



	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
1	<div style="text-align: center; border: 1px solid black; padding: 5px;"> <b>Summary of emissions from identified gas production</b> </div> <div style="text-align: center; margin-top: 5px;"> <small>Richard Heede Climate Mitigation Services 24-Jun-13</small> </div>																							
2																								
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5																								
6																								
7																								
8	1890s					1900s										1910s								
9	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
10	0.053	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534
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39																								
40		0.5	0.7	0.8	0.9	1.0	1.2	1.5	1.6	1.6	1.9	2	2	2	2	2	2	2	2	2	3	3	3	
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128	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
129	7	7	7	7	11	11	15	15	15	15	18	18	18	18	22	26	26	29	29	29	33	37	40	37
130																								
131	2	2	2	2	3	3	4	4	4	4	5	5	5	5	6	7	7	8	8	8	9	10	11	10
132																								
133	0.0%	0.0%	0.0%	0.0%	0.0%	4.5%	4.8%	5.4%	6.3%	6.8%	6.8%	8.2%	8.6%	8.5%	8.5%	7.7%	7.7%	7.4%	7.7%	7.8%	7.4%	8.0%	7.6%	7.6%
134																								
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136																								
137																								

	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT
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2	<b>Summary of emissions from identified gas production</b>																								
3																									
4	Richard Heede																								
5	Climate Mitigation Services																								
6	24-Jun-13																								
7																									
8	1920s											1930s								1940s					
9	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943
10	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534
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126																									
127	1	1	1	1	1	1	1	3	3	3	4	5	5	5	6	6	7	8	10	8	10	11	13	13	15
128																									
129	37	40	37	40	51	59	62	70	77	84	103	103	92	88	92	103	110	125	139	136	139	154	154	165	183
130																									
131	10	11	10	11	14	16	17	19	21	23	28	28	25	24	25	28	30	34	38	37	38	42	42	45	50
132																									
133	7.9%	7.8%	7.1%	7.5%	7.7%	7.7%	7.5%	14.6%	14.6%	14.5%	13.9%	17.2%	19.3%	21.6%	22.1%	21.9%	22.4%	23.6%	25.3%	22.8%	25.6%	27.3%	30.4%	29.6%	29.1%
134																									
135																									
136																									
137																									



Gas Emissions

	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
1	<b>Summary of emissions from identified gas production</b>																									
2	Richard Heede Climate Mitigation Services 24-Jun-13																									
3																										
4																										
5																										
6																										
7																										
8	1970s											1980s										1990s				
9	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
10	0.0534	0.0534	0.0534	#####	#####	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534	0.0534
11	2	3	3	4	4	5	5	5	5	8	10	11	14	17	18	17	19	21	21	22	22	25	26	30	31	32
12	28	25	25	24	23	23	22	22	21	20	20	19	19	18	17	17	16	30	29	31	34	34	36	35	37	37
13	See Apache note for gas well blow-out																									
14	0.0	0.1	0.1	0.1	0.1	0.3	0.4	2	2	3	3	3	5	6	7	7	7	9	10	9	10	10	11	8	9	10
15	4	4	5	6	8	9	10	12	13	15	14	13	14	15	15	16	17	18	18	17	17	17	17	17	18	22
16	0.01	0.20	0	1	1	1	2	2	3	3	3	3	3	4	5	5	5	6	7	10	9	11	10	10	10	10
17	82	94	99	102	107	105	97	89	89	89	88	87	79	80	75	72	78	81	79	82	89	108	110	114	113	114
18																										
19																										
20	205	225	245	251	263	254	250	231	226	218	209	208	194	178	164	153	171	135	129	134	128	122	131	129	127	123
21																										
22	80	82	85	86	88	88	87	81	82	79	80	79	75	71	66	66	66	68	68	67	72	80	81	84	87	89
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41	0.02	0.02	0.01	0.02	0.01	0.01	0.4	0	1	1	1	1	3	3	4	5	5	6	7	7	8	8	8	8	8	8
42																										
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45	18	21	23	23	26	28	28	27	27	25	26	26	27	27	26	25	26	26	28	30	33	33	34	35	33	38
46																										
47	155	181	209	234	249	274	278	270	267	265	264	267	207	187	164	157	179	178	171	181	185	194	190	197	200	204
48																										
49	322	345	377	401	418	445	492	545	606	660	713	767	821	878	945	1,011	1,108	1,213	1,293	1,355	1,453					
50																										
51																										
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53	9	11	12	13	15	14	14	13	11	12	12	12	12	11	11	10	10	9	9	10	10	11	14	16	18	17
54																										
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56																										
57	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	4	6	7	5	1	3	3
58																										
59	1	1	1	1	2	3	8	10	11	11	12	12	13	11	8	8	10	9	12	10	12	15	10	1	5	8
60																										
61	0.1	0.4	6	10	10	12	18	16	13	10	7	4	4	5	6	7	7	7	7	7	8	8	8	8	9	10
62																										
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65	8	8	9	9	8	8	8	9	8	9	9	8	8	9	10	11	12	20	20	19	22	25	23	21	18	17
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71	3	5	21	16	24	37	42	41	42	35	28	21	13	11	13	17	25	32	29	36	33	41	45	42	50	54
72																										
73	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4	7	7	7	6	9
74																										
75	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	15	14	14	14	16	16	15	14	14	14	15
76																										
77	1	1	1	1	2	2	1	2	3	3	3	3	3	3	5	6	6	7	10	14	17	20	23	26	30	29
78																										
79																										
80																										
81	1	1	1	1	1	1	1	2	3	7	11	14	18	18	18	21	28	31	32	35	38	40	45	51	53	55
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84																										
85	2	2	2	2	2	2	3	3	3	3	3	3	4	5	6	8	9	10	11	11	11	11	12	13	13	
86																										
87	2	2	2	2	2	2	3	2	26	29	33	37	41	31	32	31	33	33	36	68	73	76	75	80	80	85
88																										
89	31	33	36	34	34	36	40	42	41	46	50	57	69	79	77	76	74	72	70	68	68	70	71	71	70	70
90																										
91	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	1	1	1	1	2	2	4	4	5	6	7	5	5	7	7	8	9
92																										
93																										
94																										
95																										
96	0.1	0.2	0.2	0.2	0.3	1	2	3	2	3	4	5	6	5	6	6	7	6	6	6	7	7	9	11	15	17
97																										
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103	68	82	97	104	116	124	132	129	131	130	126	127	122	117	108	111	115	122	123	128	118	114	126	138	128	133
104																										
105	0.4	1	0	1	1	2	7	6	7	8	18	21	24	30	23	22	33	38	48	40	48	58	61	64	70	70
106																										
107																										
108																										
109	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
110																										
111	3	4	4	4	4	6	8	14	15	16	17	18	19	36	45	64	68	69	69	79	82	124	85	86	98	95
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122	0.9	0.6	0.3	0.6	1.0	2	6	9	10	11	10	11	11	11	43	40	45	50	50	50	50	50	53	55	55	
123																										
124																										
125	1,026	1,132	1,260	1,324	1,408	1,486	1,553	1,578	1,668	1,722	1,783	1,857	1,846	1,884	1,900	1,994	2,194	2,358	2,444	2,673	2,829	2,730	2,783	2,790	2,807	2,813
126																										
127	280	309	344	361	384	406	424	431	455	470	487	507	504	514	518	544	599	644	667	730	772	745	760	761	766	768
128																										
129	1,554	1,711	1,806	1,942	2,052	2,155	2,188	2,213	2,308	2,382	2,492	2,642	2,712	2,770	2,712	2,961	3,067	3,045	3,276	3,433	3,565	3,737	3,891	4,009	4,100	
130																										
131	424	467	493	530	560	588	597	604	630	650	680	721	740	756	740	741	808	837	831	894	937	973	1,020	1,062	1,094	1,119
132																										
133	66.1%	66.1%	69.7%	68.2%	68.6%	69.0%	71.0%	71.3%	72.3%	72.3%	71.6%	70.3%	68.1%	68.0%	70.1%	73.4%	74.1%	76.9%	80.3%	81.6%	82.4%	76.6%	74.5%	71.7%	70.0%	68.6%
134																										
135																										
136																										
137																										

Gas Emissions

	DS	DT	DJ	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN
1	<b>Summary of emissions from identified gas production</b>																			2		
2																				3		
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Coefficient **0.053434** Million tonnes CO<sub>2</sub>/Billion cubic feet (MtCO<sub>2</sub>/Bcf)  
 linked to "Gas Emission Factor Calc"

dataset marker

Richard Heede  
 Climate Mitigation Services  
 24-Jun-13

Copyright Climate Mitigation Services

Emissions

**Natural Gas Emissions**

Entity

1,278	Abu Dhabi National Oil (ADNOC), UAE
1,475	Anadarko, USA
397	Apache, USA
454	Bahrain Petroleum Corporation
952	BG Group (British Gas), UK
380	BHP Billiton, Australia
5,707	BP, UK
348	Canadian Natural Resources, Canada
8,465	Chevron, USA
133	CNOOC (China National Offshore Oil), China
5,426	ConocoPhillips, USA
36	CONSOL Energy, USA
816	Devon Energy, USA
210	Ecopetrol, Colombia
589	Egyptian General Petroleum, Egypt
876	EnCana, Canada
1,960	ENI, Italy
10,699	ExxonMobil, USA
17,937	Former Soviet Union
23,383	Gazprom, Russian Federation
608	Hess, USA
180	Husky, Canada
135	Iraq National Oil Company, Iraq
479	Kuwait Petroleum Corp., Kuwait
436	Libya National Oil Corp., Libya
246	Lukoil, Russian Federation
791	Marathon, USA
113	Murphy Oil, USA
119	Nexen, Canada
3,258	National Iranian Oil Company (NIOC), Iran
482	Nigerian National Petroleum, Nigeria
462	Occidental, USA
978	Oil and Gas Corporation, India
115	OMV Group, Austria
1,246	Pertamina, Indonesia
1,306	PetroChina (CNPC), China
709	Petrole Brasileiro (Petrobras), Brazil
2,099	Petroleos de Venezuela, Venezuela
3,357	Petroleos Mexicanos (PEMEX), Mexico
524	Petroleum Development Oman, Oman
1,869	Petronas, Malaysia
103	Polish Oil & Gas, Poland
982	Qatar Petroleum, Qatar
1,019	Repsol, Spain
300	Rosneft, Russian Federation
6,416	Royal Dutch Shell plc, The Netherlands
2,687	Saudi Aramco, Saudi Arabia
144	Sinopec, China
19	Sonangol, Angola
3,491	Sonatrach, Algeria
1,019	Statoil, Norway
373	Suncor / Petro-Canada, Canada
146	Syrian Petroleum, Syria
349	Talisman, Canada
1,994	Total, France
41	Yukos, Russian Federation

Total emissions from identified gas production 1900-2010 (million tonnes CO<sub>2</sub>) **120,113** y

**Cell:** E12

**Comment:** Rick Heede:

See the "Gas Emissions Factor Calc" worksheet for details, which accounts for carbon content, heating values, and final emission factor per billion cubic feet (Bcf) of gas production, including deducting for non-energy uses of natural gas (see "non-energy uses" worksheet). Ancillary emissions of fugitive methane, vented CO<sub>2</sub>, and CO<sub>2</sub> from flaring are estimated and applied in the summary entity worksheet.

**Cell:** C13

**Comment:** Rick Heede:

ADNOC details both gas production and utilization rates from 1974 through 1994 in its annual reports; see ADNOC gas production worksheet for details.

**Cell:** C17

**Comment:** Rick Heede:

CMS estimated the CO<sub>2</sub>-equivalent of Apache Corporation's 1981-1983 gas blow-out (assuming all of the gas was vented and none of it was flared). The company reported a blow rate of 35 million cf per day, which we use as the average over the sixteen month event: 35 million cf/d = 0.0168 Tcf over 30d\*16months = 0.01858 QBtu (at 1,106 Btu per cf for wet gas), which, at 14.92 MtC/QBtu, equals 0.2772 MtC (1.01581 MtCO<sub>2</sub>) and thus (at CH<sub>4</sub> at 23xCO<sub>2</sub>) = 6.3762 MtC-eq (23.3636 MtCO<sub>2</sub>-eq). This represents a significant additional impact of Apache's total estimated emissions from natural gas and oil production. See cell comment at Apache Corporation worksheet for details.

This amount is added to Apache's estimated emissions in 1982.

**Cell:** EM17

**Comment:** Rick Heede:

26Jan06 estimate of the CO<sub>2</sub>-equiv of the Apache's blow-out (assuming none of it was flared, and using only 50 percent of the 35 million cf per day): 17.5 Mcf = 0.0084 Tcf over 30d\*16 months = 0.00929 QBtu (at 1,106 Btu per cf for wet gas), which, at 14.92 MtC/QBtu, equals 0.139 MtC (0.508 MtCO<sub>2</sub>) and thus (at CH<sub>4</sub> at 23xCO<sub>2</sub>) = 3.19 MtC-eq (11.7 MtCO<sub>2</sub>-eq). These emissions are NOT included in this summary.

**Cell:** EM19

**Comment:** Rick Heede (Jan10):

Bahrain: Banagas annual emissions of CO<sub>2</sub>-equivalent if the reported 3 million SCM per of natural gas vented to the atmosphere (prior to 1979 only) is estimated by CMS to total 56.3 million tonnes of CO<sub>2</sub>e per year (MtCO<sub>2</sub>e/yr). If the natural gas (assumed to be all methane, since CMS does not have data on entrained CO<sub>2</sub> and other entrained gases) is assumed to be flared rather than vented, then emissions would total 2.25 MtCO<sub>2</sub>/yr.

**Cell:** EM129

**Comment:** Rick Heede:

CDIAC data in million tonnes of carbon converted to CO<sub>2</sub>, which is 3.664191 times Carbon if carbon and oxygen isotopes are accounted for, per Kevin Baumert May05, then at World resources Institute: CO<sub>2</sub> conversion is, precisely: C=12.0107 + O=15.9994 x 2 = 44.0095/12.0107 = 3.664191.

**Cell:** E1131

**Comment:** Rick Heede:

Updated with DCIAC emissions data for gas fuels to 2010 in December 2011.

**Cell:** EM131

**Comment:** Rick Heede:

From the associated "Methods" paper: CDIAC's emissions are estimated for each fuel using the following formula: CO<sub>2</sub> = (P) (FO) (C).

From primary and secondary gas fuel production and trade:

CO<sub>2</sub> = CO<sub>2</sub> emissions in 10<sup>6</sup> metric tonnes of carbon;

P = annual production or consumption in thousands of 10<sup>12</sup> joules;

FO = 0.98 ± 1%;

C = carbon content in 10<sup>6</sup> tonnes per thousand 10<sup>12</sup> joules = 0.0137 ± 2%.

Boden, T.A., G. Marland, and R.J. Andres. 2009. Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001.

Jan10: CMS added CDIAC extrapolations for gas emissions from their dataset "Preliminary 2007-08 Global & National Estimates by Extrapolation" (undated) to the main file cited above.

**Cell:** EM136

**Comment:** Rick Heede:

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