Benchmarking Air Emissions

Of the 100 Largest Electric Power Producers in the United States

July 2020

Data Downloads at: www.mjbradley.com

Contributors:

Preface

The 2020 Benchmarking report is the 16th collaborative effort highlighting environmental performance and progress in the nation's electric power sector. The Benchmarking series began in 1997 and uses publicly reported data to compare the emissions performance of the 100 largest power producers in the United States. The company rankings are based on 2018 generation and emissions data and aggregate industry trends are presented through 2019.

Data on U.S. power plant generation and air emissions are available to the public through several databases maintained by state and federal agencies. Publicly- and privately-owned electric generating companies are required to report fuel and generation data to the U.S. Energy Information Administration (EIA). Most power producers are also required to report air pollutant emissions data to the U.S. Environmental Protection Agency (EPA). These data are reported and recorded at the boiler, generator, or plant level, and must be combined and presented so that company-level comparisons can be made across the industry.

The Benchmarking report facilitates the comparison of emissions performance by combining generation and fuel consumption data compiled by EIA with emissions data on sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon dioxide (CO_2) and mercury (Hg) compiled by EPA; error checking the data; and presenting emissions information for the nation's 100 largest power producers in a graphic format that aids in understanding and evaluating the data. The report is intended for a wide audience, including electric industry executives, environmental advocates, financial analysts, investors, journalists, power plant managers, and public policymakers.

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Plant and company level data used in this report are available at www.mjbradley.com.

Key Findings

- The 100 largest power producers in the United States own more than 3,400 power plants and account for more than 80 percent of the sector's electric generation and reported air emissions. Their fuel mix, emissions, and emission rates vary widely as summarized throughout this report (based on 2018 data).
- For the electric sector overall, in 2019, power plant SO_2 and NOx emissions were 94 percent and 86 percent lower, respectively, than they were in 1990 when Congress passed major amendments to the Clean Air Act. In 2019, power plant SO_2 and NOx emissions were 23 percent and 14 percent lower than they were in 2018.
- Power sector CO_2 emissions decreased about 8 percent between 2018 and 2019. In 2019, power plant CO_2 emissions were 11 percent lower than 1990 levels, and about 30 percent lower than their peak in 2007. Some of the factors driving this longer-term trend include energy efficiency improvements and the displacement of coal by natural gas and renewable energy resources.
- Mercury air emissions from power plants (as reported to the TRI database) have decreased 90 percent since 2000. The first-ever federal limits on mercury and other hazardous air pollutants from coal-fired power plants went into effect in 2015.

BENCHMARKING AIR EMISSIONS

OF THE
100 LARGEST ELECTRIC POWER PRODUCERS
IN THE UNITED STATES

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Electricity in the United States

The electricity sector in the United States includes a wide array of companies that produce and distribute electricity to homes and offices, industrial facilities, and other customers. The services it provides are essential to the growth and functioning of the U.S. economy. Electricity is expected to serve a growing share of energy consumption in the U.S. with the electrification of transportation and other end-uses.

Benchmarking Analytical Resources

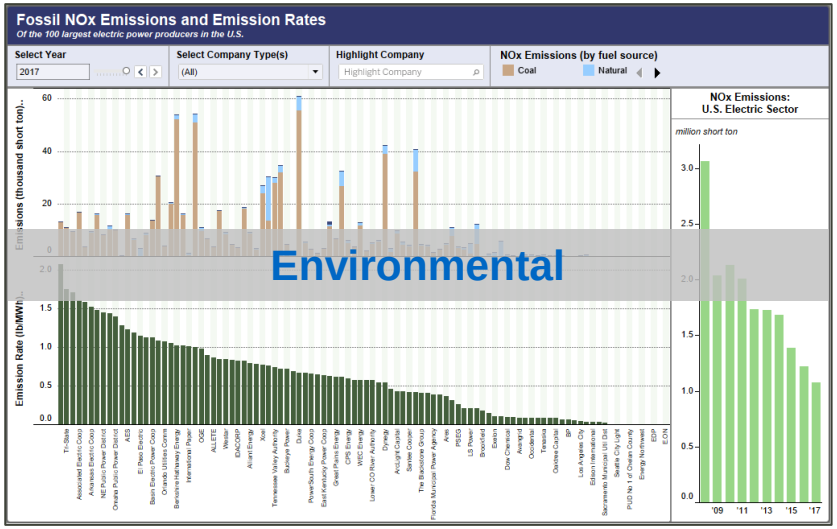
The Benchmarking Report now includes a series of interactive, web-based dashboards to further visualize the emissions and electricity generation from power producers in the United States. These tools provide insight into how facility- and company-level emissions and generation are changing over time by utilizing historical Benchmarking data (2008-2018). Data include:

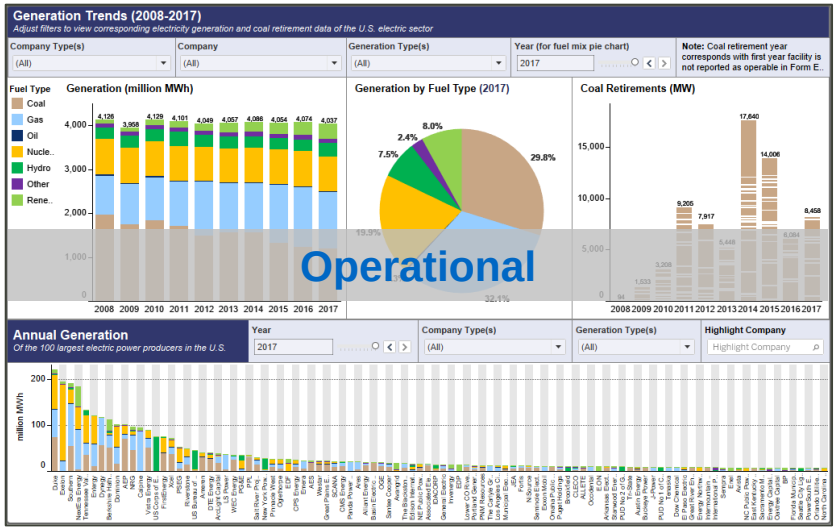
Environmental: Company-specific emissions and emission rates by company type and pollutant

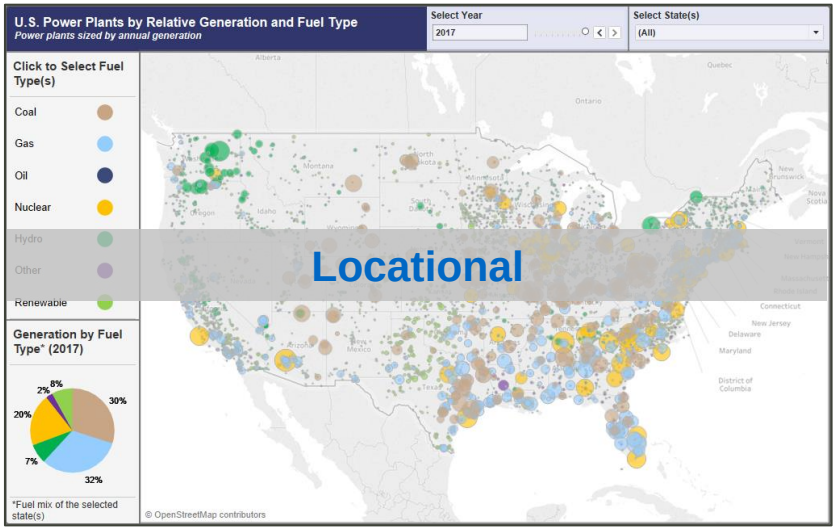
Operational: Electricity generation and relevant data aggregated by company type, company, and other metrics

Locational: Facility-level emissions and generation visualized by fuel type, company ownership, and other metrics

These tools are available at www.mjbradley.com.







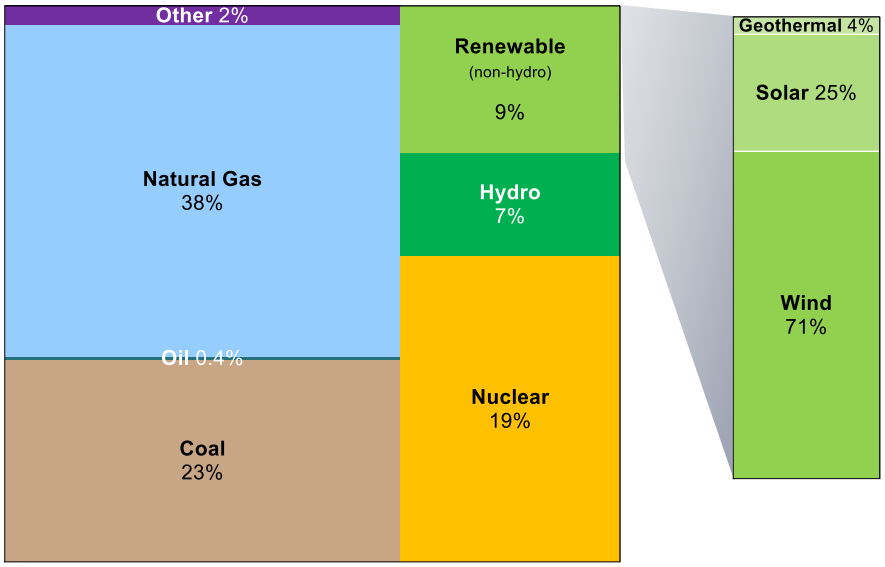
Section I

U.S. Electric Sector Highlights

U.S. Generation by Fuel Type

- In 2019, the U.S. electric system continued its general shift away from coal toward lower- and zero-emitting sources. For the third consecutive year, natural gas was the leading source of electricity generation in the U.S. (38 percent), followed by coal (23 percent).
- Nuclear plants accounted for 19 percent, hydroelectric resources 7 percent, and oil-fired resources <1 percent. Non-hydroelectric renewables: wind, solar, and geothermal, accounted for 9 percent of total U.S. generation.
- Other fuel sources such as biomass, municipal solid waste, tire-derived fuel, manufactured and waste gases, etc., accounted for 2 percent.
- This is a significant shift from the generation mix a decade ago. In 2006, coal accounted for 49 percent of power production, while natural gas generated only 20 percent.

U.S. Electricity Generation by Fuel Type (2019)



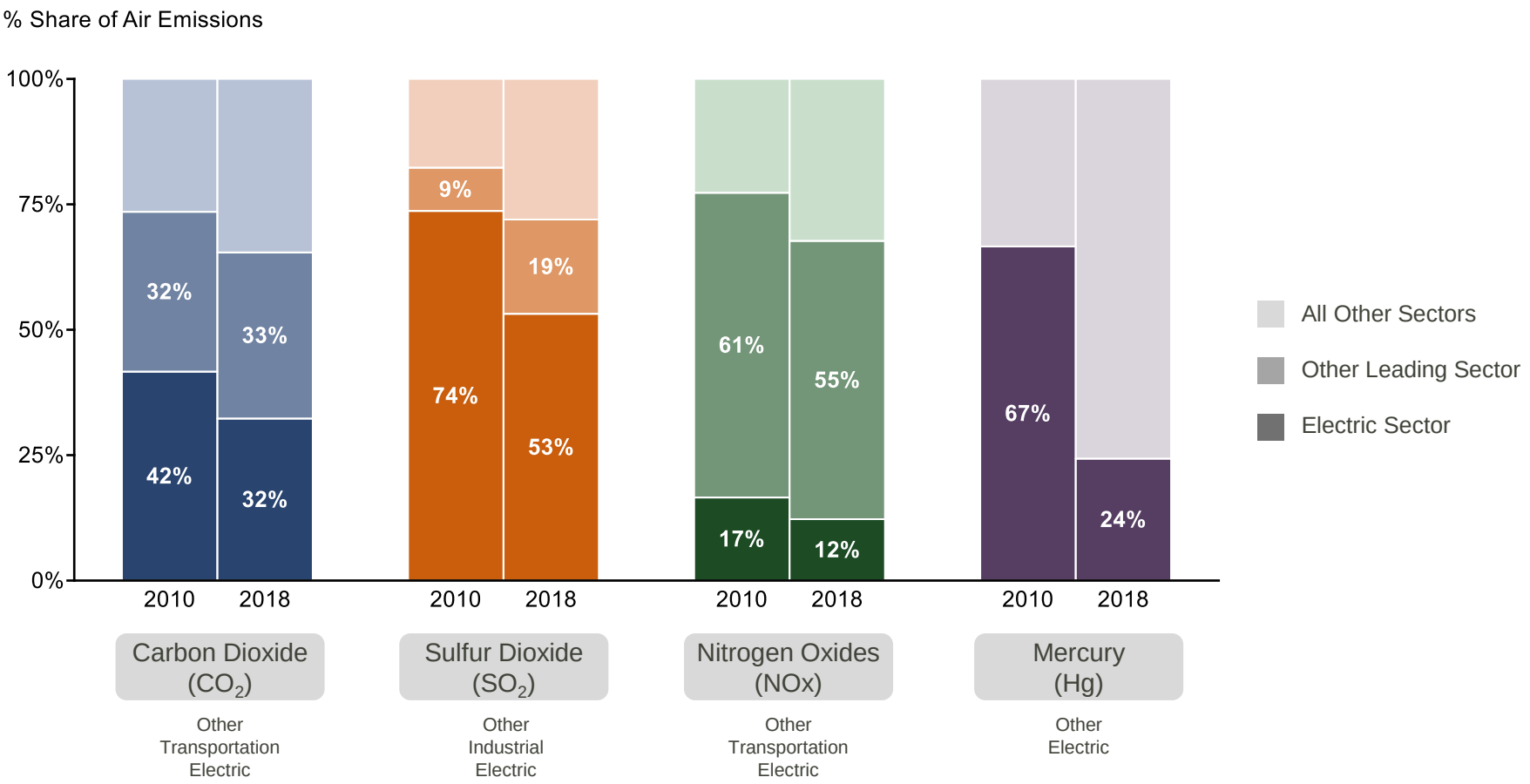
Zero-Carbon Generation in the United States

In 2019, renewables and other zero-carbon resources generated 35.7% of U.S. electricity, making it the second-leading source of power generation. Natural gas was first (38.4%) and coal was third (23.4%). Of the zero-carbon resources, nuclear made up 55%, renewables 26.4%, and hydro 18.6%.

Source: U.S. Energy Information Administration. Electric Power Monthly, Tables 1.1 and 1.1A. March 2020.

Share of Emissions by Sector

Share of Emissions: U.S. Electric Sector and Other Sectors



Source: U.S. Environmental Protection Agency. Air Pollutant Emissions Trend Data (2019). TRI National Analysis (February 2020).

Section II

Emissions of the 100 Largest Electric Power Producers

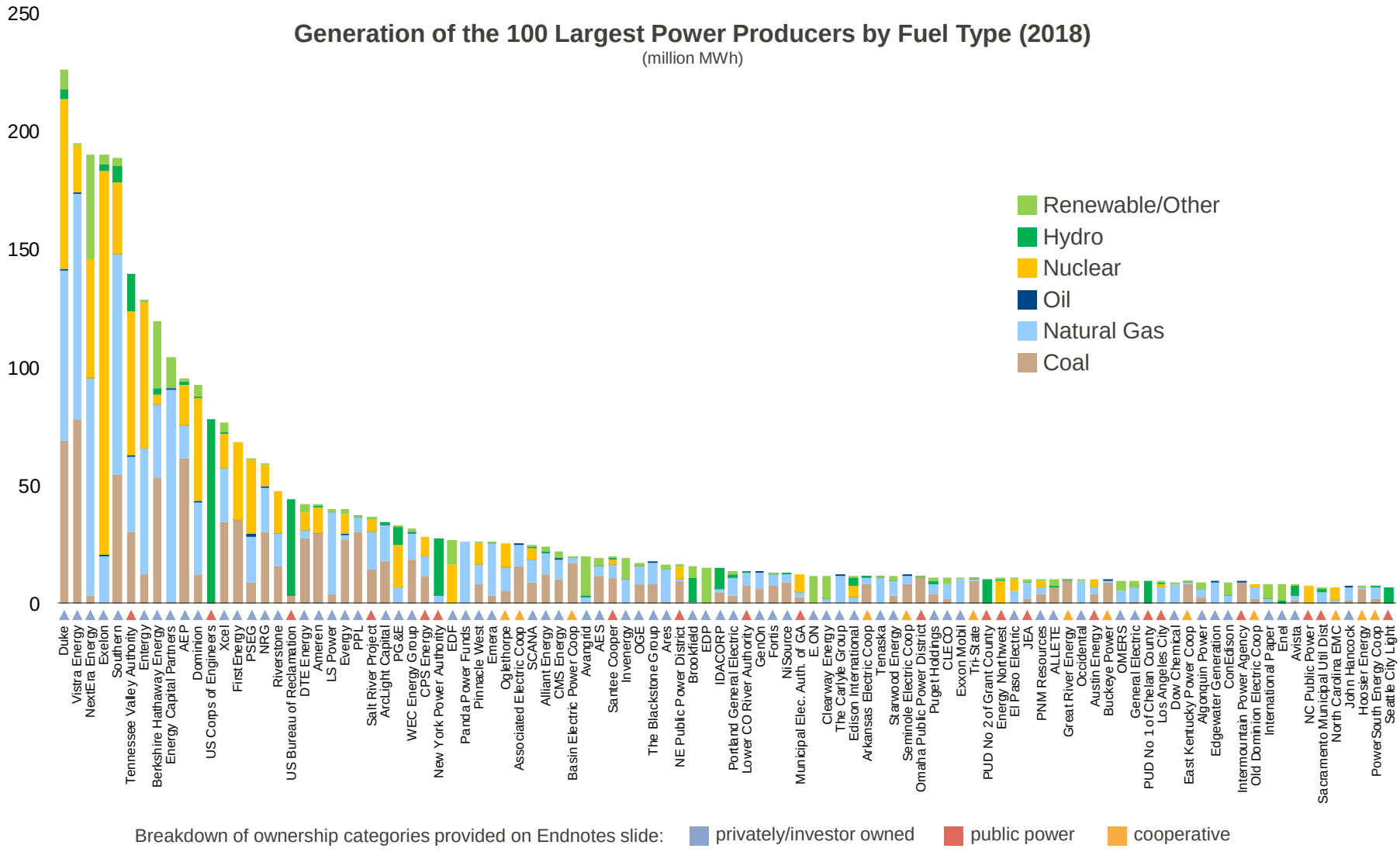
The 100 Largest Electric Power Producers

The report examines and compares the stack air pollutant emissions of the 100 largest power producers in the United States based on their 2018 generation, plant ownership, and emissions data. The table below lists the 100 largest power producers featured in this report ranked by their total electricity generation from fossil fuel, nuclear, and renewable energy facilities. These producers include public and private entities (collectively referred to as "companies" or "producers" in this report) that own roughly 3,400 power plants and account for 82 percent of reported electric generation and 81 percent of the industry's reported emissions.

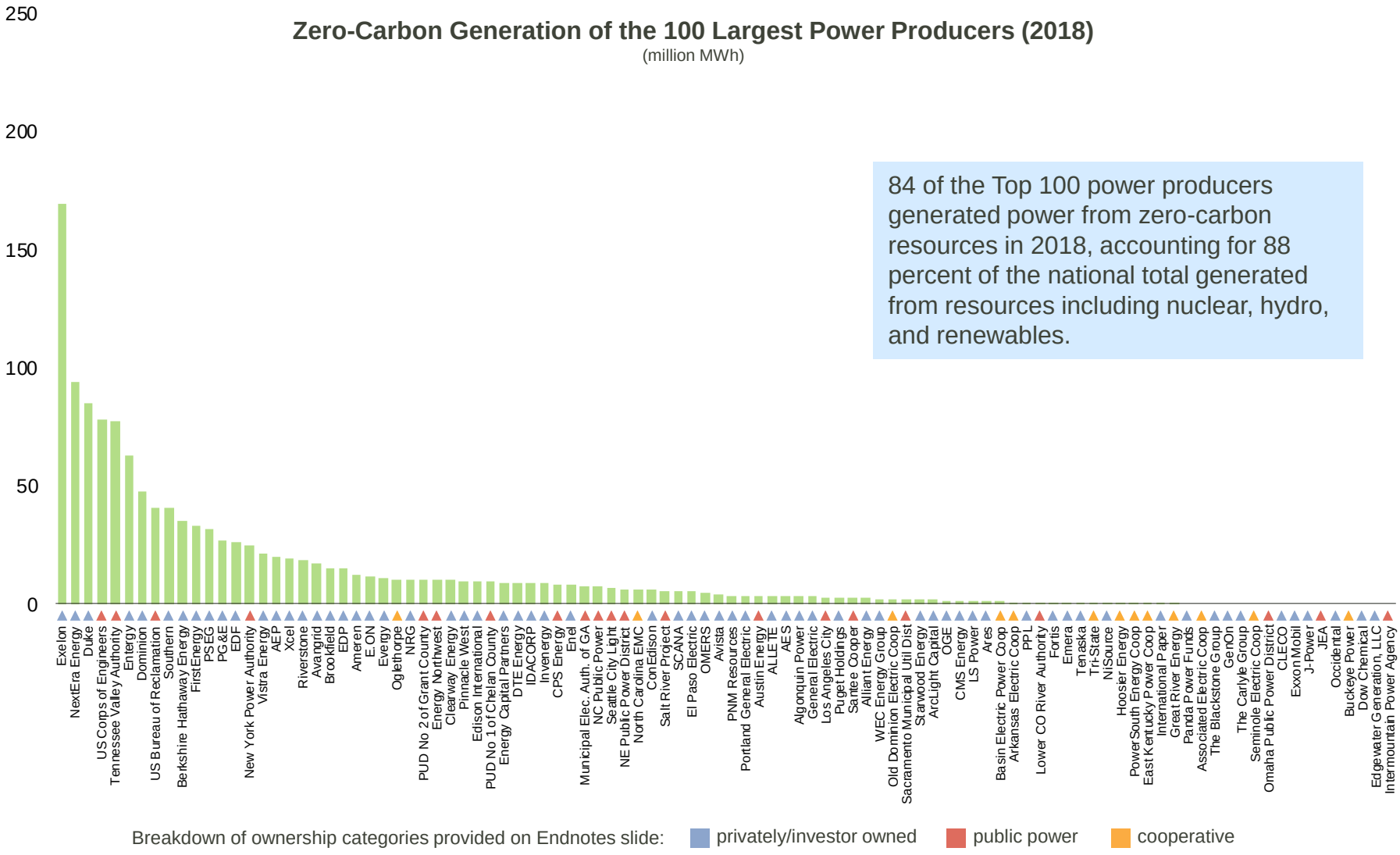
The report focuses on four power plant pollutants for which public emissions data are available: sulfur dioxide (SO_2), nitrogen oxides (NOx), mercury (Hg), and carbon dioxide (CO_2). At sufficient concentrations, these pollutants are associated with significant environmental and public health problems, including acid deposition, mercury deposition, nitrogen deposition, global warming, ground-level ozone, regional haze, and/or fine particle air pollution, which can lead to asthma and other respiratory illnesses. The report benchmarks, or ranks, each company's absolute emissions and its emission rate (determined by dividing emissions by electricity produced) for each pollutant. In 2018, the 100 largest power producers emitted in aggregate approximately 1.02 million tons of SO_2, 0.83 million tons of NOx, 3.40 tons of mercury, and 1.60 billion tons of CO_2.

RANK	PRODUCER NAME	2018 MWh (million)
1	Duke	226.5
2	Vistra Energy	194.9
3	NextEra Energy	190.4
4	Exelon	190.0
5	Southern	188.6
6	Tennessee Valley Authority	139.8
7	Entergy	128.3
8	Berkshire Hathaway Energy	119.2
9	Energy Capital Partners	104.0
10	AEP	95.1
11	Dominion	92.4
12	US Corps of Engineers	78.2
13	Xcel	76.3
14	FirstEnergy	68.2
15	PSEG	61.0
16	NRG	59.5
17	Riverstone	47.8
18	US Bureau of Reclamation	43.8
19	DTE Energy	41.9
20	Ameren	41.5
21	LS Power	39.9
22	Evergy	39.7
23	PPL	36.6
24	Salt River Project	35.7
25	ArcLight Capital	34.7
26	PG&E	32.7
27	WEC Energy Group	31.6
28	CPS Energy	28.1
29	New York Power Authority	27.8
30	EDF	26.6
31	Panda Power Funds	25.8
32	Pinnacle West	25.6
33	Emera	25.1
34	Oglethorpe	25.1
35	Associated Electric Coop	24.4
36	SCANA	23.9
37	Alliant Energy	23.8
38	CMS Energy	21.8
39	Basin Electric Power Coop	20.1
40	Avangrid	19.9
41	AES	19.3
42	Santee Cooper	19.0
43	Invenergy	19.0
44	OGE	17.3
45	The Blackstone Group	17.2
46	Ares	16.2
47	NE Public Power District	16.1
48	Brookfield	15.9
49	EDP	14.9
50	IDACORP	14.7
51	Portland General Electric	13.8
52	Lower CO River Authority	13.5
53	GenOn	12.9
54	Fortis	12.4
55	NiSource	12.0
56	Municipal Elec. Auth. of GA	11.9
57	E.ON	11.6
58	Clearway Energy	11.6
59	The Carlyle Group	11.6
60	Edison International	11.5
61	Arkansas Electric Coop	11.5
62	Tenaska	11.4
63	Starwood Energy	11.4
64	Seminole Electric Coop	11.3
65	Omaha Public Power District	11.1
66	Puget Holdings	11.0
67	CLECO	11.0
68	Exxon Mobil	10.8
69	Tri-State	10.1
70	PUD No 2 of Grant County	10.1
71	Energy Northwest	10.0
72	El Paso Electric	10.0
73	JEA	9.9
74	PNM Resources	9.9
75	ALLETE	9.8
76	Great River Energy	9.8
77	Occidental	9.8
78	Austin Energy	9.8
79	Buckeye Power	9.6
80	OMERS	9.5
81	General Electric	9.5
82	PUD No 1 of Chelan County	9.3
83	Los Angeles City	9.3
84	Dow Chemical	9.0
85	East Kentucky Power Coop	8.9
86	Algonquin Power	8.8
87	Edgewater Generation	8.7
88	ConEdison	8.7
89	Intermountain Power Agency	8.5
90	Old Dominion Electric Coop	8.2
91	International Paper	8.2
92	Enel	7.8
93	Avista	7.4
94	NC Public Power	7.0
95	Sacramento Municipal Util Dist	6.8
96	North Carolina EMC	6.7
97	John Hancock	6.7
98	Hoosier Energy	6.6
99	PowerSouth Energy Coop	6.4
100	Seattle City Light	6.4

Rankings by Generation



Rankings by Zero-Carbon Generation



84 of the Top 100 power producers generated power from zero-carbon resources in 2018, accounting for 88 percent of the national total generated from resources including nuclear, hydro, and renewables.

Breakdown of ownership categories provided on Endnotes slide: privately/investor owned | public power | cooperative

Emission Rankings

Important Note on Emission Rankings

The Benchmarking Report presents generation and emissions information of power producers, not distribution utilities that deliver electricity to customers. In order to apply a uniform methodology to all power producers, the Report assigns electricity generation and associated emissions to power producers according to their known generating asset ownership as of December 31, 2018. Assets retired or sold before this date are not allocated to power producers on a prorated basis. For example, a company which retires a generating unit before this date will not see its generation reflected in the rankings. Similarly, company which purchases a generating unit from another will take on the unit's full output for the calendar year.

The above is true even when a producer's generating facilities are part of one or more contractual agreements (e.g., power purchase contracts, etc.) with other entities (often utilities). In other words, this Report attributes all generation and emissions to the owner of an asset, not to purchasers of the asset's output or to counterparties to the contracts. Publicly available data do not allow the accurate and exhaustive tracking of such agreements.

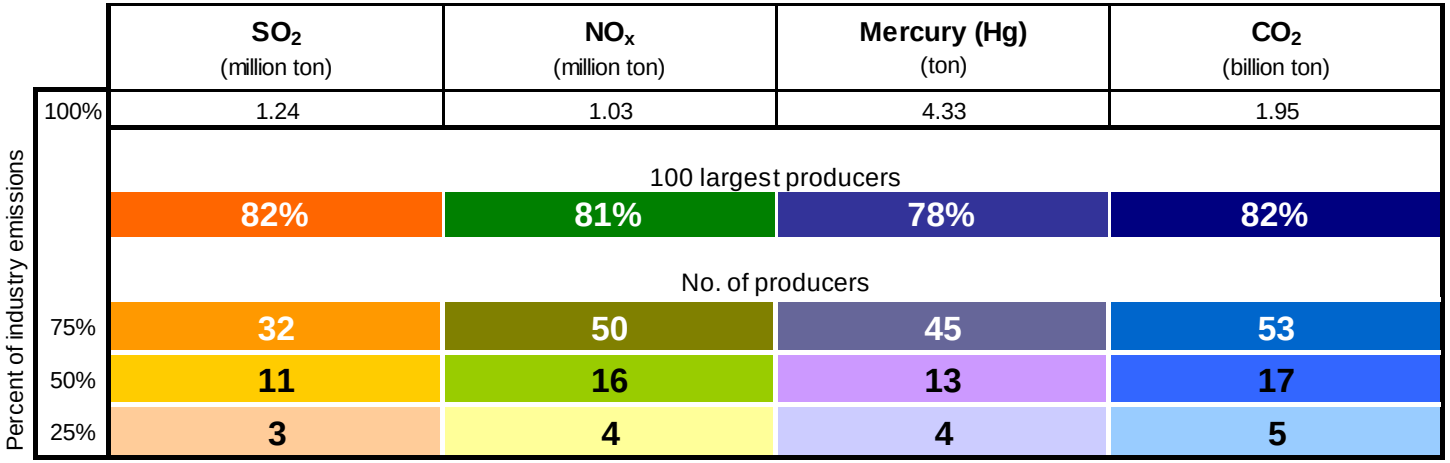
There are a host of reasons why a company's generation profile may differ from that of the electricity it delivers to customers. For example, rural cooperatives, which are non-profit entities and are thus generally unable to directly take advantage of renewable tax credits, tend to rely on power purchase agreements and other non-asset owning mechanisms to deliver renewable electricity to their customers.

A vertically integrated utility that owns a large fossil generating fleet, but also delivers purchased renewable electricity to its customers, might have lower average emission rates than the level attributed in this report to the power producer that owns the said fossil fleet, if the renewable energy purchases were factored into the utility's performance. By the same token, the utility's emissions or emission rate would increase if it contracted with a higher emitting facility or relied on market purchases with associated emissions.

The charts in the next few slides present both the total emissions by company as well as their average emission rates. The evaluation of emissions performance by both emission levels and emission rates provides a more complete picture of relative emissions performance than viewing these measures in isolation. Total emission levels are useful for understanding each producer's contribution to overall emissions loading, while emission rates are useful for assessing how electric power producers compare according to emissions per unit of energy produced when size is eliminated as a performance factor.

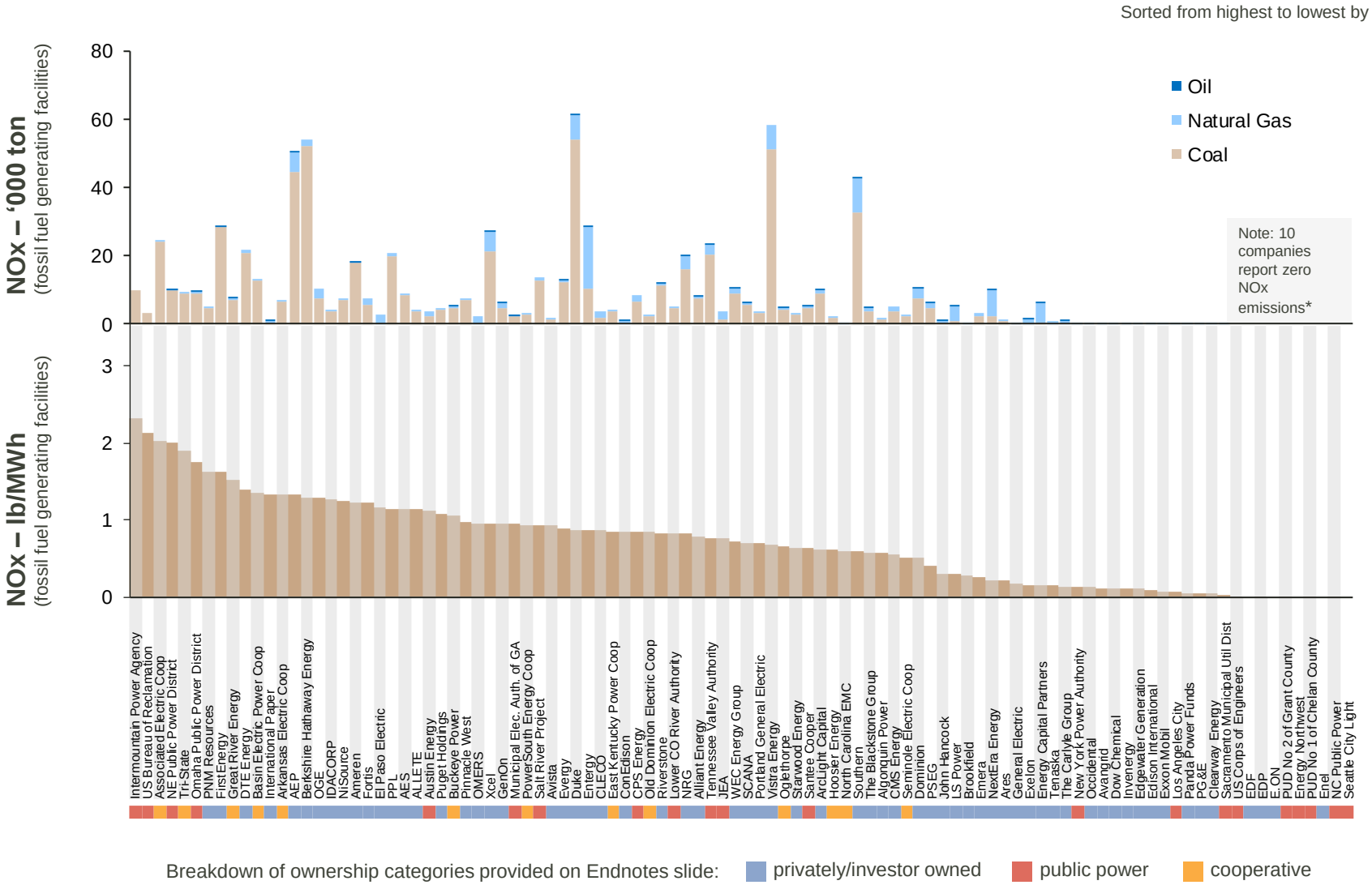
The charts illustrate significant differences in the total emission levels and emission rates of the 100 largest power producers. For example, the tons of CO_2 emissions range from zero to over 129 million tons per year. The NOx emission rates range from zero to 2.3 pounds per megawatt hour of generation. A power producer's total emissions are influenced by the amount of generation that the producer owns and by the fuels and technologies that it uses to generate electricity.

Emission Contributions



Air pollution emissions from power plants are highly concentrated among a small number of producers. For example, nearly a quarter of the electric power industry's SO_2 and CO_2 emissions are emitted by just three and four top 100 producers, respectively.

NOx: Total Emissions and Emission Rates



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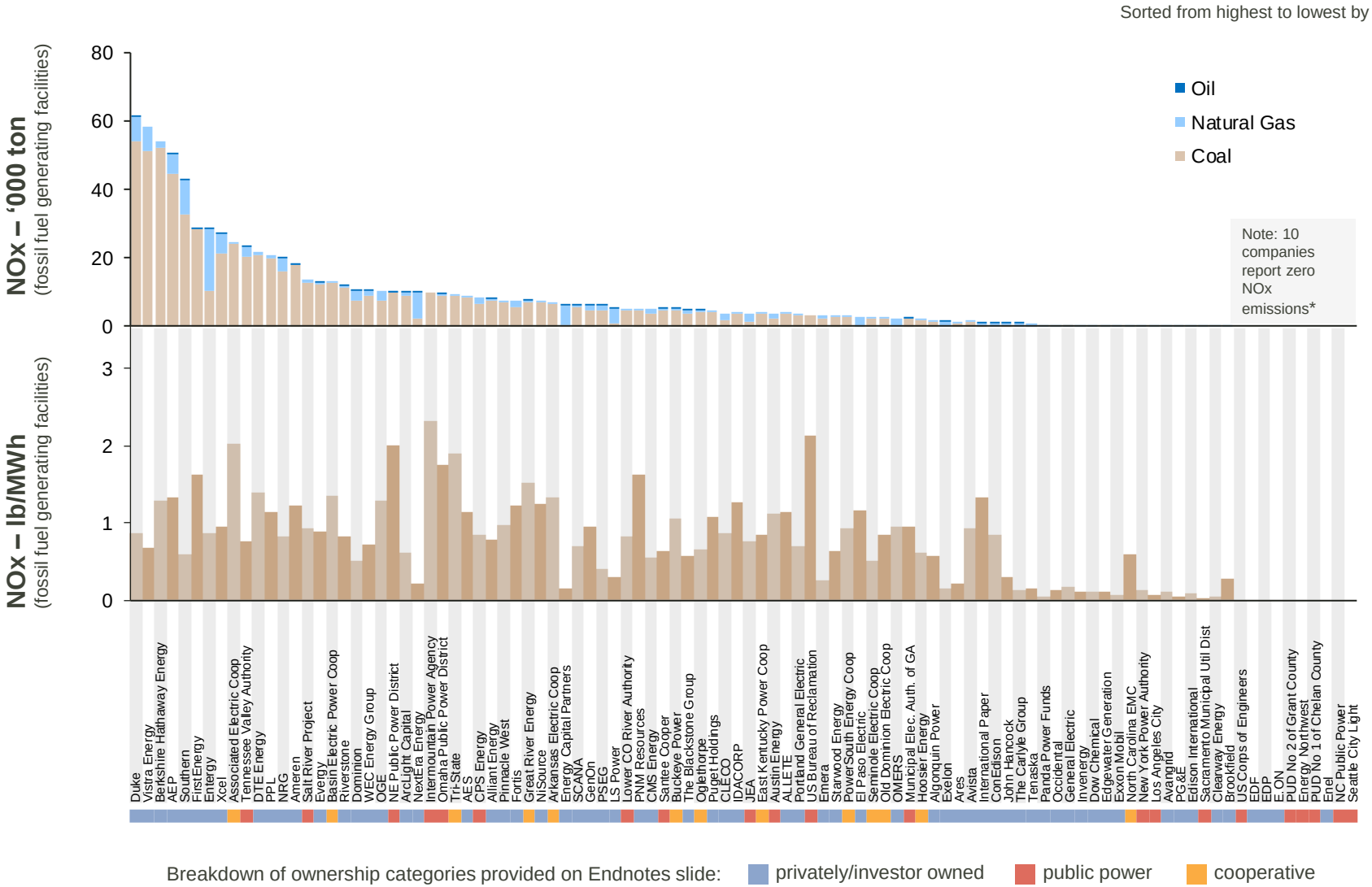
*companies with zero emissions are ordered based on total generation

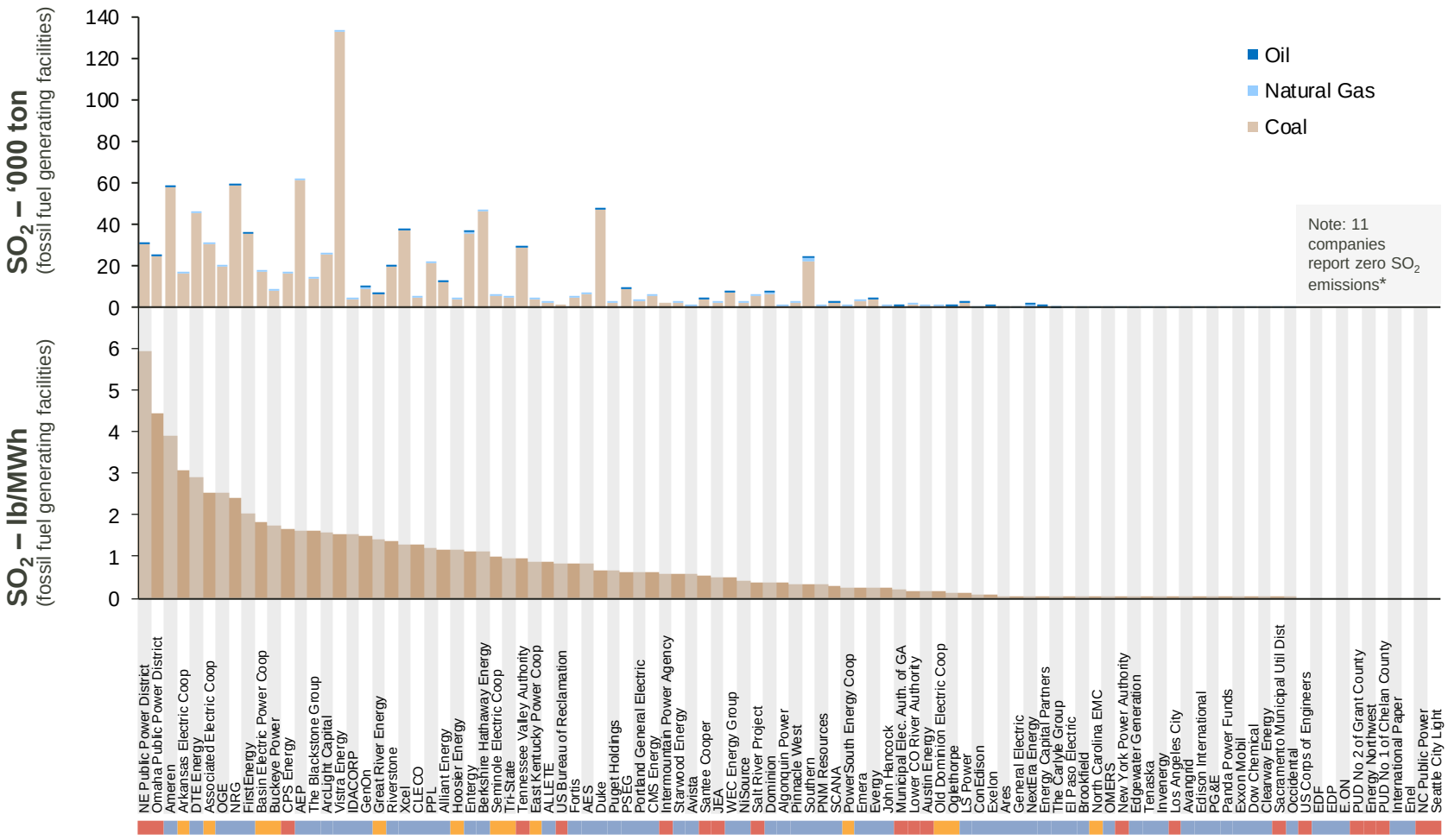
NOx: Total Emissions and Emission Rates



*companies with zero emissions are ordered based on total generation

SO_2: Total Emissions and Emission Rates

Sorted from highest to lowest by emission rate



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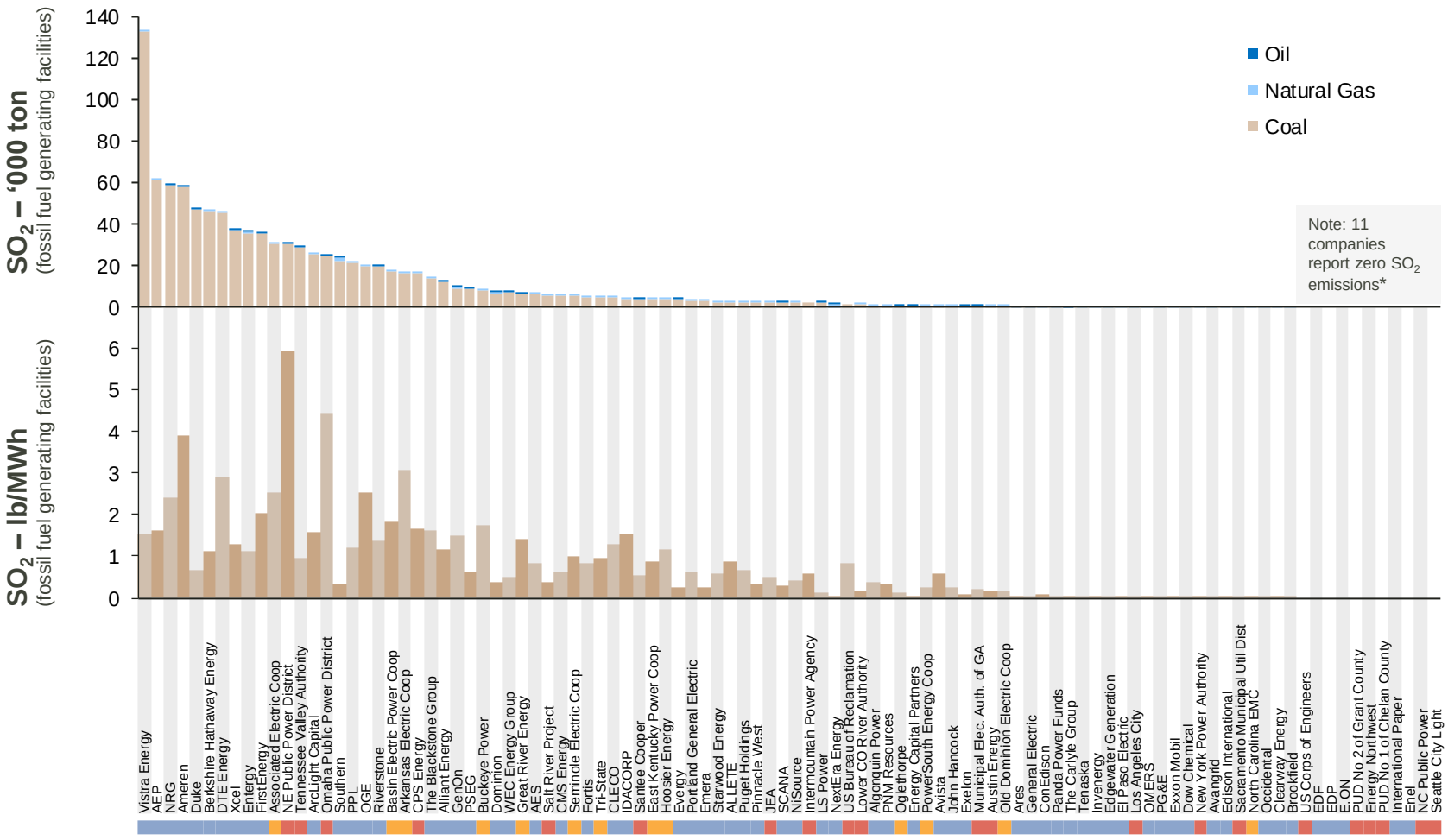
SO_2: Total Emissions and Emission Rates

Sorted from highest to lowest by total emission



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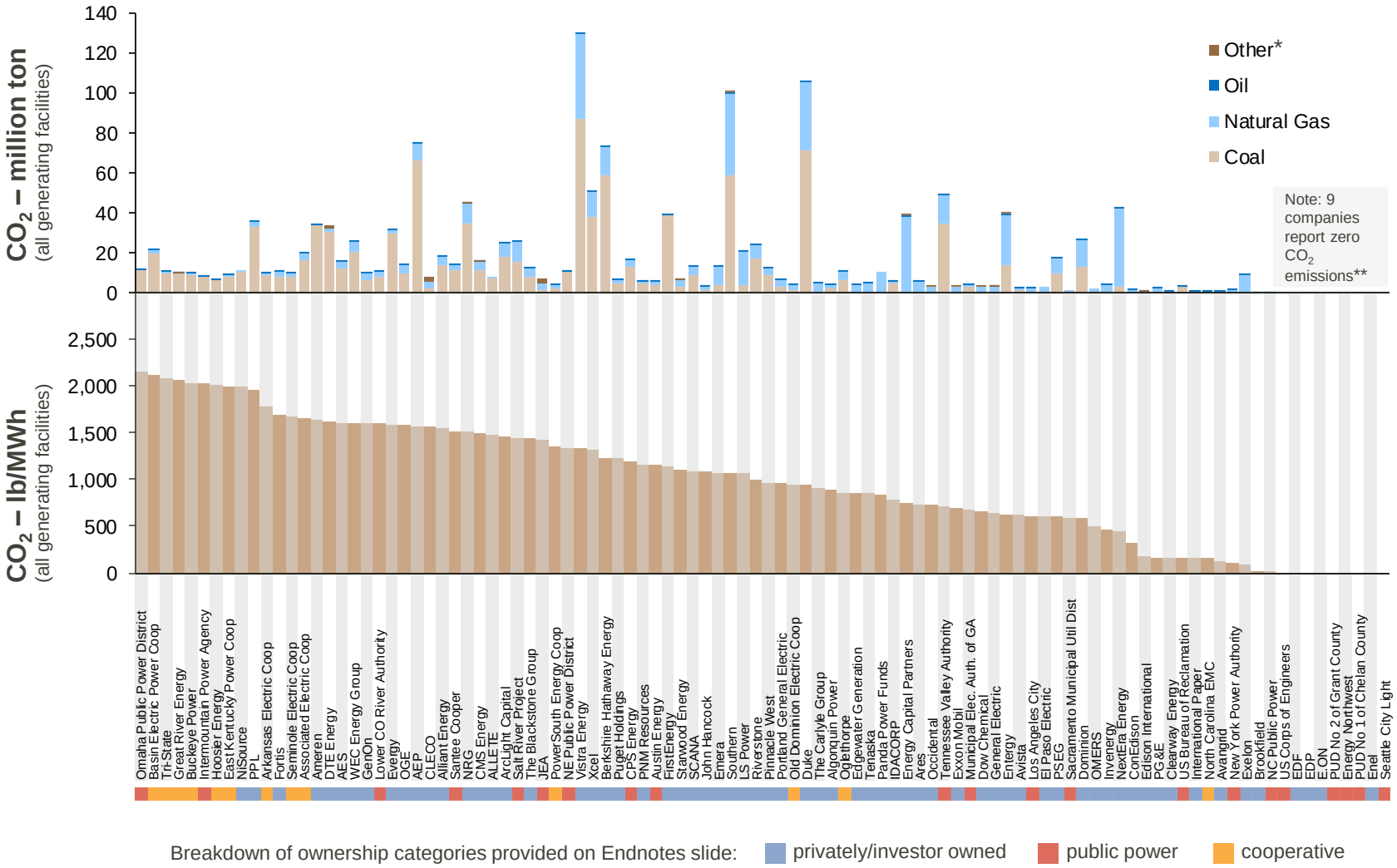
CO_2: Total Emissions and Emission Rates

Sorted from highest to lowest by emission rate



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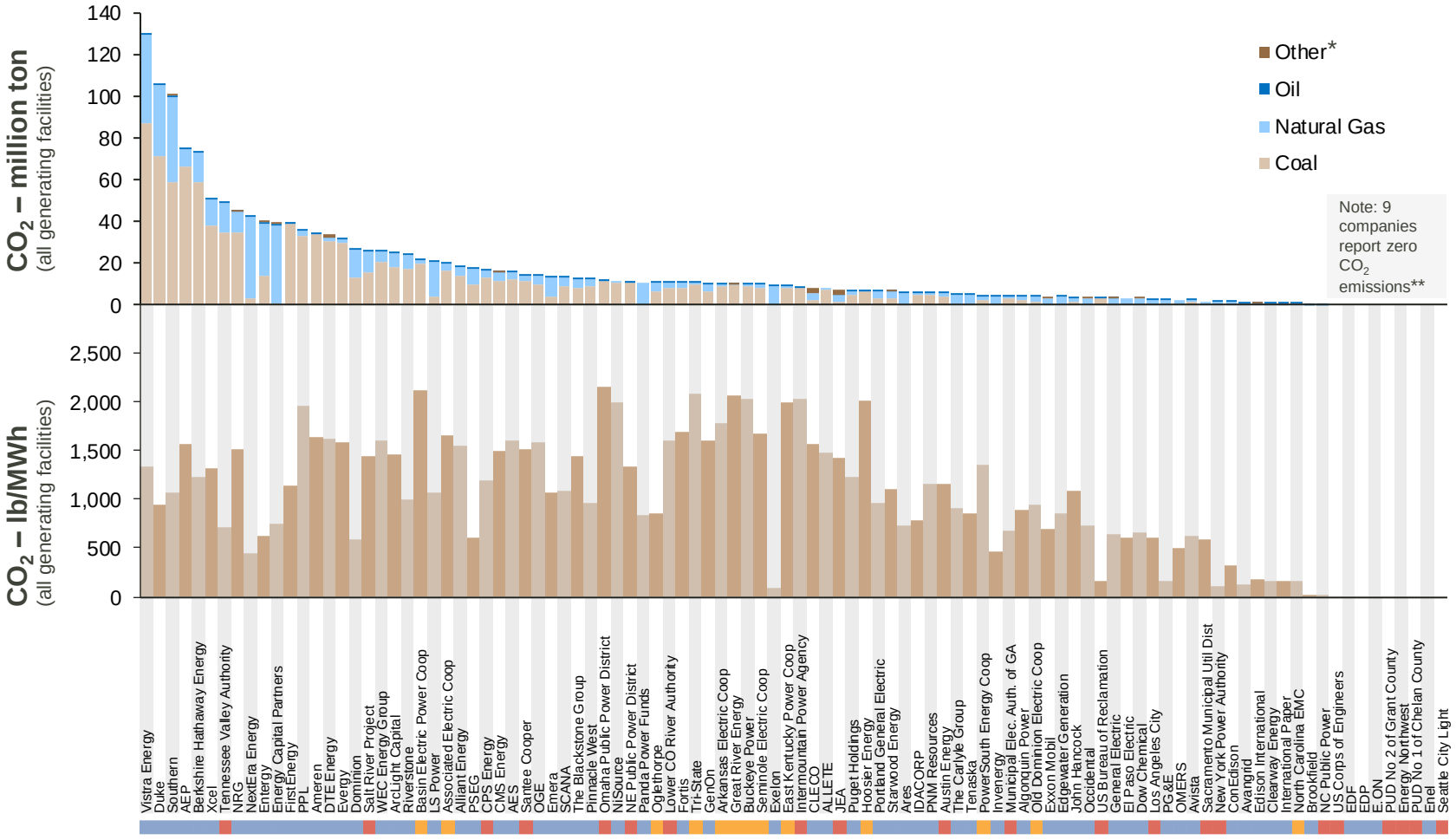
Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States
Data tables and maps at: www.mjbradley.com
July 2020

*includes wood/biomass, black liquor, MSW, landfill gas, and petroleum coke, among others
**companies with zero emissions are ordered based on total generation

CO_2: Total Emissions and Emission Rates

Sorted from highest to lowest by total emission



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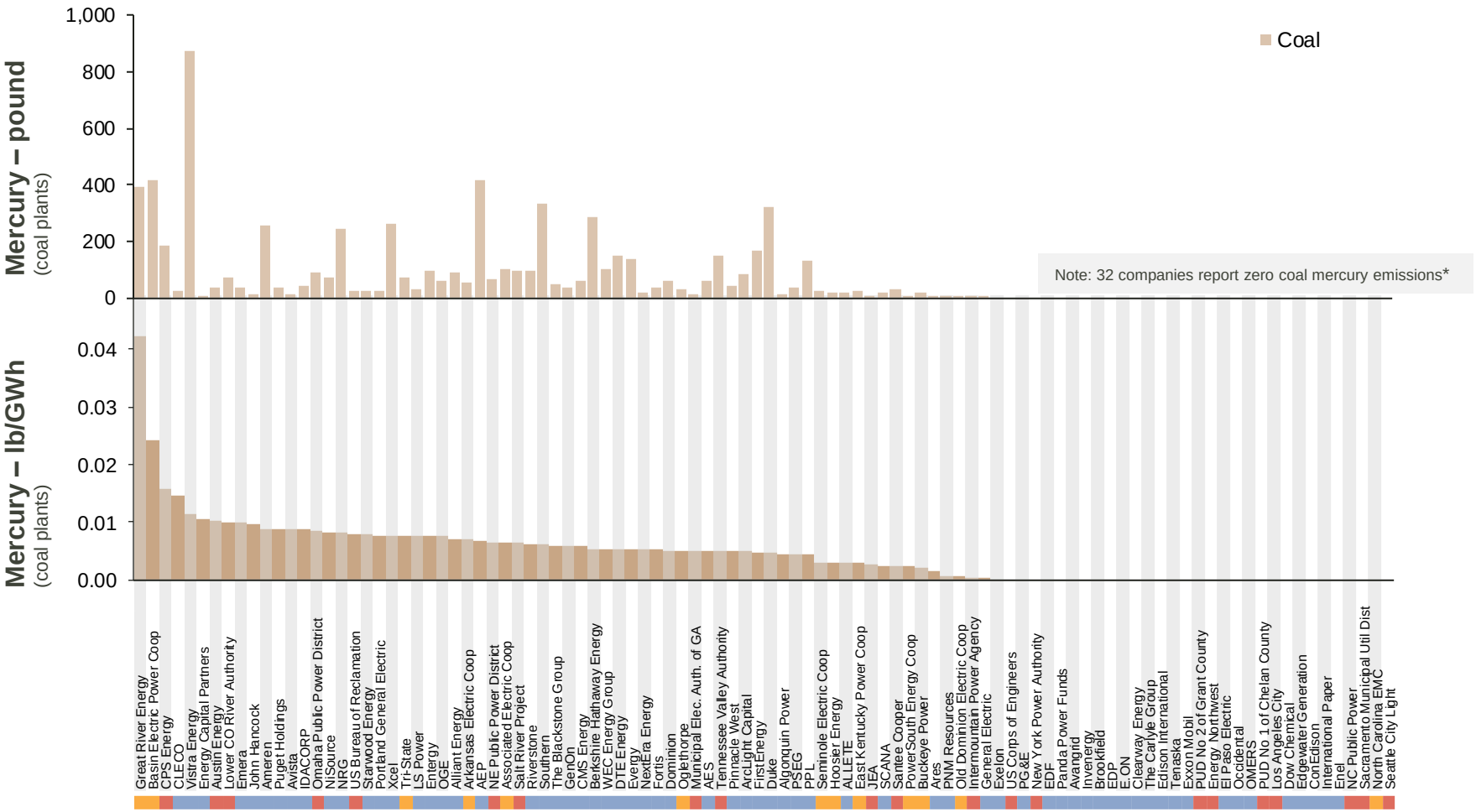
**companies with zero emissions are ordered based on total generation

Mercury: Total Emissions and Emission Rates

Sorted from highest to lowest by emission rate



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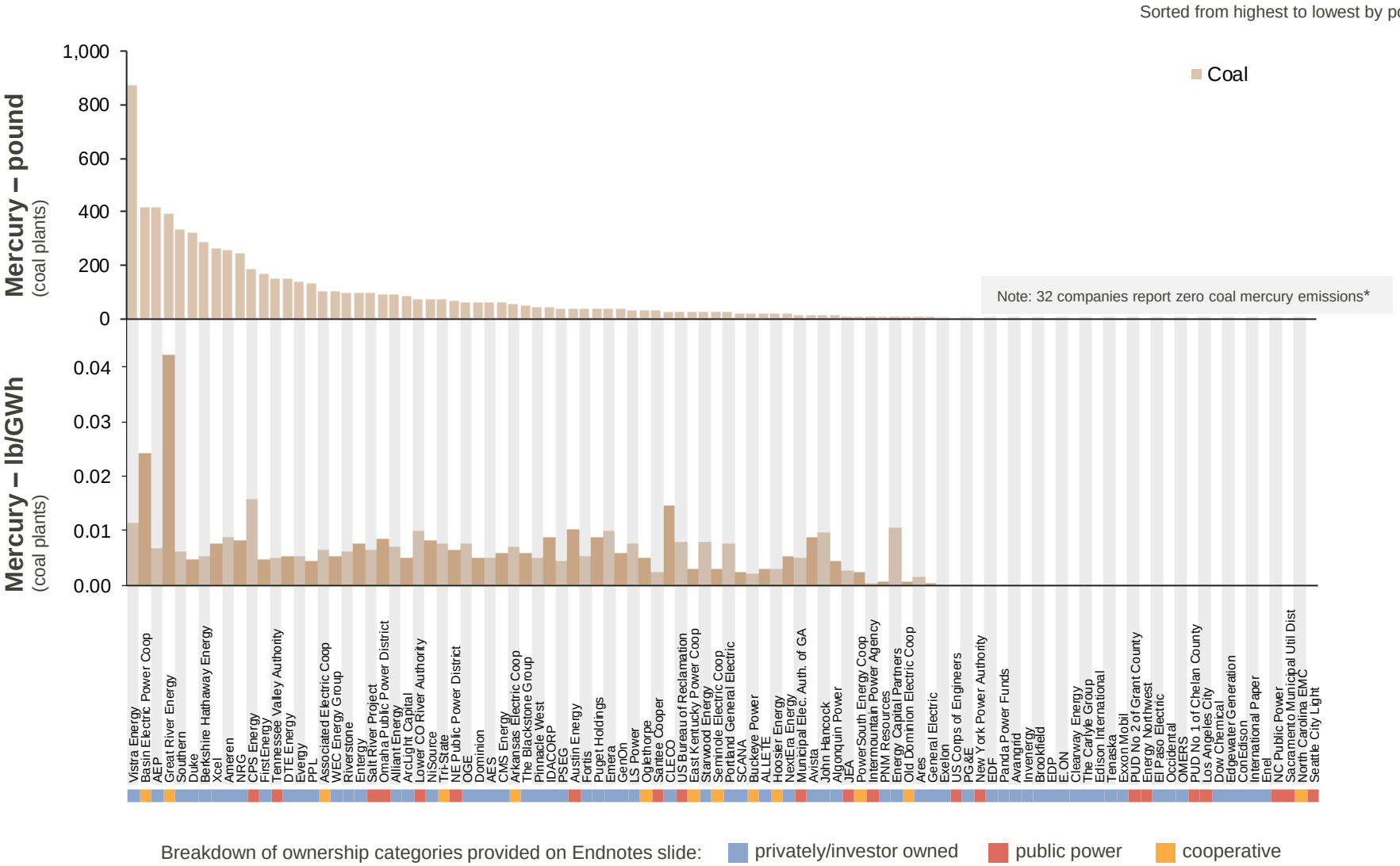
Mercury: Total Emissions and Emission Rates



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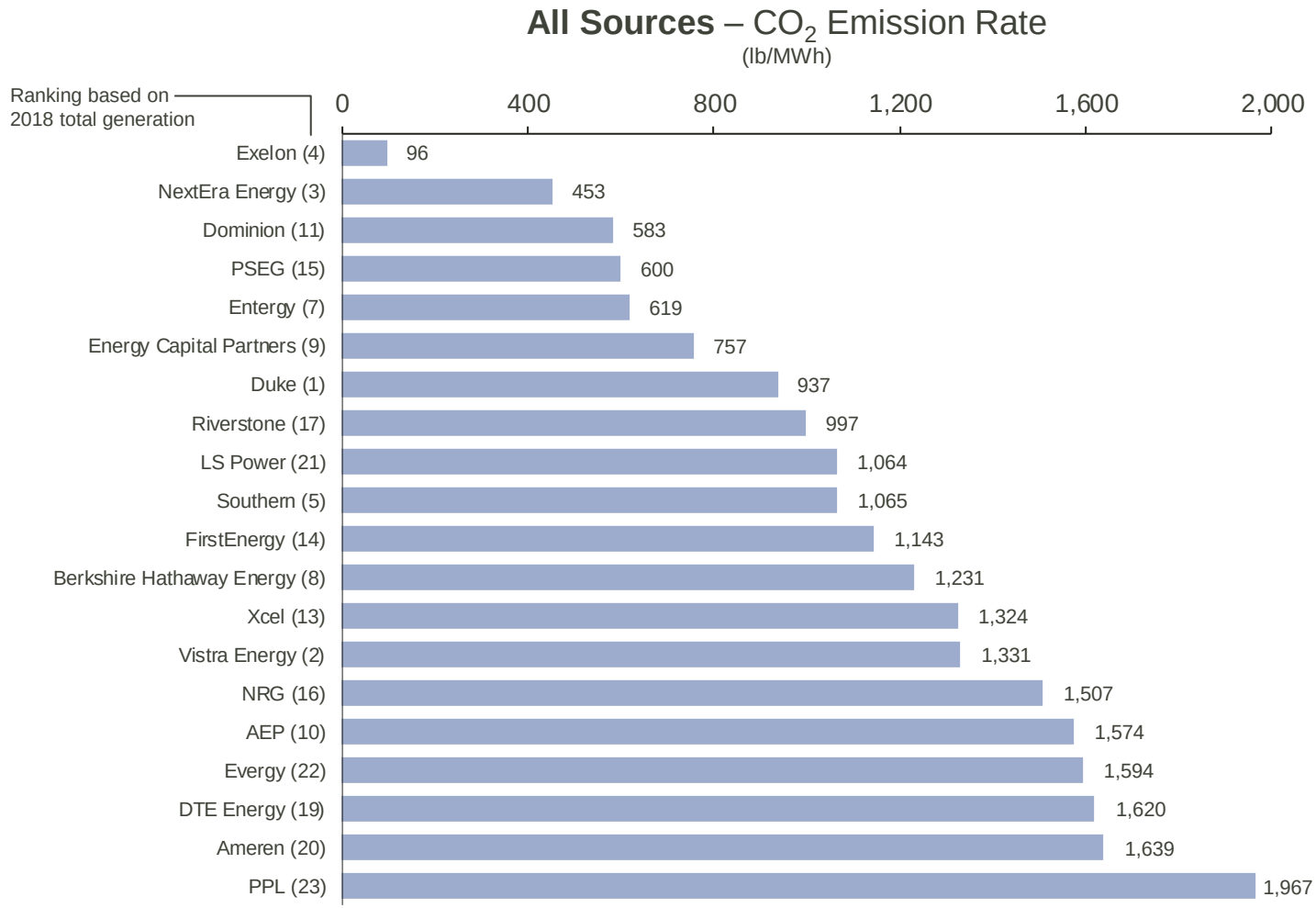
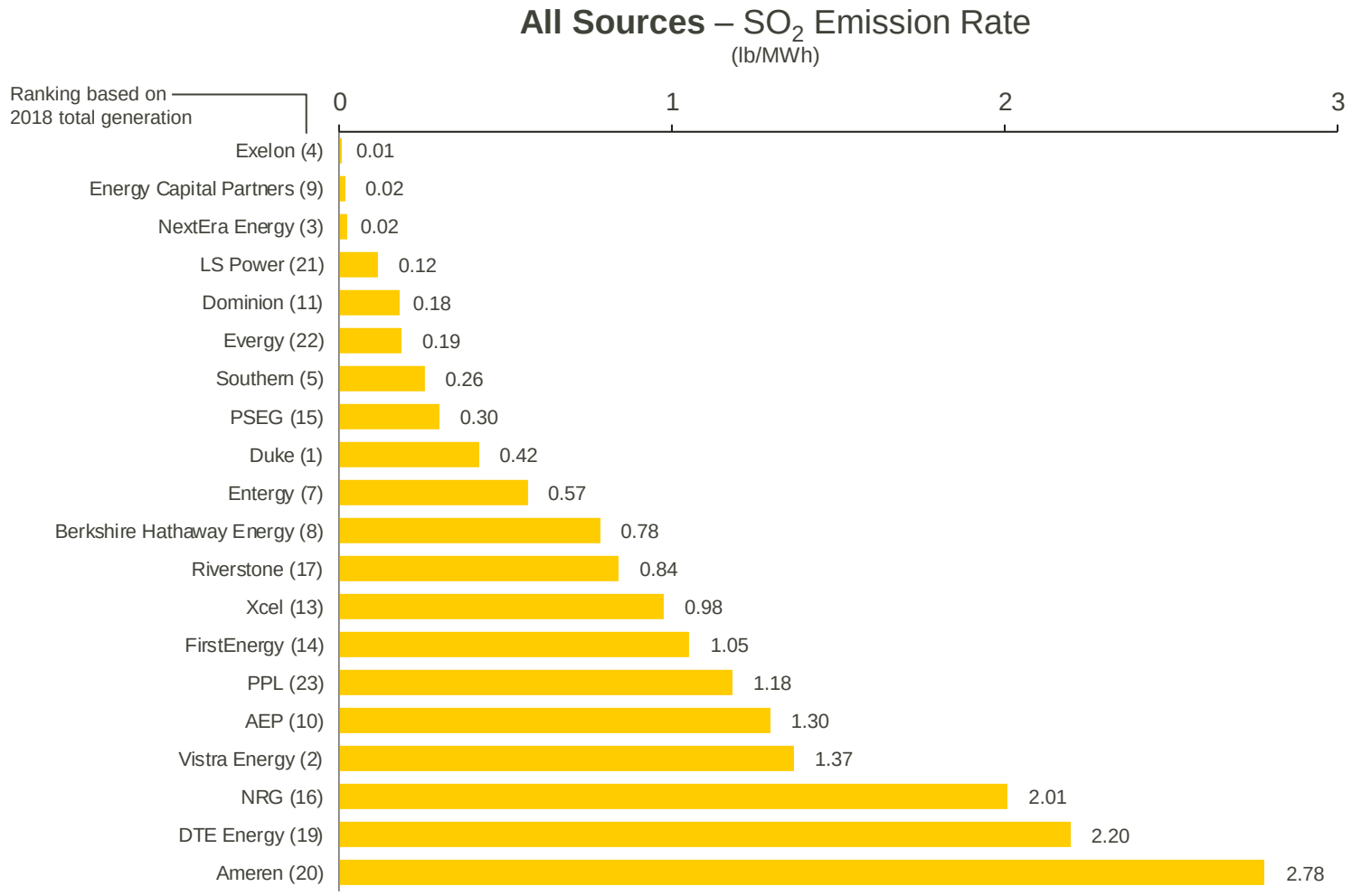
Rankings by CO_2 Emission Rate
(Top 20 Privately/Investor Owned Power Producers)



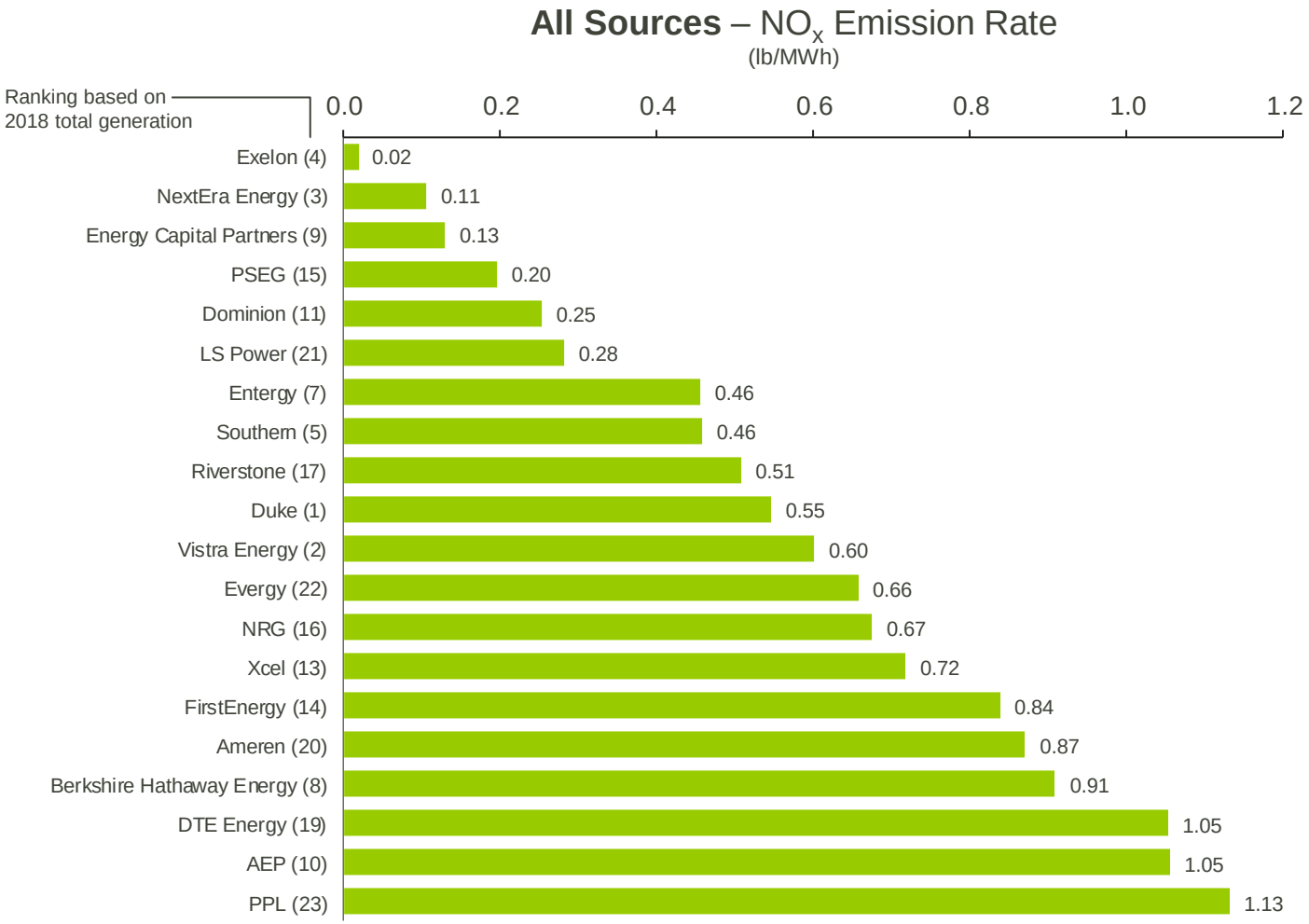
Note: "Privately/investor owned" power producers include investor owned, privately held, and foreign owned corporations. This chart does not show public power producers (federal power authorities, state power authorities, municipalities, power districts) or cooperatives.

Rankings by SO_2 Emission Rate
(Top 20 Privately/Investor Owned Power Producers)



Note: "Privately/investor owned" power producers include investor owned, privately held, and foreign owned corporations. This chart does not show public power producers (federal power authorities, state power authorities, municipalities, power districts) or cooperatives.

Rankings by NO_x Emission Rate
(Top 20 Privately/Investor Owned Power Producers)

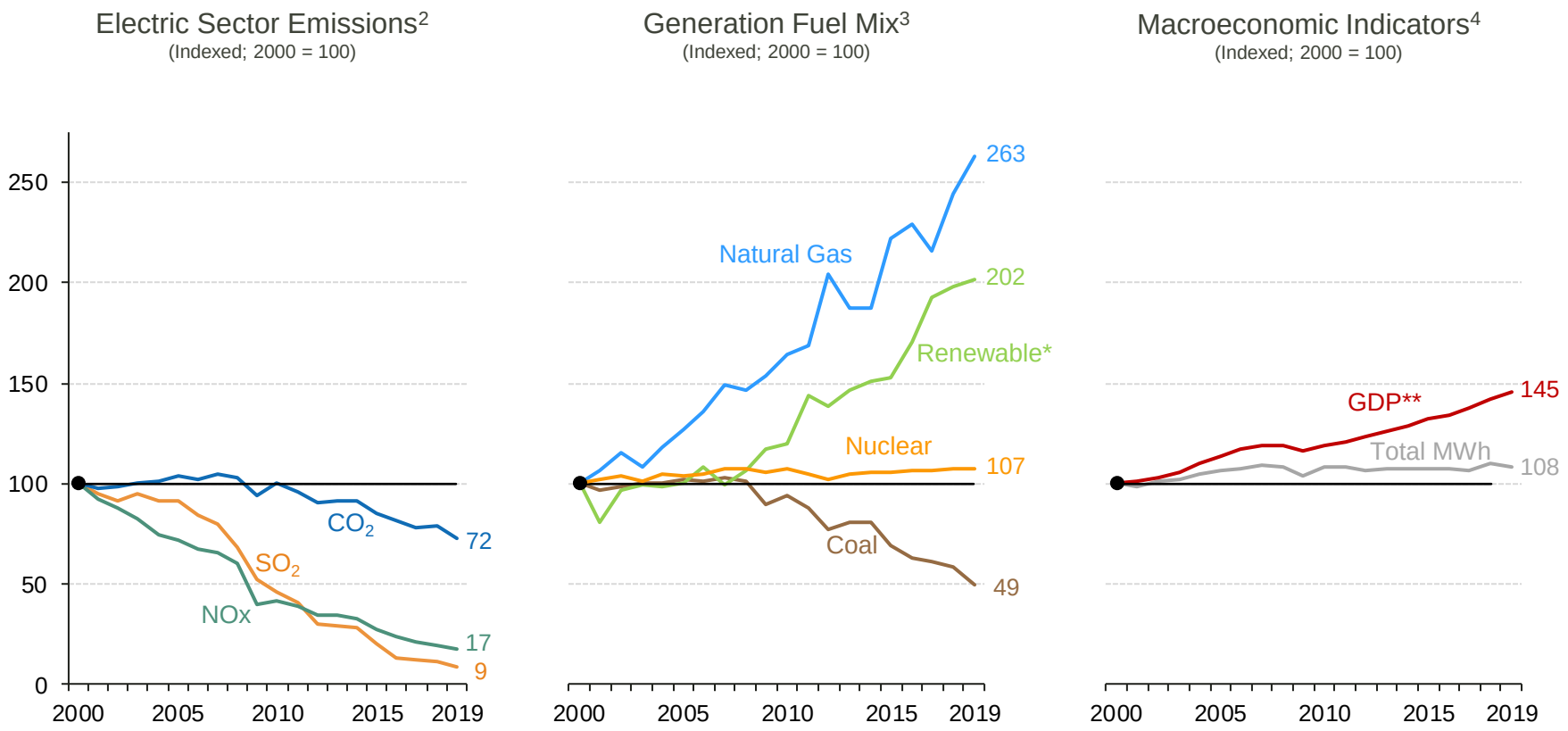


Note: "Privately/investor owned" power producers include investor owned, privately held, and foreign owned corporations. This chart does not show public power producers (federal power authorities, state power authorities, municipalities, power districts) or cooperatives.

Section III

Emissions Trends Analysis

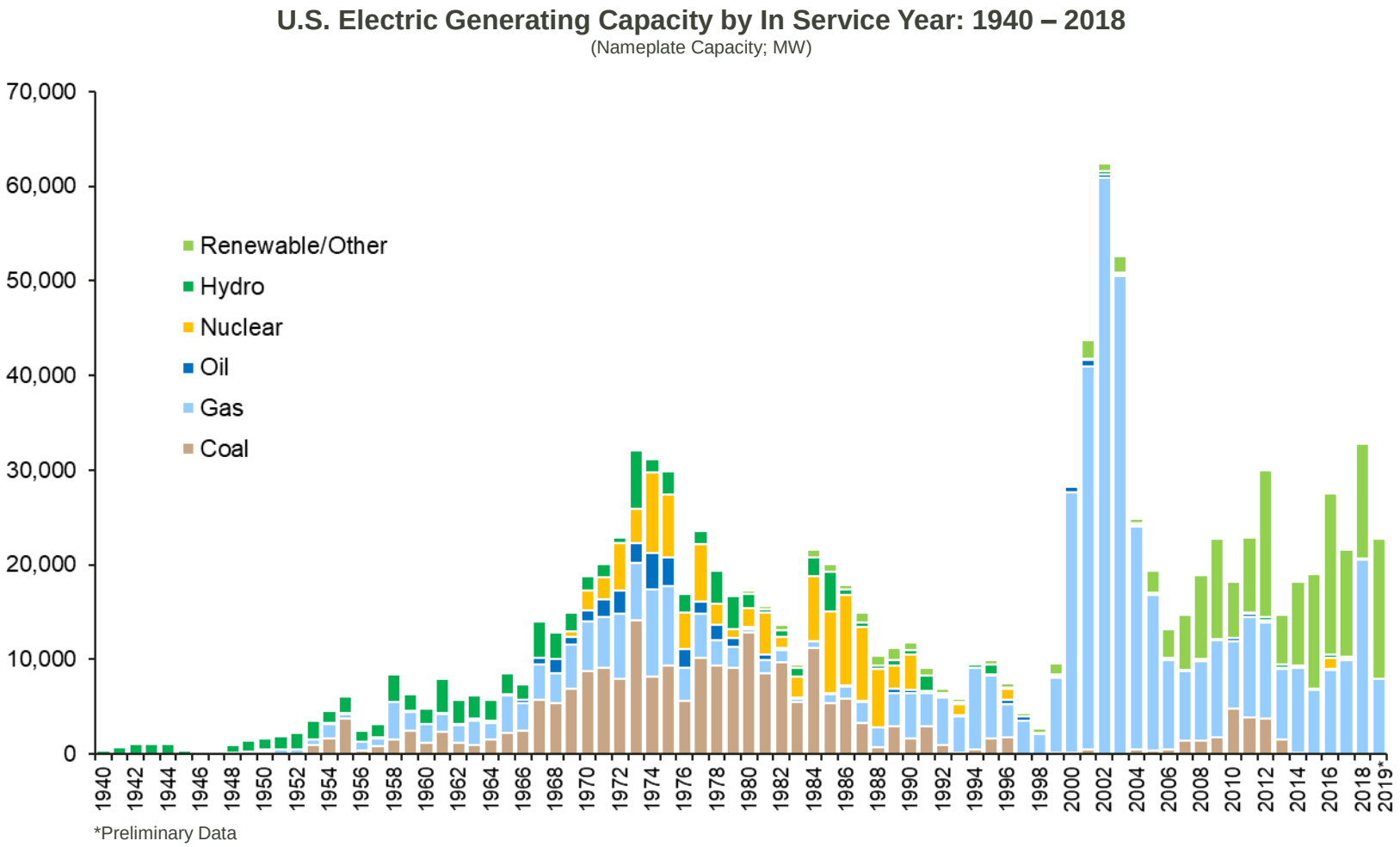
Annual Trends: U.S. Electric Sector



*Includes hydroelectric, wind, solar, biomass, geothermal, and other renewable sources.
**GDP in chained 2012 dollars.

The electric power sector has made significant progress in terms of reducing its NOx and SO_2 emissions. From 2000 through 2019, NOx and SO_2 emissions decreased 83 and 91 percent, respectively. From 2000 to 2019, CO_2 emissions decreased 28 percent while GDP grew 45 percent. Over the same period, generation from renewables doubled.[5]

Existing Capacity



Source: U.S. Energy Information Administration. EIA-860 Annual Electric Generator Report. September 3, 2019.

Average Capacity Factors

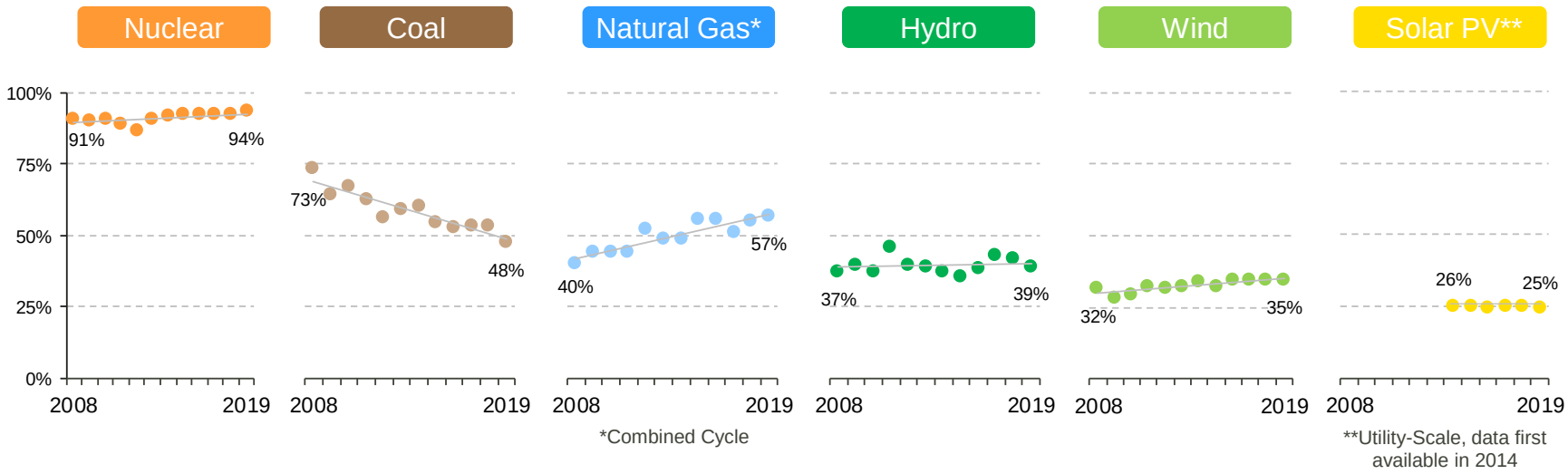
Annual Capacity Factors for Select Fuels and Technologies

Capacity factors measure the extent to which a power plant is utilized over the course of time. The technical definition is the ratio of the electrical energy produced by a generating unit to the electrical energy that could have been produced assuming continuous full power operation.

Coal plant utilization has declined in recent years; the average annual capacity factor of coal plants in the U.S. dropped from 73 percent in 2008 to 48 percent in 2019, while over the same time period, natural gas combined-cycle capacity factors rose from 40 to 57 percent.

Nuclear plants have high utilization rates, consistently running at above 90 percent average capacity factor. Hydropower capacity factors are lower but have also remained relatively constant over the past decade.

Wind capacity factors have increased from 32 percent in 2008 to 35 percent in 2019, largely due to improvements in wind turbine technology. Since EIA began publishing data for utility-scale solar projects in 2014, annual capacity factors have remained steady at around 26 percent.



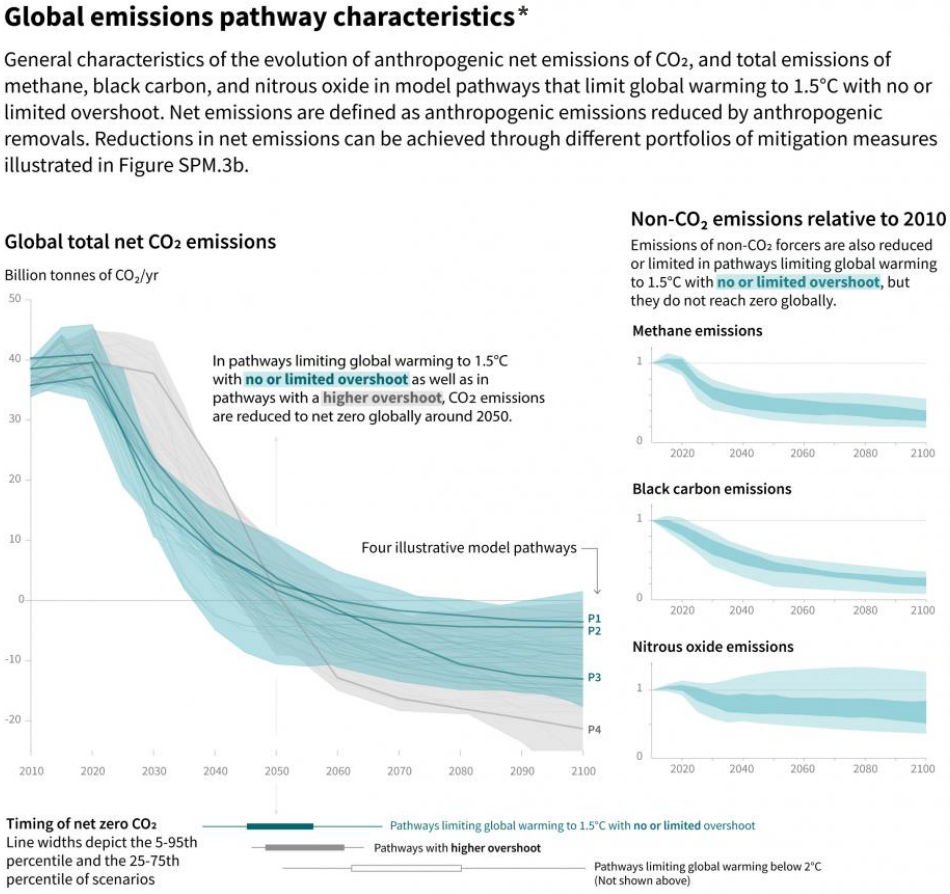
Source: U.S. Energy Information Administration. Electric Power Monthly, Tables 6.7A and 6.7B. February 26, 2020.

Deep Decarbonization

In late 2018, the Intergovernmental Panel on Climate Change (IPCC) published a special report evaluating the goal of maintaining global average temperature increases to less than 1.5°C above pre-industrial levels. According to the report, in order to limit warming to 1.5°C with limited overshoot, net global CO_2 emissions will need to decline by about 45 percent from 2010 levels by 2030 and reach "net zero" by around 2050. To limit warming to less than 2°C, CO_2 emissions would need to decline 20 percent by 2030 and reach net zero around 2075.

The graphic to the right illustrates the steep reductions in CO_2 (left) and other greenhouse gases (right) that the IPCC models are necessary to limit global warming to 1.5°C. The blue lines chart pathways to meet the goal with little or no overshoot. The gray areas illustrate pathways that overshoot the target, but then come back down.

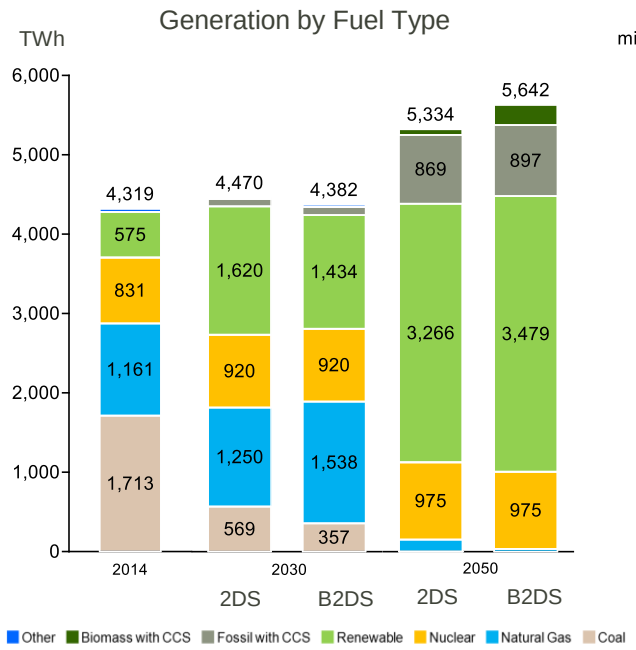
Electric power companies in the U.S. have been evaluating these "deep decarbonization" pathways to understand the potential implications for their business plans and operations. In some cases, companies have announced commitments and specific strategies to reduce their carbon emissions in line with these 2°C and 1.5°C global emissions pathways.

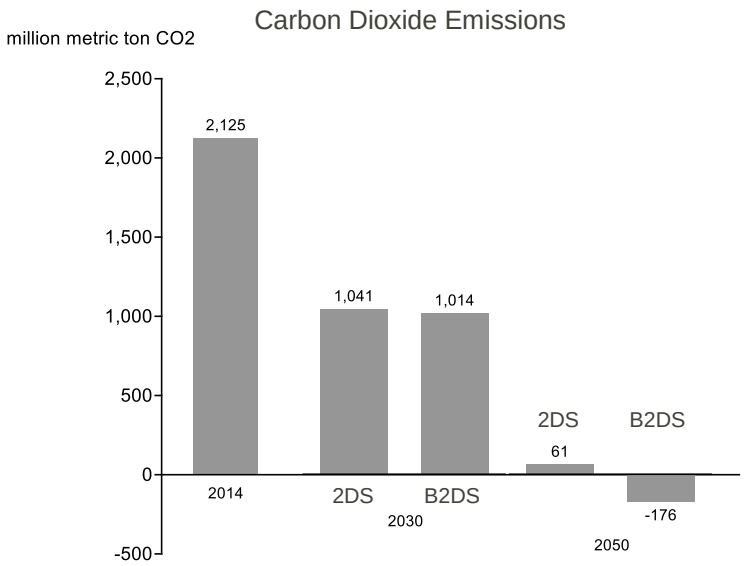


*Graphic reprinted from 2018 IPCC Special Report on Global Warming of 1.5°C

Deep Decarbonization, continued

The International Energy Agency's (IEA) Energy Technology Perspectives 2017, for example, includes two deep decarbonization pathways that are specific to the U.S. electric sector. The chart below compares IEA's projections of U.S. electric sector CO_2 emissions and the generation fuel mix for its "2°C Scenario" as well as its "Beyond 2°C Scenario". These scenarios assume that electricity will account for an increasing share of the nation's energy use due to the electrification of transportation and other sectors of the economy. Electricity generation increases 24% percent by 2050, under the 2°C Scenario and 31% under the Beyond 2°C Scenario. In order to achieve net negative emissions, the Beyond 2°C Scenario, assumes more biomass combustion with carbon capture, more renewables, and less gas-fired generation in 2050. Also included are the average CO_2 emission rates for the electric sector from the two abatement scenarios. Note that these are illustrative scenarios; there are other combinations of technologies and fuel use to achieve these same long-term emissions targets.





All Source CO_2 Emission Rates†
pounds per megawatt hour

U.S. electric sector (2017):
957

IEA B2DS and 2DS (2030):
510 to 514

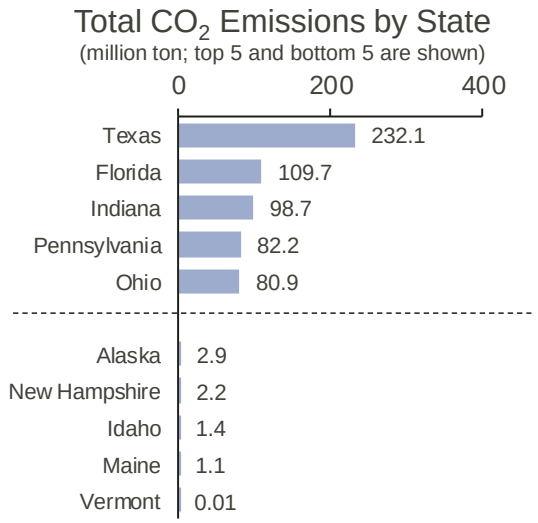
IEA B2DS and 2DS (2050):
-69 to 25

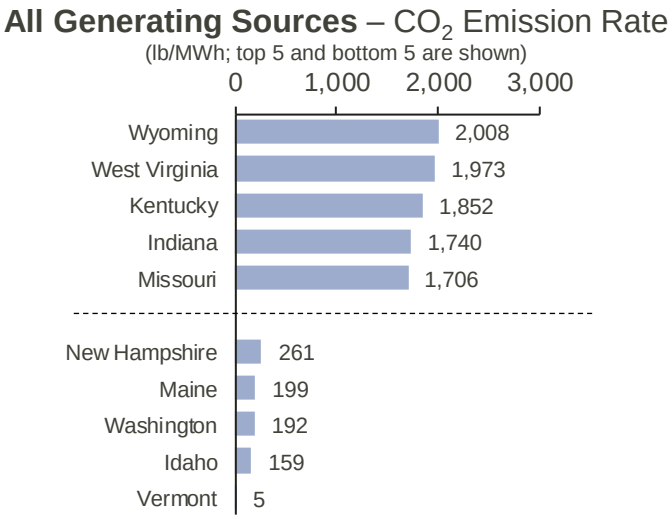
†All sources include fossil, nuclear, hydroelectric, and renewable generation.

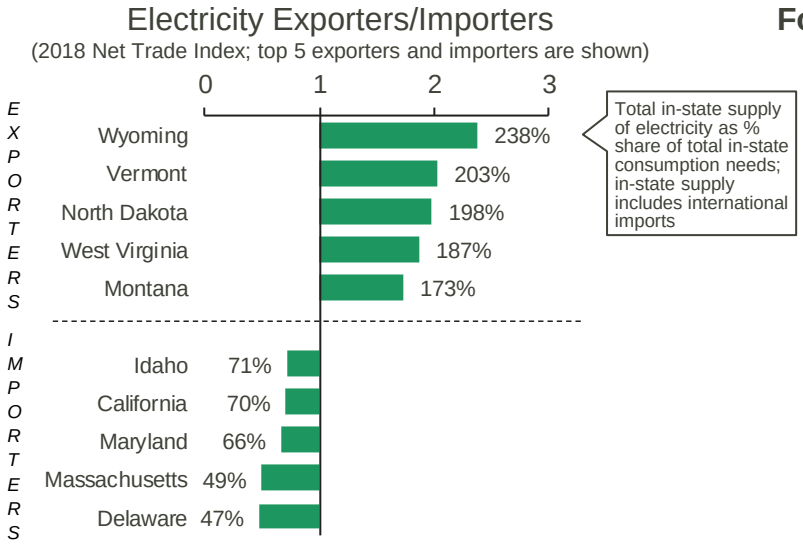
Section IV

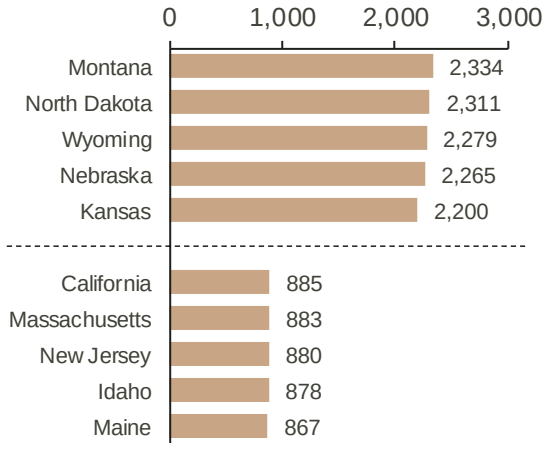
State-by-State Emissions Summary

State-by-State CO_2 Emissions: U.S. Electric Sector, 2018









Section V

Fuel Mix of 100 Largest Power Producers in 2018

Fuel Mix of 100 Largest Power Producers, 2018

Rank	Holding Company	Total (million MWh)	Share of Total					
			Coal	Gas	Oil	Nuclear	Hydro	Renewable / Other
1	Duke	226.5	30%	32%	0.3%	32%	2%	4%
2	Vistra Energy	194.9	40%	49%	0.1%	11%	0%	0%
3	NextEra Energy	190.4	2%	48%	0.3%	27%	0%	23%
4	Exelon	190.0	0%	11%	0.2%	86%	1%	2%
5	Southern	188.6	29%	50%	0.1%	16%	3%	2%
6	Tennessee Valley Authority	139.8	22%	23%	0.1%	44%	11%	0%
7	Entergy	128.3	10%	41%	0.0%	49%	0%	0%
8	Berkshire Hathaway Energy	119.2	44%	26%	0.1%	3%	3%	23%
9	Energy Capital Partners	104.0	0%	87%	0.5%	0%	0%	12%
10	AEP	95.1	65%	14%	0.2%	19%	1%	1%
11	Dominion	92.4	13%	33%	0.7%	47%	1%	5%
12	US Corps of Engineers	78.2	0%	0%	0.0%	0%	100%	0%
13	Xcel	76.3	45%	29%	0.0%	19%	1%	5%
14	FirstEnergy	68.2	51%	0%	0.2%	48%	0%	0%
15	PSEG	61.0	14%	32%	1.3%	51%	0%	1%
16	NRG	59.5	51%	31%	0.4%	15%	0%	2%
17	Riverstone	47.8	32%	29%	0.2%	39%	0%	0%
18	US Bureau of Reclamation	43.8	7%	0%	0.0%	0%	93%	0%
19	DTE Energy	41.9	66%	7%	0.2%	18%	0%	9%
20	Ameren	41.5	70%	1%	0.0%	26%	3%	0%
21	LS Power	39.9	10%	86%	0.4%	0%	0%	3%
22	Evergy	39.7	67%	6%	0.2%	22%	0%	5%
23	PPL	36.6	82%	17%	0.1%	0%	1%	0%
24	Salt River Project	35.7	41%	44%	0.1%	15%	0%	0%
25	ArcLight Capital	34.7	51%	45%	0.2%	0%	5%	0%
26	PG&E	32.7	0%	19%	0.0%	56%	24%	1%
27	WEC Energy Group	31.6	59%	34%	0.1%	0%	3%	4%
28	CPS Energy	28.1	42%	29%	0.0%	29%	0%	0%
29	New York Power Authority	27.8	0%	11%	0.4%	0%	89%	0%
30	EDF	26.6	0%	0%	0.0%	62%	0%	38%

Fuel Mix of 100 Largest Power Producers, 2018

Rank	Holding Company	Total (million MWh)	Share of Total					
			Coal	Gas	Oil	Nuclear	Hydro	Renewable / Other
31	Panda Power Funds	25.8	0%	100%	0.0%	0%	0%	0%
32	Pinnacle West	25.6	33%	30%	0.0%	35%	0%	2%
33	Emera	25.1	14%	86%	0.0%	0%	0%	0%
34	Oglethorpe	25.1	22%	37%	0.1%	41%	0%	0%
35	Associated Electric Coop	24.4	64%	36%	0.0%	0%	0%	0%
36	SCANA	23.9	35%	41%	0.6%	21%	2%	1%
37	Alliant Energy	23.8	52%	38%	0.1%	0%	1%	9%
38	CMS Energy	21.8	45%	41%	0.1%	0%	2%	12%
39	Basin Electric Power Coop	20.1	85%	10%	0.1%	0%	0%	5%
40	Avangrid	19.9	0%	14%	0.0%	0%	1%	85%
41	AES	19.3	60%	22%	0.2%	0%	0%	17%
42	Santee Cooper	19.0	58%	27%	0.2%	13%	1%	0%
43	Invenergy	19.0	0%	55%	0.0%	0%	0%	45%
44	OGE	17.3	48%	44%	0.1%	0%	0%	8%
45	The Blackstone Group	17.2	46%	54%	0.1%	0%	0%	0%
46	Ares	16.2	1%	88%	0.2%	0%	0%	10%
47	NE Public Power District	16.1	60%	3%	0.0%	35%	1%	1%
48	Brookfield	15.9	0%	1%	0.0%	0%	68%	31%
49	EDP	14.9	0%	0%	0.0%	0%	0%	100%
50	IDACORP	14.7	31%	10%	0.0%	0%	60%	0%
51	Portland General Electric	13.8	21%	55%	0.0%	0%	11%	14%
52	Lower CO River Authority	13.5	54%	44%	0.1%	0%	2%	0%
53	GenOn	12.9	45%	54%	1.2%	0%	0%	0%
54	Fortis	12.4	58%	40%	0.1%	0%	1%	1%
55	NiSource	12.0	74%	25%	0.0%	0%	0%	0%
56	Municipal Elec. Auth. of GA	11.9	23%	17%	0.0%	59%	0%	0%
57	E.ON	11.6	0%	0%	0.0%	0%	0%	100%
58	Clearway Energy	11.6	0%	15%	0.1%	0%	0%	85%
59	The Carlyle Group	11.6	0%	99%	0.9%	0%	0%	0%
60	Edison International	11.5	0%	19%	0.2%	43%	30%	8%

Fuel Mix of 100 Largest Power Producers, 2018

Rank	Holding Company	Total (million MWh)	Share of Total					
			Coal	Gas	Oil	Nuclear	Hydro	Renewable / Other
61	Arkansas Electric Coop	11.5	70%	25%	0.1%	0%	5%	0%
62	Tenaska	11.4	0%	95%	0.1%	0%	0%	5%
63	Starwood Energy	11.4	27%	58%	0.1%	0%	0%	15%
64	Seminole Electric Coop	11.3	68%	32%	0.2%	0%	0%	0%
65	Omaha Public Power District	11.1	97%	2%	0.1%	0%	0%	0%
66	Puget Holdings	11.0	37%	37%	0.1%	0%	8%	17%
67	CLECO	11.0	16%	59%	0.0%	0%	0%	24%
68	Exxon Mobil	10.8	0%	90%	0.0%	0%	0%	10%
69	Tri-State	10.1	90%	9%	0.1%	0%	0%	1%
70	PUD No 2 of Grant County	10.1	0%	0%	0.0%	0%	100%	0%
71	Energy Northwest	10.0	0%	0%	0.0%	97%	1%	2%
72	El Paso Electric	10.0	0%	51%	0.0%	49%	0%	0%
73	JEA	9.9	18%	67%	0.4%	0%	0%	15%
74	PNM Resources	9.9	41%	24%	0.1%	32%	0%	3%
75	ALLETE	9.8	65%	0%	0.0%	0%	6%	28%
76	Great River Energy	9.8	95%	4%	0.1%	0%	0%	2%
77	Occidental	9.8	0%	99%	0.0%	0%	0%	1%
78	Austin Energy	9.8	38%	28%	0.1%	34%	0%	0%
79	Buckeye Power	9.6	93%	7%	0.3%	0%	0%	0%
80	OMERS	9.5	0%	56%	0.0%	0%	0%	44%
81	General Electric	9.5	3%	67%	0.1%	0%	1%	30%
82	PUD No 1 of Chelan County	9.3	0%	0%	0.0%	0%	100%	0%
83	Los Angeles City	9.3	0%	70%	0.0%	19%	8%	3%
84	Dow Chemical	9.0	0%	88%	0.0%	0%	0%	12%
85	East Kentucky Power Coop	8.9	92%	6%	0.3%	0%	0%	2%
86	Algonquin Power	8.8	24%	40%	0.2%	0%	1%	35%
87	Edgewater Generation	8.7	0%	99%	0.5%	0%	0%	0%
88	ConEdison	8.7	0%	34%	0.4%	0%	0%	66%
89	Intermountain Power Agency	8.5	100%	0%	0.2%	0%	0%	0%
90	Old Dominion Electric Coop	8.2	18%	59%	0.7%	23%	0%	0%

Fuel Mix of 100 Largest Power Producers, 2018

Rank	Holding Company	Total (million MWh)	Share of Total					
			Coal	Gas	Oil	Nuclear	Hydro	Renewable / Other
91	International Paper	8.2	0%	22%	0.7%	0%	0%	77%
92	Enel	7.8	0%	0%	0.0%	0%	10%	90%
93	Avista	7.4	18%	23%	0.0%	0%	55%	5%
94	NC Public Power	7.0	0%	0%	0.0%	100%	0%	0%
95	Sacramento Municipal Util Dist	6.8	0%	72%	0.0%	0%	19%	9%
96	North Carolina EMC	6.7	0%	13%	0.5%	86%	0%	0%
97	John Hancock	6.7	18%	82%	0.1%	0%	0%	0%
98	Hoosier Energy	6.6	89%	10%	0.1%	0%	0%	1%
99	PowerSouth Energy Coop	6.4	31%	69%	0.2%	0%	0%	0%
100	Seattle City Light	6.4	0%	0%	0.0%	0%	100%	0%
	Total (top-100 producers)	3,415.7	28%	34%	0.2%	23%	7%	8%
	Total (all U.S. producers)	4,164.6	27%	35%	0.4%	19%	7%	11%

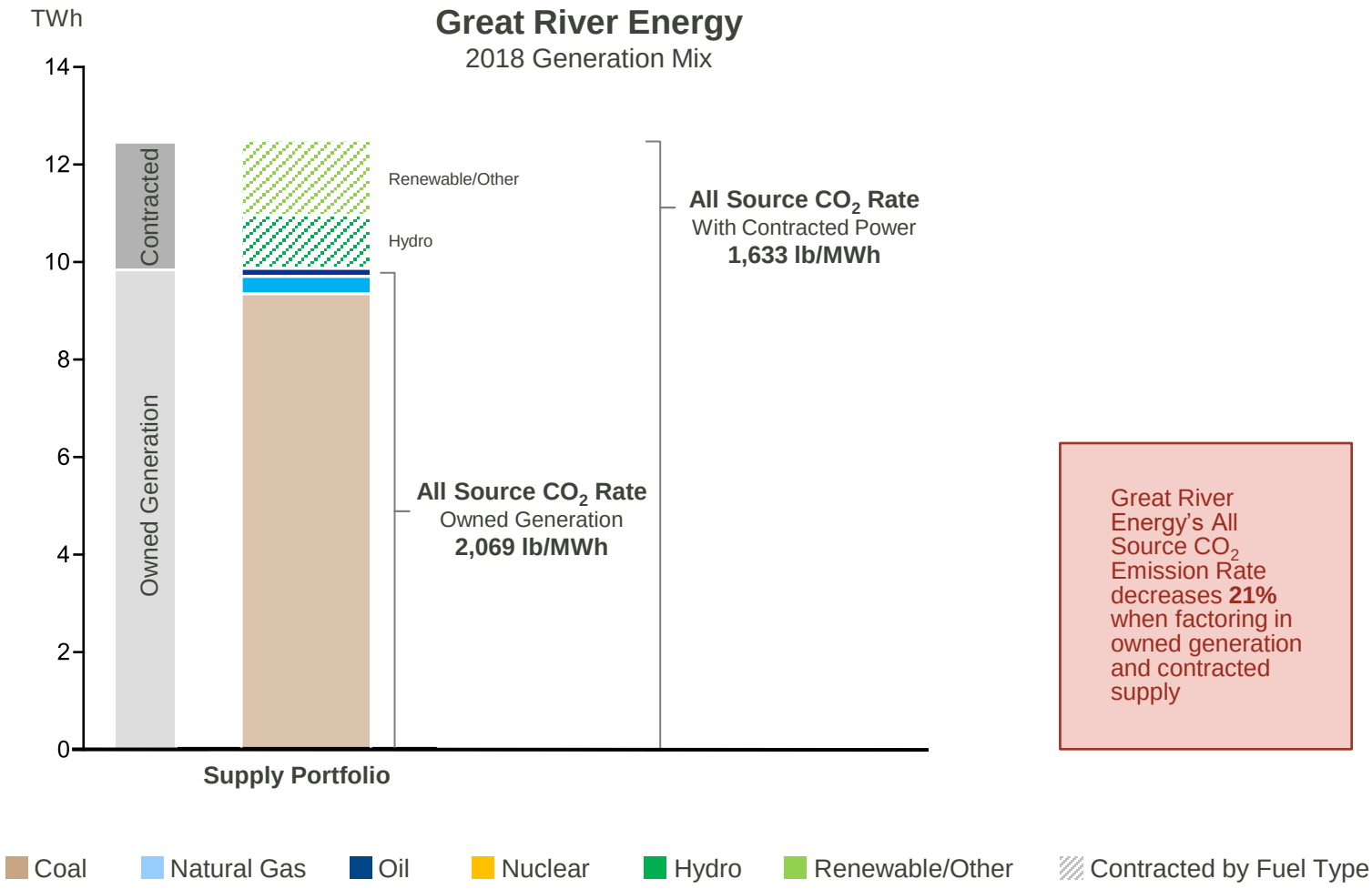
Section VI

Appendix

Ranking Utility Portfolios

- As described above, the Benchmarking Report presents generation and emissions information of power producers, not utility companies with obligations to deliver electricity to customers. In order to apply a uniform methodology to all power producers, the Report assigns electricity generation and associated emissions to power producers according to their known generating asset ownership as of December 31, 2018.
- If a power producer is also a distribution utility, the fuel mix and emissions associated with the utility's total supply portfolio may differ substantially from its owned generation, depending on the nature and extent of any power purchase agreements and other contractual agreements to which the utility may be party. The distribution utility might also rely on market purchases to supply its customers (e.g., purchases from the PJM or MISO markets). A power producer might also sell excess supply to the market or to other utilities.
- To highlight the potential implications of these two different approaches, the following slide presents the generation mix and all source CO_2 emission rate for a rural electric cooperative—Great River Energy. The graph also reports the CO_2 emission rate associated with part of the company's supply portfolio (owned generation and long-term contracts); the supply portfolio emission rate does not reflect the emissions associated with market purchases, which may be fossil-fired, renewables, or other sources.
- In the example shown, the CO_2 emission rate associated with supply is lower because Great River Energy contracts for non-emitting, renewable resources rather than owning wind or solar projects. Rural cooperatives are non-profit entities that are generally unable to take advantage of renewable tax credits, so they will tend to purchase renewable energy under long-term contracts rather than owning the facilities.
- Both approaches—generation and supply—can be helpful in evaluating a company's performance. Unfortunately, there is no publicly available source for the data that would be required to benchmark utility resource portfolios in the same way that we can benchmark owned-generation assets.
- The following slide illustrates the All Source CO_2 emissions rates for Great River Energy. The company voluntarily supplied the information displayed. The charts include the emission rate for Owned Generation only (consistent with the focus and methodology of the Benchmarking report) as well as the All Source emission rate associated with the combination of owned generation and long-term contract purchases.

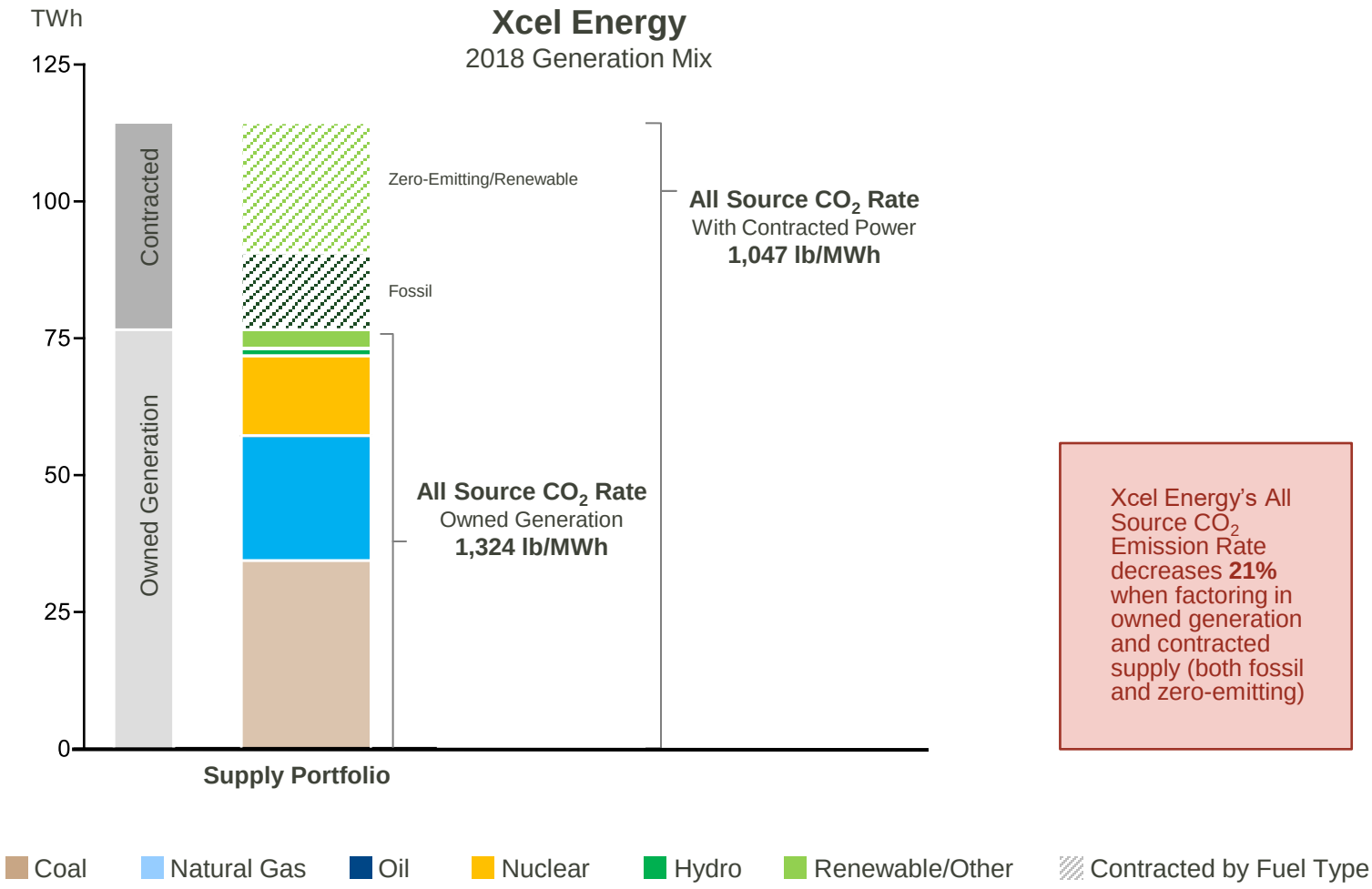
Case Study: Owned Generation and Contracted Supply



Great River Energy's All Source CO_2 Emission Rate decreases **21%** when factoring in owned generation and contracted supply

Note: additional supply may be obtained from market purchases; however, these data are not included here.

Case Study: Owned Generation and Contracted Supply



Note: contracted power includes long-term PPAs, and short-term and spot market purchases

Data Sources

The following public data sources were used to develop this report:

EPA AIR MARKETS PROGRAM DATA (AMP): EPA's Air Markets Program Data account for almost all of the SO_2 and NOx emissions, and about 20 percent of the CO_2 emissions analyzed in this report.

EPA TOXIC RELEASE INVENTORY (TRI): The 2018 mercury emissions used in this report are based on TRI reports submitted by facility managers.

EIA FORMS 923 POWER PLANT DATABASES (2018): EIA Form 923 provides data on the electric generation and heat input by fuel type for utility and non-utility power plants. The heat input data was used to calculate approximately 80 percent of the CO_2 emissions analyzed in this report.

EIA FORM 860 ANNUAL ELECTRIC GENERATOR REPORT (2018): EIA Form 860 is a generating unit level data source that includes information about generators at electric power plants, including information about generator ownership.

EPA U.S. INVENTORY OF GREENHOUSE GAS EMISSIONS AND SINKS (2019): EPA's U.S. Inventory of Greenhouse Gas Emissions and Sinks report provides in Annex 2 heat contents and carbon content coefficients of various fuel types. This data was used in conjunction with EIA Form 923 to calculate approximately 20 percent of the CO_2 emissions analyzed in this report.

Methodology

Plant Ownership

This report aims to reflect power plant ownership as of December 31, 2018. Plant ownership data used in this report are primarily based on the EIA-860 database from the year 2018. EIA-860 includes ownership information on generators at electric power plants owned or operated by electric utilities and non-utilities, which include independent power producers, combined heat and power producers, and other industrial organizations. It is published annually by EIA.

For the largest 100 power producers, plant ownership is further checked against self-reported data from the producer's 10-K form filed with the SEC, listings on their website, and other media sources. Ownership of plants is updated based on the most recent data available. Consequently, in a number of instances, ultimate assignment of plant ownership in this report differs from EIA-860's reported ownership. This primarily happens when the plant in question falls in one or more of the categories listed below:

1. It is owned by a limited liability partnership of shareholders of which are among the 100 largest power producers.
2. The owner of the plant as listed in EIA-860 is a subsidiary of a company that is among the 100 largest power producers.
3. It was sold or bought during the year 2018. Because form 10-K for a particular year is usually filed by the producer in the first quarter of the following year, this report assumes that ownership as reported in form 10-K is more accurate.

Publicly available data do not provide a straightforward means to accurately track lease arrangements and power purchase agreements. Therefore, in order to apply a standardized methodology to all companies, this report allocates generation and any associated emissions according to reported asset ownership as of December 31, 2018.

Identifying "who owns what" in the dynamic electricity generation industry is probably the single most difficult and complex part of this report. In addition to the categories listed above, shares of power plants are regularly traded and producers merge, reorganize, or cease operations altogether. While considerable effort was expended in ensuring the accuracy of ownership information reflected in this report, there may be inadvertent errors in the assignment of ownership for some plants where public information was either not current or could not be verified.

Generation Data and Cogeneration Facilities

Plant generation data used in this report come from EIA Form 923.

Cogeneration facilities produce both electricity and steam or some other form of useful energy. Because electricity is only a partial output of these plants, their reported emissions data generally overstate the emissions associated with electricity generation. Generation and emissions data included in this report for cogeneration facilities have been adjusted to reflect only their electricity generation. For all such cogeneration facilities emissions data were calculated on the basis of heat input of fuel associated with electricity generation only. Consequently, for all such facilities EIA Form 923, which report a plant's total heat input as well as that which is associated with electricity production only, was used to calculate their emissions.

Methodology (continued)

NOx and SO_2 Emissions

The EPA AMP database collects and reports SO_2 and NOx emissions data for nearly all major power plants in the U.S. Emissions information reported in the AMP database is collected from continuous emission monitoring (CEM) systems. SO_2 and NOx emissions data reported to the AMP account for all of the SO_2 and NOx emissions assigned to the 100 largest power producers in this report.

The AMP database collects and reports SO_2 and NOx emissions data by fuel type at the boiler level. This report consolidates this data at the generating unit and plant levels. In the case of jointly owned plants, because joint ownership is determined by producer's share of installed capacity, assignment of SO_2 and NOx emissions to the producers on this basis implicitly assumes that emission rates are uniform across the different units. This may cause producers to be assigned emission figures that are slightly higher or lower than their actual shares.

The appointment of NOx emissions between coal and natural gas at boilers that can burn both fuels may in certain instances slightly overstate coal's share of the emissions. This situation is likely to arise when a dual-fuel boiler that is classified as "coal-fired" within AMP burns natural gas to produce electricity in substantial amounts. In most years there would be very little economic reason to make this switch in a boiler that is not part of a combined cycle setup. Continued low natural gas prices in 2017 led to a small number of boilers switching to natural gas for most or a large part of their electricity output. Because AMP datasets do not make this distinction, apportioning emissions based on the fuel-type of the boiler would increase coal's share of emissions.

SO_2 and CO_2 emissions are mostly not affected by this issue. Natural gas emits virtually no SO_2. CO_2 emissions can be calculated from the heat input data reported in EIA Form 923, which allows for the correct apportionment of emissions between coal and natural gas.

CO_2 Emissions

A majority of CO_2 emissions used in this report were calculated using heat input data from EIA form 923 and carbon content coefficients of various fuel types provided by EPA. The table on the following slide shows the carbon coefficients used in this procedure. Non-emitting fuel types, whose carbon coefficients are zero, are not shown in the table. CO_2 emissions reported through the EPA AMP account for a small share of the CO_2 emissions used in this report.

The datasets report heat input and emissions data by fuel type at either the prime mover or boiler level. This report consolidates that data at the generating unit and plant levels. In the case of jointly owned plants, because joint ownership is determined by producer's share of installed capacity, assignment of CO_2 emissions to the producers on this basis implicitly assumes that emission rates are uniform across the different units. This may cause producers to be assigned emission figures that are slightly higher or lower than their actual shares.

Mercury Emissions

Mercury emissions data for coal power plants presented in this report were obtained from EPA's Toxic Release Inventory (TRI). Mercury emissions reported to the TRI are based on emission factors, mass balance calculations, or data monitoring. The TRI contains facility-level information on the use and environmental release of chemicals classified as toxic under the Clean Air Act. The TRI contains information on all toxic releases from a facility; mercury emissions in this report are based on air releases only. Because coal plants are the primary source of mercury emissions within the electric industry, the mercury emissions and emission rates presented in this report reflect the emissions associated with each producer's fleet of coal plants only.

Carbon Content Coefficients by Fuel Type

From Annex 2 of EPA GHG Inventory 2019

Fuel Type	Carbon Content Coefficients (Tg Carbon/Qbtu)
Coal	
Anthracite Coal	28.28
Bituminous Coal	25.40
Sub-bituminous Coal	26.20
Lignite Coal	26.67
Waste/Other Coal (includes anthracite culm, bituminous gob, fine coal, lignite waste, waste coal)	26.05
Coal-based Synfuel, including briquettes, pellets, or extrusions, which are formed by binding materials or processes that recycle materials	25.34
Coal-based Synthetic Gas	18.55
Oil	
Distillate Fuel Oil (Diesel, No. 1, No. 2, and No. 4 Fuel Oils)	20.31
Jet Fuel	19.70
Kerosene	19.96
Residual Fuel Oil (No. 5, No. 6 Fuel Oils, and Bunker C Fuel Oil)	20.48
Waste/Other Oil (including Crude Oil, Liquid Butane, Liquid Propane, Oil Waste, Re-Refined Motor Oil, Sludge Oil, Tar Oil, or other petroleum-based liquid wastes)	20.55
Petroleum Coke	27.85
Gas	
Natural Gas	14.43
Blast Furnace Gas	18.55
Other Gas	18.55
Gaseous Propane	14.43

Quality Assurance

This report examines the air pollutant emissions of the 100 largest electricity generating companies in the United States based on 2018 electricity generation, emissions, and ownership data. The report relies on publicly-available information reported by the U.S. Energy Information Administration (EIA), U.S. Environmental Protection Agency (EPA), Securities and Exchange Commission (SEC), state environmental agencies, company websites, and media articles. Emission data may include revisions to 2018 data that companies were in the process of submitting or have already submitted to EPA at the time of publication of this report.

This report relies almost entirely on publicly available information. Data sets published by EIA and EPA are the primary source of the generation and emissions data used in this report. The organizations that fund this report believe maintaining public access to this information is essential to tracking the industry's performance and making accurate and informed analyses and policy decisions.

Endnotes

1. Private entities include investor-owned and privately held utilities and non-utility power producers (e.g., independent power producers). Cooperative electric utilities are owned by their members (i.e., the consumers they serve). Publicly-owned electric utilities are nonprofit government entities that are organized at either the local or State level. There are also several Federal electric utilities in the United States, such as the Tennessee Valley Authority.

Power plant ownership in this report is divided into three categories: privately/investor owned (investor-owned corporations, privately held corporations, foreign-owned corporations), public power (federal power authorities, state power authorities, municipalities, power districts), and cooperative.

2. Electric Sector Emissions data from EPA AMP database available at http://ampd.epa.gov/ampd/

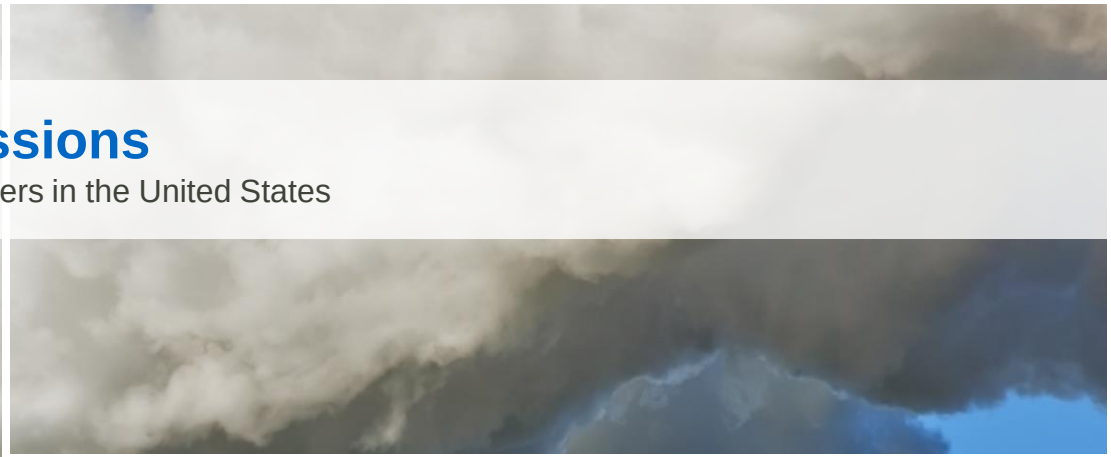
3. Generation data from EIA Monthly Energy Review Table 7.2a Electricity Generation Total for All Sectors available at https://www.eia.gov/totalenergy/data/monthly/#electricity

4. Gross Domestic Product (GDP) data from the U.S. Bureau of Economic Analysis available at https://www.bea.gov/national/index.htm#gdp

5. The sources used in the Annual Trends figure have already made national-level 2019 data available, allowing the trends section to extend through 2019. Detailed 2019 data used for the company-specific analysis of the top 100 electricity producers was not yet available at the time of report publication.

Benchmarking Air Emissions

Of the 100 Largest Electric Power Producers in the United States



Bank of America

100 North Tryon Street
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