

Who is responsible for climate change?

Background paper to Rick Heede's "Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854-2010"

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Climate change is no longer an abstract concept that scientists and environmentalists discuss, but a reality of many people's lives. Over the past few years record breaking and extreme weather events including sweltering summers, super-storms, wildfires and shrinking icecaps, alongside the acidifying of the oceans as more CO₂ dissolves, are just a small taste of what may come.

At the same time fossil fuel corporations continue to extract more resources that will continue to damage our climate while they reap the financial benefits at the cost of the environment.

However, what if it was possible to estimate how much oil, coal and natural gas has been extracted, and to estimate how much these resources had contributed to the current levels of carbon in the atmosphere? Richard Heede, a scientist and managing director of a private consultancy focused on developing emissions inventories, has done exactly that. His research on the cumulative (historic) carbon emissions from 90 carbon producers, published in a paper called *Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854-2010* was peer reviewed this year and is now published in the journal Climatic Change.

Based on the best available data, he has estimated the cumulative carbon pollution each producer has contributed to date and compared that to the best global estimates for emissions from all sources. It means those who have been the biggest contributors to greenhouse gas emissions so far can now be named and challenged on their contribution to climate change and the impacts we are now experiencing.

Heede's analysis starts in 1854, the year for which the earliest production data are available (for Westmoreland Coal). He then compared his results to data from the U.S. Department of Energy's (DOE) Carbon Dioxide Information Analysis Center (CDIAC) database for fossil fuel CO₂, flaring, and cement production which dates back to as early as 1751 (in the case of coal).

Main findings of Richard Heede's paper

The primary driver of climate change is not current emissions, but the cumulative (historic) emissions that have been pumped out since the industrial revolution. The research carried out by Heede estimates, for the first time, the extent to which 90 named entities - the largest multinational and state-owned producers of crude oil, natural gas, coal, and cement since in some cases as early as 1854 - have contributed the lion's share of cumulative global CO₂ and methane emissions.

The findings in the article call attention to the estimated role and responsibility of 90 individual entities or so called carbon major entities (CME's) in the growth of greenhouse gas emissions and resulting climate impacts. All CME's are listed in Annex 1.

Key findings:

- 90 carbon major entities (CMEs) are responsible for an estimated 914 billion tonnes of carbon dioxide equivalent (GtCO₂e) of cumulative world emissions of industrial CO₂ and methane between 1854 and 2010;
- That is equivalent to 63% of estimated global industrial emissions of CO₂ and methane;
- The entities split into 83 of the world's largest fossil fuel producers (crude oil & NGLs, natural gas, and coal) plus seven cement manufacturers;
- This is how the fifty of the investor-owned companies spread out geographically¹:
 - USA is home to 21,
 - Europe is the base for 17: five in the UK, three in Germany, two in France, Italy and Switzerland respectively and one the Netherlands, Spain, Austria respectively
 - Canada is the base for six,
 - Russia is home to two, and
 - Australia, Japan, Mexico, South Africa all have one respectively

Table 1: Percentage of emissions per CME

CME	Number	Cumulative Gt CO ₂ e	Percentage of total 914 CME	Percentage of total 1,450.33 CDIAC ²
Investor-owned company	50 companies	315	34.5%	21.72%
State-owned company	31 enterprises	288	31.5%	19.86%
State	9 former and current states	312	34.1%	21.51%
Total carbon producers analysed in the research	90 carbon majors	914	100%	63%
Total CDIAC global emissions 1750-2010		1,450.33	100%	100%

¹ Some of the analysed entities no longer exist.

² The Carbon Dioxide Information Analysis Center (CDIAC) emissions database for fossil fuel CO₂, flaring, and cement production from 1751 through 2010 totals 1,323 GtCO₂, and 1,450 GtCO₂e *with methane emissions*.

Heede also calculated the percentage of emissions each one was responsible for.

- 350.1 GtCO₂e are attributed to all investor-owned and state-owned oil companies (including vented and flaring CO₂ and fugitive methane) of the report, which meet the production of ≥8 million tonnes of carbon (MtC) in a recent year. This is equivalent to 24% of estimated cumulative world emissions of industrial CO₂ and methane between 1751 and 2010.³
- The largest five investor-owned companies alone contributed 181.2 GtCO₂e, equivalent to 12.5 % of the global historic emissions through 2010.⁴
- The largest 10 investor-owned companies contributed 229.5 GtCO₂e, equivalent to 15.8 % of estimated global industrial emissions through 2010.⁵
- The largest 12 investor-owned companies contributed 242.3 GtCO₂e, equivalent to 16.7 % of the global historic emissions through 2010.⁶
- The largest 20 investor-owned companies contributed 278.2 GtCO₂e, equivalent to 19.2% of the global historic emissions through 2010.⁷
- Of the 50 investor-owned companies, all the 21 U.S.-based ones combined (one no longer exists) are responsible for an estimated 172.6 Gt CO₂e (equivalent to 12%) of global emissions through 2010. (Note: This is more than the cumulative emissions of the former Soviet Union (129 GtCO₂e) or China (124 GtCO₂e) and more than half of all nine former and current nation state carbon producers combined (312 GtCO₂e).
- The 24 investor-owned coal companies are responsible for an estimated 79.2 GtCO₂e, and the three state-owned coal companies (one of which, no longer exists) for 36.6 GtCO₂e. For investor-owned companies this is equivalent to 5.5% of total global accumulated emissions. For investor- and state-owned companies combined this is equivalent to almost 8% (115.8 GtCO₂e).⁸
- The 90 entities are responsible for an estimated 27.95 GtCO₂e in 2010, or 886 tCO₂e per second.⁹

Table 2: Numbers by source for all CMEs¹⁰

Source	Total GtCO ₂ e linked to CMEs	Global ¹¹ 1751-2010 GtCO ₂ e	% of global (of 100%) from CMEs	% of total carbon producers
Oil&NGLs	365.7	472.0	77.5	40
Coal	329.6	642.5	51.3	36.05
Natural Gas	120.1	176.1	68.2	13.14
Cement	13.2	32.5	40.6	1.45
Flaring	6.0	12.6	47.9	0.66
Vented CO ₂	4.8	Not applicable	Not applicable	0.53
Own fuel use	7.1	Not applicable	Not applicable	0.78
Fugitive Methane	67.6	114.6	59.0	7.40
Sum	914.3	1,450.3	63%	100%

³ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.20

⁴ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.29

⁵ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.29

⁶ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.29

⁷ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.29

⁸ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.22-23

⁹ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.24

¹⁰ based on Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.17

¹¹ Global CO₂ combustion data from CDIAC, methane from Stern&Kaufmann and European Commission JRC data

Table 3: Top 20 investor-owned CME's 2010 and cumulative emissions¹²

Entity	2010 emissions MtCO ₂ e	Cumulative MtCO ₂ e	% cumulative global, 1751- 2010
1. Chevron, USA	423	51,096	3.52%
2. ExxonMobil, USA	655	46,672	3.22%
3. BP, UK	554	35,837	2.47%
4. Royal Dutch Shell, Netherlands	478	30,751	2.12%
5. ConocoPhillips, USA	359	16,866	1.16%
6. Peabody Energy, USA	519	12,432	0.86%
7. Total, France	398	11,911	0.82%
8. Consol Energy, Inc., USA	160	9,096	0.63%
9. BHP Billiton, Australia	320	7,606	0.52%
10. Anglo American, UK	242	7,242	0.50%
11. RWE, Germany	148	6,843	0.47%
12. ENI, Italy	258	5,973	0.41%
13. Rio Tinto, UK	161	5,961	0.41%
14. Arch Coal, USA	341	5,888	0.41%
15. Anadarko, USA	96	5,195	0.36%
16. Occidental, USA	109	5,063	0.35%
17. Lukoil, Russian Federation	322	3,873	0.27%
18. Sasol, South Africa	113	3,515	0.24%
19. Repsol, Spain	126	3,381	0.23%
20. Marathon, USA	59	2,985	0.21%

Right column compares each entity's cumulative emissions to CDIAC's global industrial emissions 1751-2010. The totals above combine attributed emissions from crude oil & NGL, natural gas, and coal combustion of marketed products, plus ancillary emissions from venting, flaring, own fuel use and fugitive CO₂ and CH₄.

The fossil fuel industry is making profits to the detriment of the of the planet and the people. The following table (4) shows the financial returns being made by the top 20 investor-owned companies, that Heede analysed.

Table 4: Net income of investor-owned CMEs¹³

Company	Cumulative emissions 1854-2010 MtCO ₂ e	Annual net income (before extraordinary items) \$ Bn	Financial year
Chevron	51,096	26.2	Jan - Dec 2012
ExxonMobil	46,672	44.9	Jan - Dec 2012
BP	35,837	11.6	Jan - Dec 2012
Royal Dutch Shell	30,751	26.6	Jan - Dec 2012
ConocoPhillips	16,866	8.4	Jan - Dec 2012
Peabody	12,432	- 0.6	Jan - Dec 2012
TOTAL	11,911	13.8	Jan - Dec 2012
Console Energy	9,096	0.4	Jan - Dec 2012
BHP Billiton	7,606	10.9	Jun 2012 - Jun 2013

¹² Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.29

¹³ Calculations based on Bloomberg Data and then converted into USD

Anglo American	7,242	- 1.5	Jan - Dec 2012
RWE	6,843	1.8	Jan - Dec 2012
ENI	5,973	10	Jan - Dec 2012
Rio Tinto	5,961	- 3	Jan - Dec 2012
Arch Coal	5,888	- 0.7	Jan - Dec 2012
Anadarko	5,195	2.4	Jan - Dec 2012
Occidental	5,063	4.6	Jan - Dec 2012
Lukoil	3,873	11	Jan - Dec 2012
Sasol	3,515	3	Jun 2012 - Jun 2013
Repsol, Spain	3,381	2.6	Jan - Dec 2012
Marathon	2,985	3.4	Jan - Dec 2012

Point of no return

Heede's new research demonstrates, by using the best available data, it is possible to estimate the historical carbon pollution that these CMEs have contributed to date. But these fossil fuel and cement companies not only have responsibility for their greenhouse gas emissions to date, and therefore a share in a collective responsibility for the damage resulting from climate change now and in the future. Some of them still plan to exploit untapped oil, gas and coal reserves while the living systems of the planet are under such pressure from the CO₂ and methane that is already in the atmosphere.

The most recent Intergovernmental Panel on Climate Change ([IPCC](#)) report, published late September 2013, found that to hold warming below 2°C with a reasonable level of certainty, total further emissions from fossil fuels, cement, industry and waste should not exceed 140 gigatons of carbon which is about 500 GtCO₂. This is less than 20 percent of estimated available carbon reserves that has already been found to date. It also stated that manmade climate change was irrefutable.

Greenpeace laid out in the study [Point of No Return](#) how continuing on the current course will make it difficult, if not impossible, to prevent the widespread and catastrophic impacts of climate change. The report pinpoints 14 massive energy projects that would significantly push emissions so high, that humanity will exceed the 2 degrees Celsius point. This means that if the remaining reserves are exploited there will be no way to stop runaway climate change.

The 14 carbon intensive projects highlighted in the *Point of No Return* report range from massive coal expansion in Australia, China, the US and Indonesia, to oil expansion in the tar sands of Canada, the Arctic and Brazil to new gas production in the Caspian Sea and the US.

The costs of exploiting these projects will be substantial: billions spent to deal with the destruction of extreme weather events and the deaths of tens of millions from the impacts by as soon as 2030.¹⁴ Who is going to pay for these costs? The people most affected, governments trying to implement adaptation technology, or ultimately the tax payers that need to finance government backed action?

Heede's unique research is a key building block in efforts to hold those responsible for the greenhouse gas emissions that are fueling climate change and its current and future devastating impacts. To date, those responsible for emissions have escaped liability, while at the same time, those being harmed have no one to blame

¹⁴ DARA and the Climate Vulnerable Forum (2012). Climate Vulnerability Monitor: A Guide to the Cold Calculus of a Hot Planet. 2nd Edition, DARA, Madrid, Spain, p. 24. <http://daraint.org/climate-vulnerability-monitor/climate-vulnerabilitymonitor-2012/>

and no way to recover the damage they have incurred. This data points the finger at entities that must reduce emissions, starting with a commitment to leave fossil fuels in the ground.



Energy Revolution

If we want to stop runaway climate change we need a radical change and the solution is within our grasp: renewable energy has made a true breakthrough globally and it's challenging fossil fuels.

Last year over half of all new installed electric capacity worldwide was from renewable sources.¹⁵ Wind, solar, biomass and waste-to-power, geothermal, marine and small hydro technologies produce 6.5% of world's electricity.¹⁶ In some countries, modern renewables are reaching much higher levels already, proving that renewables work on large scale. For example, Denmark is on its way to produce 50% of its electricity with wind power by 2020.¹⁷

By 2050, renewable energy could meet almost all of the world's energy needs, if the right policies are put in place, and if energy efficiency becomes a priority.¹⁸

Fossil fuels should be recognised for what they are a 19th century energy source, it is time for governments to embrace smart energy solutions for the 21st century clean, sustainable and affordable renewable energy such as solar, wind combined with the latest efficiency technologies. Greenpeace demands that our governments act now to speed up the clean energy transition.

¹⁵ Renewable Energy Policy Network for the 21st Century (REN21). 2013. Renewables 2013 Global Status Report. Available online at: <http://www.ren21.net/REN21Activities/GlobalStatusReport.aspx>

¹⁶ Frankfurt School-UNEP Centre/BNEF. 2013. Global Trends in Renewable Energy Investment 2013

¹⁷ European Wind Energy Association (EWEA). 2012. Denmark: 50% wind powered electricity by 2020. EWEA blog 16th July 2012. Available online: <http://www.ewe.org/blog/2012/07/denmark-50-wind-powered-electricity-by-2020/>

¹⁸ <http://energyblueprint.info/>

Annex

Annex 1: List of Carbon Major Entities (CMEs)

Table 1: All 81 investor- & state-owned carbon & cement entities and cumulative emissions¹⁹

Entity	Products (fuel, cement)	Flaring, own fuel, vented CO ₂	Fugitive methane	Total emissions	Percent of global
	GtCO ₂	GtCO ₂	GtCO ₂ e	GtCO ₂ e	1751-2010
1. ChevronTexaco, USA	46.28	1.48	3.34	51.10	3.52%
2. ExxonMobil, USA	41.60	1.54	3.53	46.67	3.21%
3. Saudi Aramco, Saudi Arabia	42.82	1.03	2.18	46.03	3.17%
4. BP, UK	32.51	1.02	2.31	35.84	2.47%
5. Gazprom, Russian Federation	25.09	2.13	4.92	32.14	2.22%
6. Royal Dutch Shell, The Netherlands	27.57	0.99	2.19	30.75	2.12%
7. National Iranian Oil Company	26.71	0.76	1.62	29.08	2.01%
8. Pemex, Mexico	18.14	0.59	1.29	20.03	1.38%
9. British Coal Corporation, UK *	17.74	0.00	1.50	19.25	1.33%
10. ConocoPhillips, USA	14.70	0.67	1.50	16.87	1.16%
11. Petroleos de Venezuela	14.77	0.44	0.95	16.16	1.11%
12. Coal India	14.28	0.00	1.21	15.49	1.07%
13. Peabody Energy, USA	11.46	0.00	0.97	12.43	0.86%
14. Total, France	10.79	0.35	0.77	11.91	0.82%
15. PetroChina, China	9.67	0.28	0.61	10.56	0.73%
16. Kuwait Petroleum Corp.	9.80	0.23	0.48	10.50	0.72%
17. Abu Dhabi NOC, UAE	8.84	0.26	0.57	9.67	0.67%
18. Sonatrach, Algeria	7.96	0.40	0.91	9.26	0.64%
19. Consol Energy, Inc., USA	8.38	0.00	0.71	9.10	0.63%
20. BHP Billiton, Australia	6.97	0.06	0.58	7.61	0.52%
21. Anglo American, UK	6.68	0.00	0.57	7.24	0.50%
22. Iraq National Oil Company	6.70	0.14	0.29	7.14	0.49%
23. RWE, Germany	6.31	0.00	0.54	6.84	0.47%
24. Pertamina, Indonesia	6.16	0.21	0.46	6.83	0.47%
25. Libya National Oil Corp.	6.22	0.15	0.32	6.69	0.46%
26. Nigerian National Petroleum	6.06	0.15	0.33	6.54	0.45%
27. Petrobras, Brazil	5.49	0.16	0.34	5.99	0.41%
28. ENI, Italy	5.20	0.24	0.54	5.97	0.41%
29. Rio Tinto, UK	5.50	0.00	0.47	5.96	0.41%
30. Arch Coal, USA	5.43	0.00	0.46	5.89	0.41%
31. Petronas, Malaysia	4.56	0.22	0.50	5.27	0.36%
32. Anadarko, USA	4.56	0.18	0.46	5.20	0.36%
33. Occidental, USA	4.63	0.09	0.34	5.06	0.35%
34. Statoil, Norway	3.89	0.15	0.33	4.37	0.30%
35. Oil & Gas Corporation, India	3.71	0.14	0.31	4.16	0.29%
36. Lukoil, Russian Federation	3.60	0.09	0.19	3.87	0.27%
37. Sasol, South Africa	3.24	0.00	0.27	3.52	0.24%
38. Qatar Petroleum	3.00	0.13	0.29	3.41	0.24%
39. Repsol, Spain	2.96	0.13	0.29	3.38	0.23%
40. Marathon, USA	2.64	0.11	0.24	2.99	0.21%
41. Yukos, Russian Federation *	2.69	0.06	0.12	2.86	0.20%
42. Egyptian General Petroleum	2.48	0.09	0.20	2.77	0.19%
43. Rosneft, Russian Federation	2.50	0.07	0.15	2.72	0.19%
44. Petroleum Development Oman	2.40	0.08	0.18	2.66	0.18%
45. Hess, USA	2.09	0.08	0.19	2.36	0.16%
46. Xstrata, Switzerland	2.05	0.00	0.17	2.22	0.15%
47. Massey Energy, USA	2.03	0.00	0.17	2.20	0.15%
48. Alpha Natural Resources, USA	1.98	0.00	0.17	2.15	0.15%
49. Singareni Collieries, India	1.74	0.00	0.15	1.88	0.13%

¹⁹ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.27

50. Ecopetrol, Colombia	1.66	0.05	0.10	1.81	0.12%
51. Sonangol, Angola	1.69	0.03	0.07	1.79	0.12%
52. Cyprus Amax, USA *	1.61	0.00	0.14	1.75	0.12%
53. EnCana, Canada	1.40	0.09	0.20	1.69	0.12%
54. Devon Energy, USA	1.41	0.08	0.19	1.69	0.12%
55. BG Group, UK	1.24	0.09	0.21	1.54	0.11%
56. Sinopec, China	1.41	0.04	0.08	1.53	0.11%
57. Westmoreland Mining, USA	1.41	0.00	0.12	1.53	0.11%
58. Suncor, Canada	1.24	0.05	0.11	1.41	0.10%
59. Syrian Petroleum	1.29	0.04	0.08	1.40	0.10%
60. Kiewit Mining, USA	1.19	0.00	0.10	1.29	0.09%
61. North American Coal, USA	1.09	0.00	0.09	1.18	0.08%
62. RAG, Germany	1.05	0.00	0.09	1.14	0.08%
63. China National Offshore Oil Co.	1.03	0.03	0.06	1.12	0.08%
64. Luminant, USA	0.97	0.00	0.08	1.05	0.07%
65. Lafarge, France	1.04	0.00	0.00	1.04	0.07%
66. Holcim, Switzerland	1.01	0.00	0.00	1.01	0.07%
67. Canadian Natural Resources	0.83	0.04	0.09	0.96	0.07%
68. Apache, USA	0.81	0.04	0.10	0.95	0.07%
69. Bahrain Petroleum	0.78	0.05	0.11	0.93	0.06%
70. Talisman, Canada	0.79	0.04	0.09	0.92	0.06%
71. Murray Coal, USA	0.73	0.00	0.06	0.80	0.05%
72. UK Coal, UK	0.73	0.00	0.06	0.79	0.05%
73. Husky Energy, Canada	0.59	0.02	0.05	0.66	0.05%
74. Nexen, Canada **	0.59	0.02	0.04	0.65	0.04%
75. HeidelbergCement, Germany	0.59	0.00	0.00	0.59	0.04%
76. Cemex, Mexico	0.55	0.00	0.00	0.55	0.04%
77. Polish Oil & Gas	0.42	0.02	0.03	0.47	0.03%
78. Italcementi, Italy	0.46	0.00	0.00	0.46	0.03%
79. Murphy Oil, USA	0.37	0.02	0.03	0.42	0.03%
80. Taiheiyo, Japan	0.40	0.00	0.00	0.40	0.03%
81. OMV Group, Austria	0.30	0.01	0.03	0.35	0.02%
Total IOC & SOE producers	543.23	15.68	43.58	602.49	41.54%
Total CDIAC, 1751-2010	1,323.09	na	114.65	1,450.33	
Percent this study of CDIAC	41.06%	na	38.01%	41.54%	

This table includes each entity's estimated emissions from fuel combustion (net of non-energy uses), flaring, own fuel use, and ancillary emissions of CO₂ and CH₄ (in CO₂e units). Emissions from cement manufacturing are listed under product emissions, but are vented process emissions from the calcination of calcium carbonate. * not extant; production and emission quantified for these entities but not attributed to extant entities. ** Nexen was acquired by CNOOC in 2012.

Table 2: 2010 and cumulative emissions of all nation-state carbon producers²⁰

Entity	2010 emissions MtCO ₂ e	Cumulative MtCO ₂ e	% cumulative global, 1751-2010
1. Former Soviet Union (coal, oil, gas)	na	129,717	8.94%
2. China (coal and cement)	7,898	124,089	8.56%
3. Poland (coal)	294	26,750	1.84%
4. Russian Federation (coal)	695	11,243	0.78%
5. Czechoslovakia (coal)	na	7,347	0.51%
6. Kazakhstan (coal)	287	4,442	0.31%
7. Ukraine (coal)	145	3,370	0.23%
8. North Korea (coal)	88	2,802	0.19%
9. Czech Republic (coal)	92	2,000	0.14%
Total:	9,500	311,760	21.50%

"Nation-states" are centrally planned economies, current and former, and do not include state-owned entities (SOEs).

²⁰ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.31

Annex 2: General background on the data

- The Carbon Dioxide Information Analysis Center (CDIAC) emissions database for fossil fuel CO₂, flaring, and cement production from 1751 through 2010 totals 1,323 GtCO₂, and 1,450 GtCO_{2e} *with methane emissions*.
- A threshold for inclusion in this study was set at the production of ≥8 million tonnes of carbon (MtC) in a recent year. Some entities have since been added, while others were absorbed through mergers or acquisitions.
- Of the emissions calculated from production figures traced to carbon fossil fuel and cement production, half has been emitted since 1986.²¹
- CDIAC data starts at 1751 (for coal).
- The earliest production data is available for 1854 (Westmoreland Coal).
- The results are compared to CDIAC estimates of annual and cumulative carbon dioxide and methane emissions by from as early as 1751 (in the case of coal) to 2010.
- “No starting year was set for fossil fuel production; this is determined by the availability of production data for each entity. The earliest data are for 1854 (Westmoreland Coal).”²²
- “The largest multinational oil companies were established prior to World War I, and most state-owned oil companies were formed in the 1970s.²³ Production data are often unavailable for the early years of an entity’s existence, but most production data are relatively complete from the 1930s forward.”²⁴
- “According to the global emissions database maintained by the Carbon Dioxide Information Analysis Center (CDIAC), of cumulative emissions over the 1751-2010 period,
 - only 0.4 percent had been emitted by 1854,
 - 3.4 percent by 1900,
 - and 10.4 percent by 1930”^{25,26}

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²¹ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.5

²² Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.9

²³ Standard Oil 1870; BP (Anglo Persian Oil Company, in 1909, as a subsidiary of Burmah Oil); Royal Dutch Shell 1907; Chevron (as the Texas Fuel Company in 1901, Texaco, and Pacific Coast Oil Company as Standard Oil of California, Socal); Gulf Oil and Mobil (Socony –Vacuum Oil Company) were established in 1911 upon the Supreme Court dissolution of Standard Oil Trust; Gulf Oil in 1907; ENI in 1926 (as AGIP); Pemex in 1938. For more information on the “wave of nationalization” in the 1970s and early 1980s, see: Victor, David G., David Hults, & Mark Thurber (2012), Figure 20.2.

²⁴ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.9

²⁵ Marland, Gregg, T. A. Boden, & R. J. Andres (2011) “Global, Regional, and National CO₂ Emissions.” In *Trends: A Compendium of Data on Global Change*, Carbon Dioxide Information Analysis Center, Oak Ridge Nat. Lab., U.S. DOE.

²⁶ Heede, R. 2013. Carbon Majors: Accounting for carbon and methane emissions 1854-2010. Methods and Results Report. p.9