Entity emissions from combustion, venting, flaring, and fugitive methane

Richard Heede
Climate Accountability Institute
25-Jan-20

t Petroleum Co.

Kuwait Petroleum Co.

	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT
			1930s							1930s			1940s										1950s										1960s							1960s
	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
																			0.2	1.3	2	4	5	7	9	11	13	15	17	18	20	21	23	24	27	28	31	32	34	34
																																					0.0	0.0	0.0	0.0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	2	4	5	7	9	11	13	15	17	18	20	21	23	24	27	28	31	32	34	34
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	2	4	5	7	9	11	13	15	17	19	20	22	23	24	27	29	32	33	34	35
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	3	4	5	7	9	12	14	16	18	20	21	23	25	25	29	31	34	34	36	36
	3,906	4,195	3,855	3,441	3,104	3,276	3,565	3,759	4,141	4,430	4,188	4,364	4,760	4,884	4,914	5,097	5,068	4,254	4,536	5,104	5,383	5,199	5,976	6,475	6,577	6,742	6,834	7,490	7,977	8,318	8,538	8,857	9,345	9,366	9,699	10,248	10,781	11,282	11,807	12,184
	1,066	1,145	1,052	939	847	894	973	1,026	1,130	1,209	1,143	1,191	1,299	1,333	1,341	1,391	1,383	1,161	1,238	1,393	1,469	1,419	1,631	1,767	1,795	1,840	1,865	2,044	2,177	2,270	2,330	2,417	2,550	2,556	2,647	2,797	2,942	3,079	3,222	3,325
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.05%	0.07%	0.08%	0.11%	0.14%	0.16%	0.19%	0.20%	0.21%	0.22%	0.24%	0.25%	0.25%	0.26%	0.28%	0.28%	0.30%	0.29%	0.29%	0.28%
	22.8	24.4	22.3	19.9	17.9	18.8	20.4	21.0	23.3	24.8	23.4	24.8	26.2	27.0	27.0	27.4	26.9	23.5	24.7	27.6	29.2	28.1	30.4	32.2	32.7	33.1	33.1	35.9	38.4	39.7	40.9	42.7	44.6	44.3	45.1	47.1	49.4	51.3	53.4	54.7
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11%	0.12%	0.12%	0.12%	0.12%	0.12%

Entity emissions from combustion, venting, flaring, and fugitive methane

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Kuwait Petroleum Co.

	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD
10			1970s										1980s										1990s										2000s			
11	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
15	35	38	41	43	72	133	277	282	291	267	289	339	237	172	112	112	148	136	164	138	163	216	144	18	142	253	271	271	271	285	244	221	285	277	266	270
16	0.9	1.0	1	1	2	3	8	10	11	11	12	12	13	11	8	8	10	9	12	10	12	15	8	1	5	10	11	11	11	17	17	16	18	16	15	17
18	36	39	42	44	74	136	285	292	302	278	301	351	250	183	120	120	158	145	176	148	175	231	152	19	147	264	282	282	282	303	261	238	303	293	281	287
20	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	2	4	4	5	4	5	5	4	3	2	2	2	2	3	2	3	3	2	0	2	4	4	4	4	5	4	4	5	4	4	4
22	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	1	1	1	1	2	3	6	6	7	6	7	8	6	4	3	3	4	3	4	4	4	6	4	0	3	6	6	6	6	7	6	6	7	7	7	7
29	37	39	43	45	75	139	291	298	309	284	307	359	256	188	123	123	162	148	180	151	180	237	155	20	151	270	289	289	289	310	267	243	311	300	287	294
33	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1
39	2	2	2	2	4	7	15	15	16	14	16	18	13	9	6	6	8	7	9	7	9	12	8	1	8	14	15	15	15	15	13	12	15	15	14	15
40	0	0	0	0	0	1	2	3	3	3	3	3	4	3	2	2	3	3	3	3	3	4	2	0	1	3	3	3	3	5	5	5	5	4	4	5
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	2	2	2	3	4	8	17	18	19	17	19	22	16	12	8	8	11	10	12	10	12	16	10	1	9	16	18	18	18	20	18	16	20	19	18	19
45	39	42	45	48	80	147	308	316	327	302	326	381	273	200	131	131	172	158	192	161	192	253	165	21	160	286	306	306	306	330	285	260	331	319	306	313
48	12,849	13,705	14,840	15,440	16,158	17,016	16,943	16,921	17,819	18,308	18,979	19,485	19,392	18,865	18,725	18,903	19,453	20,146	20,433	21,095	21,902	22,232	22,547	23,032	22,313	22,580	22,742	23,232	23,963	24,103	24,018	24,326	25,025	25,235	25,788	27,034
49	3,507	3,740	4,050	4,214	4,410	4,644	4,624	4,618	4,863	4,996	5,180	5,318	5,292	5,149	5,110	5,159	5,309	5,498	5,576	5,757	5,977	6,067	6,153	6,286	6,089	6,162	6,207	6,340	6,540	6,578	6,555	6,639	6,830	6,887	7,038	7,378
51	0.29%	0.29%	0.29%	0.29%	0.47%	0.82%	1.72%	1.76%	1.73%	1.55%	1.62%	1.84%	1.32%	1.00%	0.66%	0.65%	0.83%	0.74%	0.88%	0.72%	0.82%	1.07%	0.69%	0.09%	0.67%	1.19%	1.27%	1.24%	1.21%	1.29%	1.11%	1.00%	1.24%	1.19%	1.11%	1.09%
54	57.2	60.6	86.8	92.3	99.4	112.6	112.5	105.2	117.3	114.8	122.9	119.4	110.5	93.4	92.8	89.4	86.3	87.0	86.8	84.9	92.0	93.2	90.0	89.1	89.9	89.7	90.1	89.9	91.9	89.3	84.0	82.0	82.6	83.0	82.8	88.0
56	0.14%	0.14%	0.10%	0.10%	0.16%	0.26%	0.54%	0.61%	0.57%	0.54%	0.55%	0.65%	0.53%	0.47%	0.32%	0.33%	0.44%	0.40%	0.50%	0.43%	0.47%	0.61%	0.39%	0.05%	0.36%	0.66%	0.70%	0.70%	0.69%	0.81%	0.76%	0.72%	0.88%	0.83%	0.80%	0.78%

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	2000s						2010s											Cumulative		Entity emissions				to 2015	to 2016	to 2017	to 2018
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	MtCO2e						Cumulative	Cumulative	Cumulative	Cumulative
																		(except where noted)	V	(V = verified)				MtCO2e (except where noted)	MtCO2e (except where noted)	MtCO2e (except where noted)	MtCO2e (except where noted)
	318	289	260	293	315	273	275	339	373	347	389	388	388	367	371					Entity CO2 emissions			kg CO2/tCO2	to 2015	to 2016	to 2017	to 2018
V	18	23	23	23	24	22	22	26	29	31	28	32	33	32	33			12,283		Oil & NGLs	MtCO2	linked		11,157	11,545	11,912	12,283
V																		756		Natural Gas	MtCO2	linked		658	690	723	756
	336	312	283	316	338	294	297	365	402	378	417	419	420	399	404			-		Coal	MtCO2	linked		-	-	-	-
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			13,039	V	Combustion total	MtCO2	sum		11,815	12,235	12,634	13,039
	5	5	4	5	5	4	4	5	6	6	6	6	6	6	6			47		Oil & NGLs: Venting	MtCO2	calculated	3.83 linked	43	44	46	47
	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2			196		Oil & NGLs: Flaring	MtCO2	calculated	15.94 linked	178	184	190	196
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			43		Own fuel use	MtCO2	calculated	57.26 linked	38	40	41	43
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			22		Natural Gas: Venting	MtCO2	calculated	28.53 linked	19	20	21	22
	8	8	7	8	8	7	7	9	10	10	10	10	11	10	10			1		Natural Gas: Flaring	MtCO2	calculated	1.74 linked	1	1	1	1
																		309	V	Venting & Flaring total	MtCO2	sum		278	289	299	309
																		-		Cement	MtCO2	linked					
	344	320	290	323	347	301	305	374	412	388	427	430	431	409	415												
V																		13,348		Total CO2 emissions	MtCO2	sum	row 18+24+26	12,093	12,524	12,933	13,348
																				Entity methane emissions			kg CH4/tCO2				
	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1			24		Methane: Oil & NGLs	MtCH4	calculated	1.92 linked	21	22	23	24
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			7		Methane: Natural Gas	MtCH4	calculated	9.88 linked	6	7	7	7
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-		Methane: Coal	MtCH4	calculated	4.03 linked	-	-	-	-
V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			31	V	Total methane emissions	MtCH4	sum		28	29	30	31
																				Entity methane emissions			GWP				
	17	16	14	16	17	15	15	18	20	19	21	21	21	20	20			662		Methane: Oil & NGLs	MtCO2e	calculated	28	601	622	642	662
	5	6	6	6	7	6	6	7	8	9	8	9	9	9	9			209		Methane: Natural Gas	MtCO2e	calculated	28	182	191	200	209
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-		Methane: Coal	MtCO2e	calculated	28	-	-	-	-
	22	22	20	22	24	21	21	25	28	27	29	30	30	29	29			871		Total methane emissions	MtCO2e	sum	(per IPCC SAR)	783	813	841	871
	366	342	311	345	370	322	326	399	441	415	456	460	461	438	444												
V																		14,218	V	Total attributed emissions	MtCO2e	sum		12,876	13,337	che 13,774	14,218
	28,308	29,264	30,231	31,135	31,854	31,414	33,018	34,136	34,660	34,825	35,089	35,106	35,251	35,681	36,443												
V																		1,612,851		CDIAC CO2 emissions	MtCO2			1,505,476	1,540,727	1,576,408	1,612,851
V	7,726	7,986	8,250	8,497	8,693	8,573	9,011	9,316	9,459	9,504	9,576	9,581	9,620	9,738	9,946			440,166		Oil, Natural Gas, Coal, Flaring, & Cement	Mt Carbon						
																		CDIAC sums December 2019									
	1.22%	1.09%	0.96%	1.04%	1.09%	0.96%	0.92%	1.10%	1.19%	1.11%	1.22%	1.22%	1.22%	1.15%	1.14%			0.83%		Entity percent of total CO2 emissions	Percent			0.80%	0.81%	0.82%	0.83%
	91.7	94.7	98.4	99.5	101.2	99.9	105.1	109.5	113.4	115.2	118.2	117.8	118.4	120.0	122.7												
V																		6,971		CDIAC/EDGAR methane	Tg CH4			6,610	6,728	6,848	6,971
	0.86%	0.83%	0.74%	0.79%	0.83%	0.74%	0.71%	0.83%	0.89%	0.84%	0.87%	0.90%	0.90%	0.85%	0.85%			0.45%		Entity percent of total CH4 emissions	Percent			0.42%	0.43%	0.44%	0.45%

Cell: FY48
Comment: Rick Heede:
CAI compares entity emissions to the CDIAC / Global Carbon Project (www.globalcarbonproject.org) annual estimate of carbon dioxideee emissions from fossil fuels and cement production. The CAI Carbon Majors methodology is based on the CDIAC methdology; see: Heede, Richard (2019) Carbon Majors: Accounting for carbon and methane emissions 1854-2010 Methods & Results Report, ISBN 978-3-659-57841-0, OmniScriptum, Riga, 148 pp.
Reference of the full global carbon budget 2019: Pierre Friedlingstein, Matthew W. Jones, Michael O'Sullivan, Robbie M. Andrew, Judith Hauck, Glen P. Peters, Wouter Peters, Julia Pongratz, Stephen Sitch, Corinne Le Quéré, Dorothee C. E. Bakker, Josep G. Canadell, Philippe Ciais, Rob Jackson, Peter Anthoni, Leticia Barbero, Ana Bastos, Vladislav Bastrikov, Meike Becker, Laurent Bopp, Erik Buitenhuis, Naveen Chandra, Frédéric Chevallier, Louise P. Chini, Kim I. Currie, Richard A. Feely, Marion Gehlen, Dennis Gilfillan, Thanos Gkritzalis, Daniel S. Goll, Nicolas Gruber, Sören Gutekunst, Ian Harris, Vanessa Haverd, Richard A. Houghton, George Hurtt, Tatiana Ilyina, Atul K. Jain, Emilie Joetzjer, Jed O. Kaplan, Etsushi Kato, Kees Klein Goldewijk, Jan Ivar Korsbakken, Peter Landschützer, Siv K. Lauvset, Nathalie Lefèvre, Andrew Lenton, Sebastian Lienert, Danica Lombardozzi, Gregg Marland, Patrick C. McGuire, Joe R. Melton, Nicolas Metzl, David R. Munro, Julia E. M. S. Nabel, Shin-Ichiro Nakaoka, Craig Neill, Abdirahman M. Omar, Tsuneo Ono, Anna Peregon, Denis Pierrot, Benjamin Poulter, Gregor Rehder, Laure Resplandy, Eddy Robertson, Christian Rödenbeck, Roland Séférian, Jörg Schwinger, Naomi Smith, Pieter P. Tans, Hanqin Tian, Bronte Tilbrook, Francesco N Tubiello, Guido R. van der Werf, Andrew J. Wiltshire, Sönke Zaehle. Global Carbon Budget 2019, Earth Syst. Sci. Data, 2019. https://doi.org/10.5194/essd-11-1783-2019
See also: Gilfillan, D., Marland, G., Boden, T. and Andres, R.: Global, Regional, and National Fossil-Fuel CO2 Emissions.

Cell: FY54
Comment: Rick Heede:
This study's total fugitive and vented methane from oil and natural gas systems and coal mining are summed here and compared to CDIAC's estimate for 1860 to 1969 (Stern & Kaufmann, 1998). CAI uses revised data rom EDGAR for 1970-2015, with extrapolation by CAI for 2016-2018 (based on growth of emissions from oil, gas, and coal production).There is a non-linearity at 1969/1970 btw dataasets.
Methane emissions may be revised if a more comprehensive and integrated dataset becomes available.
Furthermore, the Stern & Kaufman does not estimate methane emissions from oil (only gas-related CH4). The most recent EDGAR Nov19 datasets aggregate methane emissions from the Oil & Gas sector. CAI disaggregates methane from oil and methane from gas on the basis of an earlier EDGAR dataset 1970-2008 that reports CH4 from oil and gas separately. CAI uses this average allocation of ~695% from gas and ~30.5% from oil to estimate methane emissions from both sectors. This, given the fluctuations of methane emissions --the proportion from natural gas increases over time (from 50% in 1970 to 76% in 2008) -- this disaggregation is only approximate.

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

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