, and fugitive methane

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

Richard Heede
Climate Accountability Institute
26-Jan-20

Total SA, France

Total SA, France

	CC	CD	CE	CF	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
10	1920s						1930s							1930s			1940s										1950s											
11	1924	1925	1926	1927	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
15											11	15	18	22	26	29	33	37	40	44	48	51	55	59	63	66	70	74	77	81	85	88	92	96	99	103	107	110
18	-										11	15	18	22	26	29	33	37	40	44	48	51	55	59	63	66	70	74	77	81	85	88	92	96	99	103	107	110
20	-										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
21	-										0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
22	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-										0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
29	-										11	15	19	22	26	30	34	37	41	45	49	52	56	60	64	67	71	75	79	83	86	90	94	98	101	105	109	113
33	-										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
34	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-										0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
39	-										1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6
40	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-										-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-										1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6
45	-										12	16	20	24	28	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	99	103	107	111	115	119
48	3,525	3,573	3,606	3,891	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
49	962	975	984	1,062	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
51	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.31%	0.40%	0.45%	0.51%	0.62%	0.69%	0.71%	0.77%	0.84%	0.88%	0.96%	1.23%	1.24%	1.18%	1.18%	1.30%	1.19%	1.16%	1.20%	1.22%	1.26%	1.20%	1.18%	1.17%	1.19%	1.19%	1.16%	1.20%
54	21.1	21.2	21.2	23.0	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
56	-	-	-	-	-	-	-	-	-	-	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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

Richard Heede
Climate Accountability Institute

26-Jan-20

Total SA, France

	1960s								1970s										1980s										1990s										1990s									
	1962	1963	1964	1965	1966	1967	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
	114	118	121	125	129	133	136	140	144	147	168	87	96	80	83	79	79	78	69	41	37	32	34	83	87	133	148	161	143	154	154	155	194	212	194	200	204	199
											0.9	0.6	0.3	0.6	1.0	2	6	9	10	11	10	11	11	43	40	45	50	50	50	53	55	55	60	61	66	66	61	62
	114	118	121	125	129	133	136	140	144	147	169	88	96	81	84	81	85	87	80	52	48	43	45	127	127	178	198	212	193	206	208	211	254	272	259	266	264	261
	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	1	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2	2	3	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	2	2	2	2	3	3	3	3	3	3
	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3	3	3	4	4	3	4
	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	-	-	-	-	-	-	-	-	-	-	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
	2	2	2	2	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	5	5	7	7	8	7	8	8	8	9	9	10	10	9	9
	116	120	124	128	131	135	139	143	146	150	173	90	98	82	86	83	87	89	82	54	49	45	47	132	132	185	206	219	200	214	216	219	263	282	269	276	274	270
	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	0	0	1	1	1	1	1	1	1	1	1
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	6	6	7	7	7	7	7	8	8	8	9	5	5	4	4	4	4	4	4	2	2	2	2	4	5	7	8	9	8	8	8	8	10	11	10	11	11	11
	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	1	2	3	3	3	3	3	3	12	11	13	14	14	14	15	15	15	17	17	18	18	17	17
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	6	7	7	7	7	7	8	8	8	9	5	5	4	5	5	6	7	7	5	5	5	5	16	16	20	22	23	22	23	23	24	27	28	29	29	28	28
	123	126	130	134	138	142	146	150	154	158	182	95	103	87	90	88	93	96	89	59	54	50	52	148	148	204	227	242	222	237	239	243	290	310	297	305	301	298
	9,699	10,248	10,781	11,282	11,807	12,184	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
	2,647	2,797	2,942	3,079	3,222	3,325	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
	1.20%	1.17%	1.15%	1.13%	1.11%	1.11%	1.08%	1.04%	0.99%	0.97%	1.07%	0.53%	0.58%	0.49%	0.48%	0.45%	0.46%	0.46%	0.42%	0.29%	0.26%	0.24%	0.24%	0.65%	0.65%	0.88%	0.94%	0.99%	0.89%	0.93%	0.97%	0.97%	1.16%	1.21%	1.12%	1.14%	1.14%	1.11%
	45.1	47.1	49.4	51.3	53.4	54.7	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
	0.49%	0.48%	0.47%	0.47%	0.46%	0.47%	0.46%	0.44%	0.32%	0.31%	0.34%	0.15%	0.17%	0.15%	0.14%	0.15%	0.17%	0.20%	0.21%	0.20%	0.19%	0.19%	0.20%	0.67%	0.64%	0.83%	0.85%	0.87%	0.85%	0.91%	0.93%	0.94%	1.08%	1.12%	1.11%	1.16%	1.18%	1.21%

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

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26-Jan-20

Total SA, France

to 2015

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		Cumulative MtCO2e (except where noted)	V (V = verified)	Entity emissions					Cumulative MtCO2e (except where noted)
2000s										2010s																			
194	197	215	225	238	231	219	220	218	226	222	166	165	158	140	168	172	182	212			V	10,161		Oil & NGLs	MtCO2	linked			9,594
73	79	88	93	106	107	105	107	113	104	125	119	115	121	118	118	126	130	129			V	2,968		Natural Gas	MtCO2	linked			2,584
																								Coal	MtCO2	linked			-
268	276	304	319	345	338	324	327	331	330	348	285	280	279	258	286	298	312	341				13,129	V	Combustion total	MtCO2	sum			12,177
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				39		Oil & NGLs: Venting	MtCO2	calculated	3.83	linked	37
3	3	3	4	4	4	3	4	3	4	4	3	3	3	2	3	3	3	3				162		Oil & NGLs: Flaring	MtCO2	calculated	15.94	linked	153
4	5	5	5	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7				170		Own fuel use	MtCO2	calculated	57.26	linked	148
2	2	3	3	3	3	3	3	3	3	4	3	3	3	3	3	4	4	4				85		Natural Gas: Venting	MtCO2	calculated	28.53	linked	74
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				5		Natural Gas: Flaring	MtCO2	calculated	1.74	linked	4
10	11	12	13	14	14	14	14	14	14	15	14	13	14	13	14	14	15	15				461	V	Venting & Flaring total	MtCO2	sum			416
																						-		Cement	MtCO2	linked			
278	287	316	331	359	352	337	341	345	343	363	299	293	293	272	299	312	327	356			V	13,590		Total CO2 emissions	MtCO2	sum	row 18+24+26		12,593
						54	55	57	54	62	56	54	56	53	55	58	61	62				summed scope 1 CO2 & CH4		(for UCS carbon intensity project, Jan17)					
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				20		Methane: Oil & NGLs	MtCH4	calculated	1.92	linked	18
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				29		Methane: Natural Gas	MtCH4	calculated	9.88	linked	26
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				-		Methane: Coal	MtCH4	calculated	4.03	linked	-
1	1	1	1	2	2	1	1	2	1	2	1	1	1	1	1	2	2	2			V	49	V	Total methane emissions	MtCH4	sum			44
10	11	12	12	13	12	12	12	12	12	12	9	9	9	8	9	9	10	11				547		Methane: Oil & NGLs	MtCO2e	calculated	28		517
20	22	24	26	29	30	29	30	31	29	35	33	32	33	33	33	35	36	36				821		Methane: Natural Gas	MtCO2e	calculated	28		715
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				-		Methane: Coal	MtCO2e	calculated	28		-
31	33	36	38	42	42	41	42	43	41	47	42	41	42	40	42	44	46	47				1,368		Total methane emissions	MtCO2e	sum	(per IPCC SAR)		1,231
309	320	352	369	401	394	378	383	388	384	410	341	334	334	312	341	357	373	404			V	14,958	V	Total attributed emissions	MtCO2e	sum			13,825
25,025	25,235	25,788	27,034	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
6,830	6,887	7,038	7,378	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			V	440,166		Oil, Natural Gas, Coal, Flaring, & Cement	Mt Carbon				
																						CDIAC sums December 2019							
1.11%	1.14%	1.22%	1.22%	1.27%	1.20%	1.12%	1.10%	1.08%	1.09%	1.10%	0.88%	0.85%	0.84%	0.77%	0.85%	0.89%	0.92%	0.98%				0.84%		Entity percent of total CO2 emissions	Percent				0.84%
82.6	83.0	82.8	88.0	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
1.33%	1.40%	1.56%	1.54%	1.65%	1.58%	1.48%	1.49%	1.52%	1.46%	1.59%	1.37%	1.28%	1.30%	1.22%	1.26%	1.33%	1.36%	1.37%				0.70%		Entity percent of total CH4 emissions	Percent				0.67%

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

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?vP_GHG