1.01%	0.71%
92	Southwestern, USA	426	116	0.03%	1	11	23	4	111	572	0.05%	0.03%
93	Suncor, Canada	2,159	589	0.14%	29	18	22	7	204	2,432	0.19%	0.13%
94	Syrian Petroleum, Syria	1,399	382	0.09%	20	10	11	4	118	1,558	0.12%	0.09%
95	Taiheiyo, Japan	518	141	0.03%						518	0.04%	0.03%
96	Teck Resources, Canada	910	248	0.06%				4	103	1,013	0.08%	0.06%
97	Total, France	13,129	3,583	0.84%	167	124	170	49	1,368	14,958	1.19%	0.83%
98	TurkmenGaz, Turkmenistan	2,216	605	0.14%	9	54	106	19	531	2,915	0.23%	0.16%
99	UK Coal, UK	792	216	0.05%				3	90	882	0.07%	0.05%
100	Ukraine	4,292	1,171	0.28%				17	485	4,777	0.38%	0.26%
101	Vale, Brazil	226	62	0.01%				1	25	251	0.02%	0.01%
102	Vistra Luminant, USA	1,201	328	0.08%				5	136	1,337	0.11%	0.07%
103	Westmoreland Mining, USA	2,028	554	0.13%				8	229	2,257	0.18%	0.12%
104	Whitehaven Coal, Australia	232	63	0.01%				1	26	258	0.02%	0.01%
105	Wintershall, Germany	824	225	0.05%	7	13	23	5	135	1,002	0.08%	0.06%
106	Woodside, Australia	591	161	0.04%	4	11	20	4	111	738	0.06%	0.04%
107	YPF, Argentina	770	210	0.05%	8	10	17	4	107	912	0.07%	0.05%
108	Yukos, Russia	2,686	733	0.17%	42	11	2	5	154	2,896	0.23%	0.16%
	Total CO2 & methane emissions	1,112,342	303,571	71.4%	7,408	6,394	9,397	4,405	123,350	1,258,891	100.0%	69.627%
								146,549	sum ancillary			

Total Methane			
This study, MtCO2	V	123,350	This study, MtCO2e
CDIAC emissions, MtCO2	V	195,192	CDIAC-EDGAR methane 1860-2018 CDIAC CH4, MtCO2e
			linked to Ancillary "General Non-CO2 data" (CDIAC & EDGAR 1860-2018)
Percent this study of total CDIAC 1751-2010	V	63.19%	Percent of CDIAC

Total CO2: fossil fuels, flaring, venting, cement			
1,135,541	This study, MtCO2	V	
1,612,851	CDIAC, MtCO2	V	
70.41%	Percent of CDIAC	V	

Total CO2 and methane		
1,258,891	This study, MtCO2e	V
1,808,043	CDIAC, MtCO2e	V
69.627%	% of CDIAC	V

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: BI9
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 AR4 value of 28 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 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 Fifth Assessment Report (AR5) GWP value for methane -- 28xCO2 -- 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 Fifth Assessment Report (AR5) GWP value for methane -- 28xCO2 -- 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 combution: 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: BE11
Comment: Rick Heede:
The IPCC Fifth Assessment Report (AR5) GWP value for methane -- 28xCO2 -- 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).
21Jan2020: This calculation (at '[AncillaryCH4&CO2.xls]Entity CDP Scopes 1-3'!O832) has been corrupted. We restore the value of 57.26438622 kg CO2/tCO2 in this cell. A revised calculation may update this value.

Cell: AL133
Comment: Rick Heede:
Data of emissions from coal mining is based on Stern & Kaufman 1998 for 1860 to 1969 (S&K data goes to 1994). However, we inserted EDGAR (European Joint Commission for coal mining and for combined oil and gas CH4 emissions. As of 21 January 2020, we link to "Coal methane column, sum at cell Z681, summing column Z from 1860 to 2018, in TgCH4 and converted to CO2e (GWP of 28xCO2, per IPCC AR4, 2007).
In the event a full historical database on coal (and/or oil and gas) methane emissions becomes available, then the data will be reviised.

Stern, David I., & Robert K. Kaufmann (1998) "Annual Estimates of Global Anthropogenic Methane Emissions: 1860-1994," in Trends Online: A Compendium of Data on Global Change, Carbon Dioxide Information Analysis Center, Oak Ridge National Lab., U.S. DOE, Oak Ridge, Tenn., U.S.A.
http://cdiac.esd.ornl.gov/trends/meth/ch4.htm#flaring
Crippa, M., G. Oreggioni, D. Guizzardi, M. Muntean, E. Schaaf, E. Lo Vullo, E. Solazzo, F. Monforti-Ferrario, J.G.J. Olivier, & E. Vignati (2019) Fossil CO2 and GHG emissions of all world countries - 2019 Report, Publications Office of the European Union, Luxembourg. ISBN 978-92-76-11100-9.
https://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG

Cell: BB133
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.
Update Jun20: CDIAC / GCP data 1751-2018 sums to 440,166 MtC, which, times 3.664191 CO2/C = 1,1612,851 MtCO2.

Cell: BK133
Comment: Rick Heede:

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Cell: BK135
Comment: Rick Heede:

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