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**Date of Hearing:** 1/22/2019

**Case No.** 18-501-EL-FOR, 18-1392-EL-RDR, 18-1393-EL-AAM

**PUCO Case Caption:** 2018 Long-Term Forecast Report of Ohio Power Company and Related Matters, Application of Ohio Power Company for Approval to Enter Into Renewable Energy Purchase Agreements for Inclusion in the Renewable Generation Rider and Application of Ohio Power Company for Approval to Amend its Tariffs.

Volume IV

**List of exhibits being filed:**

OCC-13, 14, 15, 16, 17

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**Reporter's Signature:** Karen Sue Gibson

**Date Submitted:** _____

BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

- - -

| | | |
|---|---|---|
| In the Matter of the 2018 Long-Term Forecast Report of Ohio Power Company and Related Matters. | : | Case No. 18-501-EL-FOR |
| In the Matter of the Application of Ohio Power Company for Approval to Enter Into Renewable Energy Purchase Agreements for Inclusion in the Renewable Generation Rider. | : | Case No. 18-1392-EL-RDR |
| In the Matter of the Application of Ohio Power Company for Approval to Amend its Tariffs. | : | Case No. 18-1393-EL-ATA |

- - -

PROCEEDINGS

before Ms. Sarah Parrot and Ms. Greta See, Attorney Examiners, at the Public Utilities Commission of Ohio, 180 East Broad Street, Room 11-A, Columbus, Ohio, called at 9:00 a.m. on Tuesday, January 22, 2019.

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ARMSTRONG & OKEY, INC.
222 East Town Street, Second Floor
Columbus, Ohio 43215-5201
(614) 224-9481 - (800) 223-9481

- - -

# Benchmarking Air Emissions

## Of the 100 Largest Electric Power Producers in the United States

**June 2018**

Presentation of Results

Data Downloads at: www.mjbradley.com

**Report Authors:**

Christopher Van Atten
Amlan Saha
Lauren Slawsky
Clement Russell
Luke Hellgren

**Contributors:**

Bank of America

Ceres
Sustainability is the bottom line.

Entergy

Exelon

NRDC

# Preface

The 2018 Benchmarking report is the 14th 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 current report is based on 2016 generation and emissions data.

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.

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

For questions or comments about this report, please contact:

Christopher Van Atten
M. J. Bradley & Associates LLC
47 Junction Square Drive
Concord, MA 01742, USA
Telephone: +1 978 369 5533
E-mail: vanatten@mjbradley.com

# Key Findings

- In 2016, power plant $SO_2$ and NOx emissions were 91 percent and 82 percent lower, respectively, than they were in 1990 when Congress passed major amendments to the Clean Air Act.

- In 2016, power plant $CO_2$ emissions were nearly the same as 1990 levels (1 percent higher). From 2005 through 2016, power plant $CO_2$ emissions declined by 24 percent. Some of the factors driving this trend include energy efficiency improvements and the displacement of coal by natural gas and renewable energy resources.

- Mercury air emissions from power plants have decreased 86 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

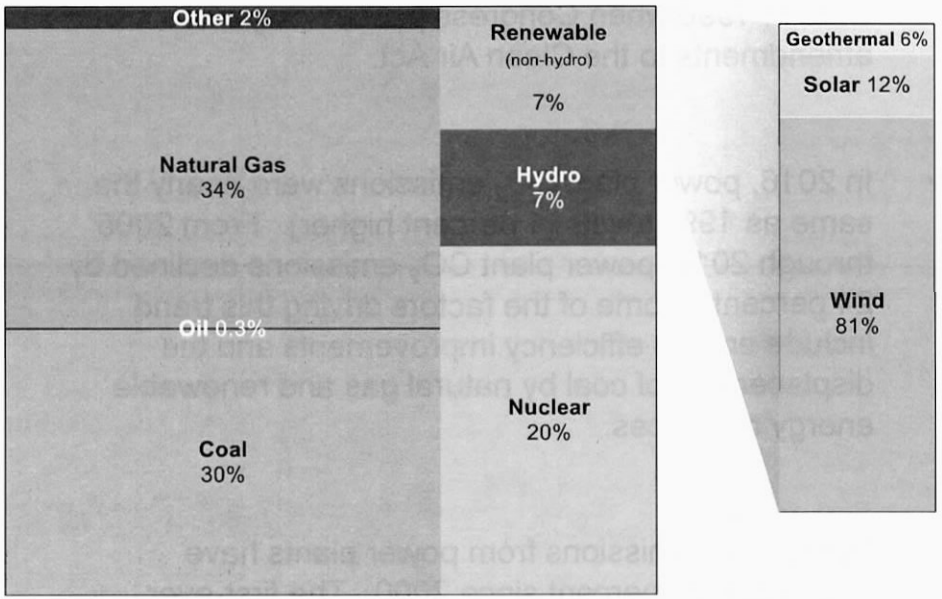
OF THE
100 LARGEST ELECTRIC POWER PRODUCERS
IN THE UNITED STATES

**Download plant level data from the 2018 Benchmarking Air Emissions report at:**
**www.mjbradley.com**

# U.S. Generation by Fuel Type

- In 2016, the U.S. electric system continued its general shift away from coal toward lower- and zero-emitting sources. For the first time, natural gas (34 percent) overtook coal (30 percent) as the largest source of electricity in the U.S.
- Nuclear plants accounted for 20 percent, hydroelectric resources 7 percent, oil-fired resources <1 percent, and non-hydroelectric renewables and other fuel sources such as non-biogenic municipal solid waste, tire-derived fuel, manufactured and waste gases, etc. accounted for 7 and 2 percent, respectively.
- This marks a shift away from higher-emitting power sources compared to a decade ago (2006), when coal and natural gas accounted for 49 percent and 20 percent of power production, respectively.

**U.S. Electricity Generation by Fuel Type (2016)**




Source: U.S. Energy Information Administration. EIA-923 Monthly Generation and Fuel Consumption 2016 Final Release. January, 2018.

# The 100 Largest Electric Power Producers

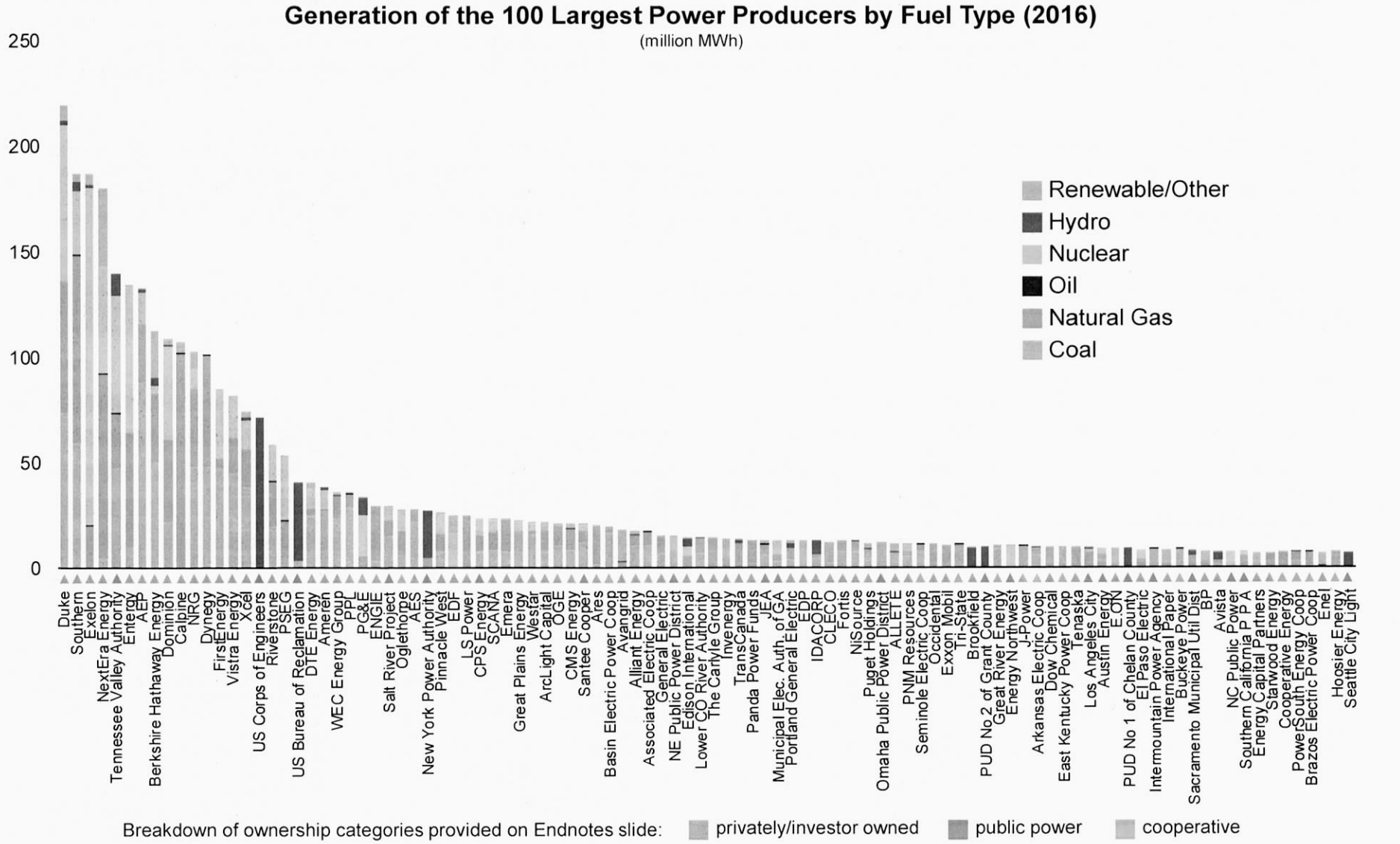
The report examines and compares the stack air pollutant emissions of the 100 largest power producers in the United States based on their 2016 generation, plant ownership, and emissions data. The table below lists the 100 largest power producers featured in this report ranked by their total electricity 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 3,000 power plants and account for 84 percent of reported electric generation and 86 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 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.

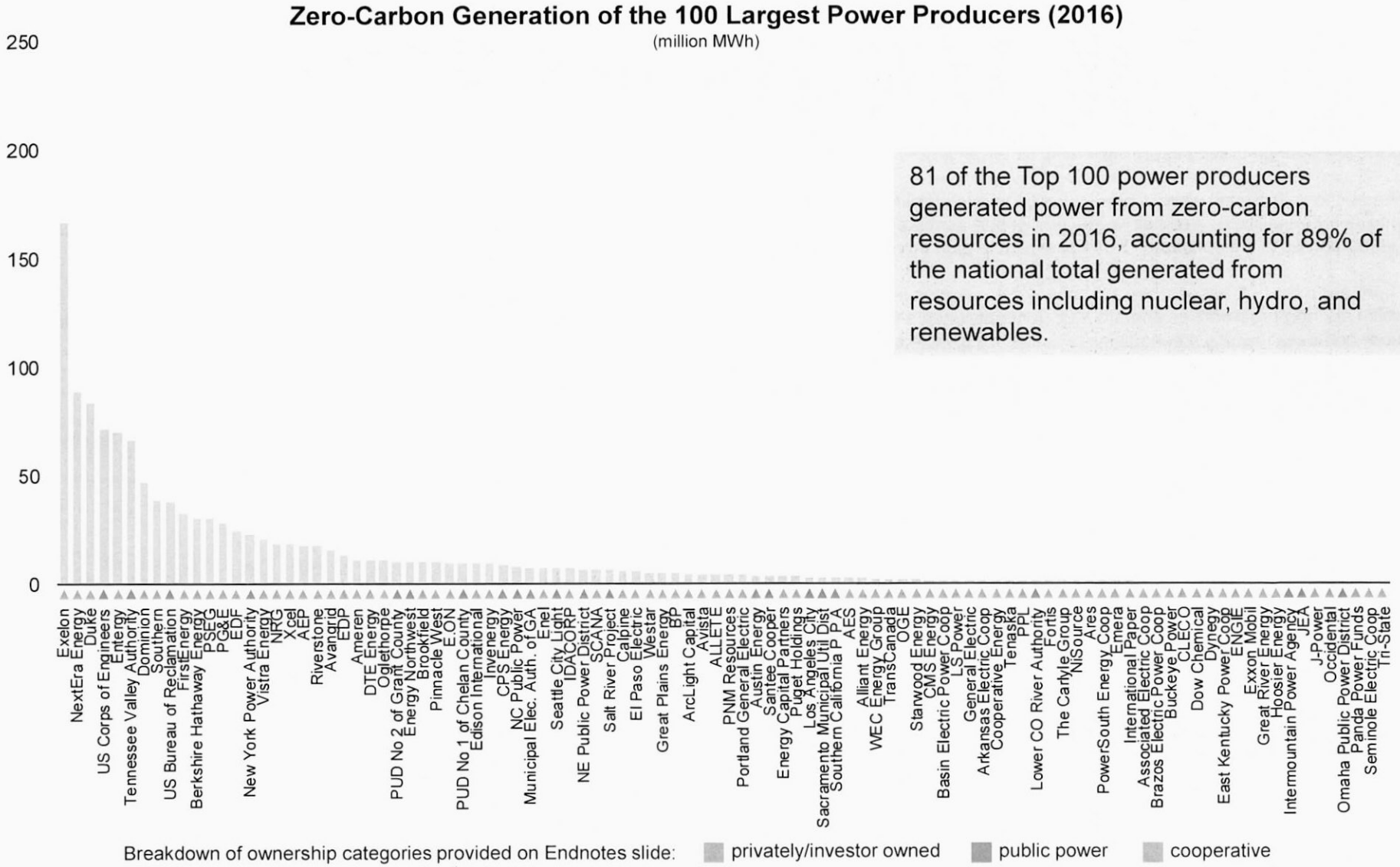
The 100 largest power producers emitted in aggregate approximately 1.26 million tons of $SO_2$, 1.01 million tons of NOx, 5.26 tons of mercury, and 1.70 billion tons of $CO_2$.

| RANK | PRODUCER NAME | 2016 MWh (million) | RANK | PRODUCER NAME | 2016 MWh (million) | RANK | PRODUCER NAME | 2016 MWh (million) | RANK | PRODUCER NAME | 2016 MWh (million) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Duke | 219.8 | 26 | Salt River Project | 28.6 | 51 | The Carlyle Group | 13.6 | 76 | Arkansas Electric Coop | 9.8 |
| 2 | Southern | 187.0 | 27 | Oglethorpe | 27.8 | 52 | Invenergy | 13.5 | 77 | Dow Chemical | 9.7 |
| 3 | Exelon | 186.9 | 28 | AES | 27.7 | 53 | TransCanada | 13.1 | 78 | East Kentucky Power Coop | 9.6 |
| 4 | NextEra Energy | 180.5 | 29 | New York Power Authority | 26.9 | 54 | Panda Power Funds | 13.1 | 79 | Tenaska | 9.5 |
| 5 | Tennessee Valley Authority | 139.6 | 30 | Pinnacle West | 26.0 | 55 | JEA | 13.0 | 80 | Los Angeles City | 9.3 |
| 6 | Entergy | 134.3 | 31 | EDF | 24.9 | 56 | Municipal Elec. Auth. of GA | 13.0 | 81 | Austin Energy | 9.3 |
| 7 | AEP | 133.0 | 32 | LS Power | 24.8 | 57 | Portland General Electric | 12.9 | 82 | E.ON | 9.3 |
| 8 | Berkshire Hathaway Energy | 112.8 | 33 | CPS Energy | 23.4 | 58 | EDP | 12.9 | 83 | PUD No 1 of Chelan County | 9.2 |
| 9 | Dominion | 108.8 | 34 | SCANA | 22.8 | 59 | IDACORP | 12.8 | 84 | El Paso Electric | 8.7 |
| 10 | Calpine | 107.7 | 35 | Emera | 22.6 | 60 | CLECO | 12.4 | 85 | Intermountain Power Agency | 8.4 |
| 11 | NRG | 103.2 | 36 | Great Plains Energy | 22.0 | 61 | Fortis | 11.9 | 86 | International Paper | 8.2 |
| 12 | Dynegy | 100.4 | 37 | Westar | 21.8 | 62 | NiSource | 11.8 | 87 | Buckeye Power | 8.2 |
| 13 | FirstEnergy | 85.0 | 38 | ArcLight Capital | 21.6 | 63 | Puget Holdings | 11.4 | 88 | Sacramento Municipal Util Dist | 7.9 |
| 14 | Vistra Energy | 82.0 | 39 | OGE | 21.4 | 64 | Omaha Public Power District | 11.3 | 89 | BP | 7.5 |
| 15 | Xcel | 74.4 | 40 | CMS Energy | 21.2 | 65 | ALLETE | 11.1 | 90 | Avista | 7.4 |
| 16 | US Corps of Engineers | 71.2 | 41 | Santee Cooper | 20.4 | 66 | PNM Resources | 11.0 | 91 | NC Public Power | 7.3 |
| 17 | Riverstone | 58.4 | 42 | Ares | 20.3 | 67 | Seminole Electric Coop | 10.9 | 92 | Southern California PPA | 7.3 |
| 18 | PSEG | 52.6 | 43 | Basin Electric Power Coop | 19.9 | 68 | Occidental | 10.8 | 93 | Energy Capital Partners | 7.2 |
| 19 | US Bureau of Reclamation | 40.6 | 44 | Avangrid | 17.8 | 69 | Exxon Mobil | 10.7 | 94 | Starwood Energy | 7.2 |
| 20 | DTE Energy | 40.5 | 45 | Alliant Energy | 17.2 | 70 | Tri-State | 10.5 | 95 | Cooperative Energy | 7.1 |
| 21 | Ameren | 38.7 | 46 | Associated Electric Coop | 16.4 | 71 | Brookfield | 10.1 | 96 | PowerSouth Energy Coop | 7.1 |
| 22 | WEC Energy Group | 36.0 | 47 | General Electric | 15.3 | 72 | PUD No 2 of Grant County | 10.1 | 97 | Brazos Electric Power Coop | 7.1 |
| 23 | PPL | 35.4 | 48 | NE Public Power District | 14.8 | 73 | Great River Energy | 10.0 | 98 | Enel | 7.1 |
| 24 | PG&E | 33.5 | 49 | Edison International | 14.0 | 74 | Energy Northwest | 10.0 | 99 | Hoosier Energy | 6.9 |
| 25 | ENGIE | 29.1 | 50 | Lower CO River Authority | 13.8 | 75 | J-Power | 9.9 | 100 | Seattle City Light | 6.7 |

# Rankings by Generation



# Rankings by Zero-Carbon Generation



# 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, 2016.

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 (see case study slide).

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.

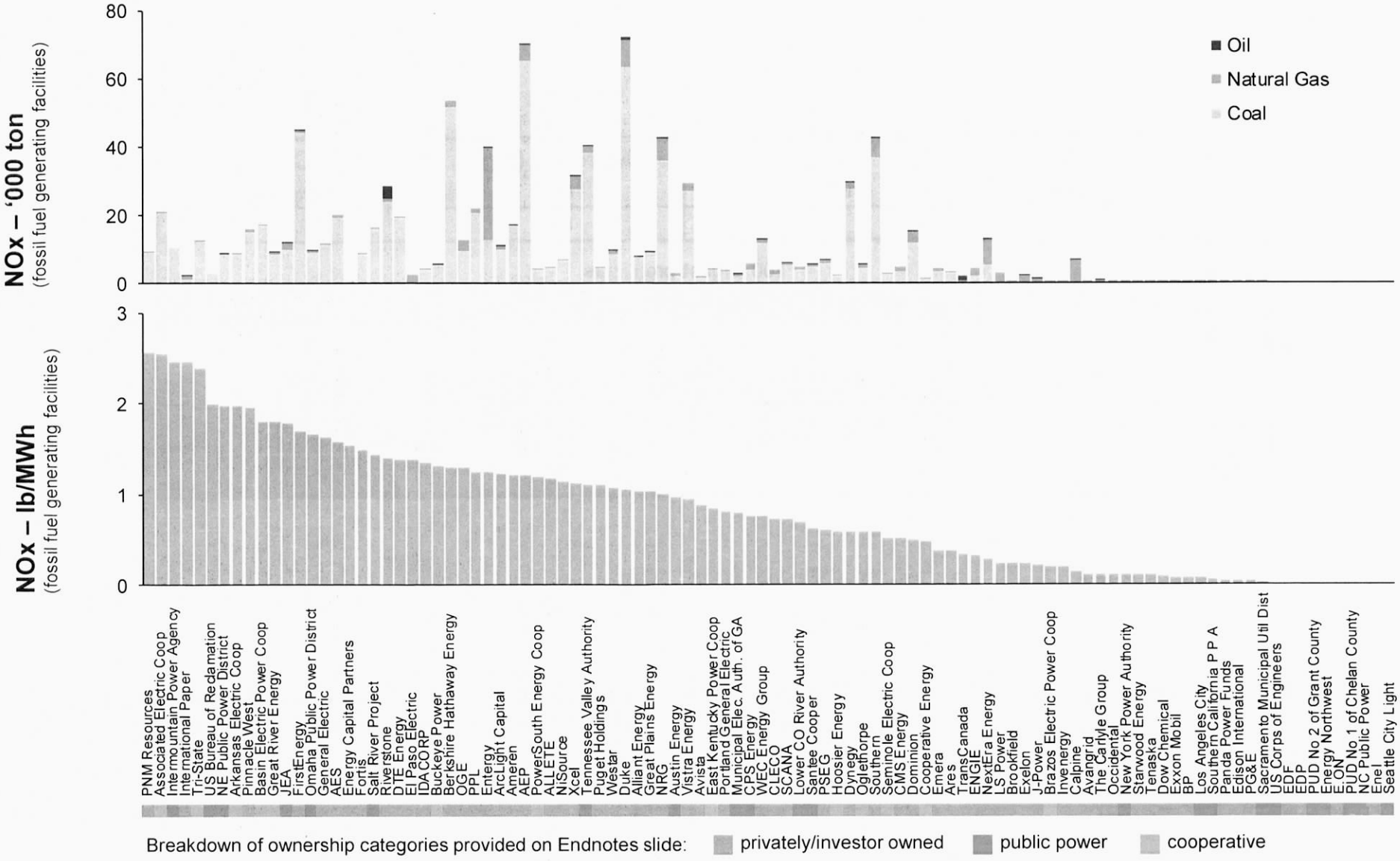
The charts illustrate significant differences in the total emission levels and emission rates of the 100 largest power producers. For example, the tons of $CO_2$ emissions range from zero to nearly 108 million tons per year. The NOx emission rates range from zero to 2.6 pounds of emissions per megawatt hour of generation. The total tons of emissions from any producer are influenced by the total amount of generation that a producer owns and by the fuels and technologies used to generate electricity.

# Emission Contributions

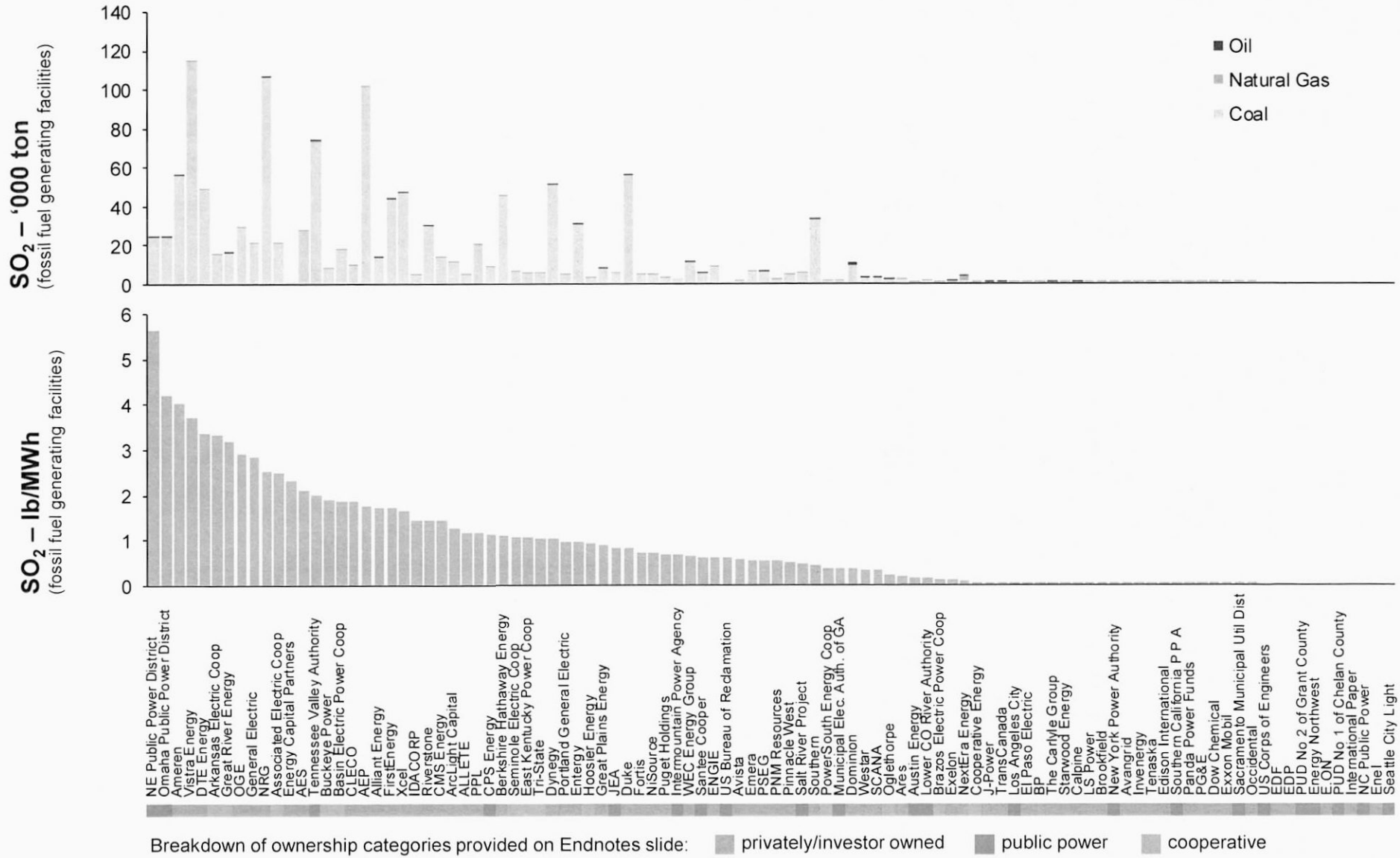
| Percent of industry emissions | $SO_2$ (million ton) | NOx (million ton) | Mercury (Hg) (ton) | $CO_2$ (billion ton) |
|---|---|---|---|---|
| 100% | 1.47 | 1.22 | 6.72 | 2.02 |
| | 100 largest producers | | | |
| | 86% | 83% | 78% | 84% |
| | No. of producers | | | |
| 75% | 28 | 45 | 44 | 48 |
| 50% | 10 | 15 | 13 | 16 |
| 25% | 3 | 5 | 3 | 5 |

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 five top 100 producers, respectively.

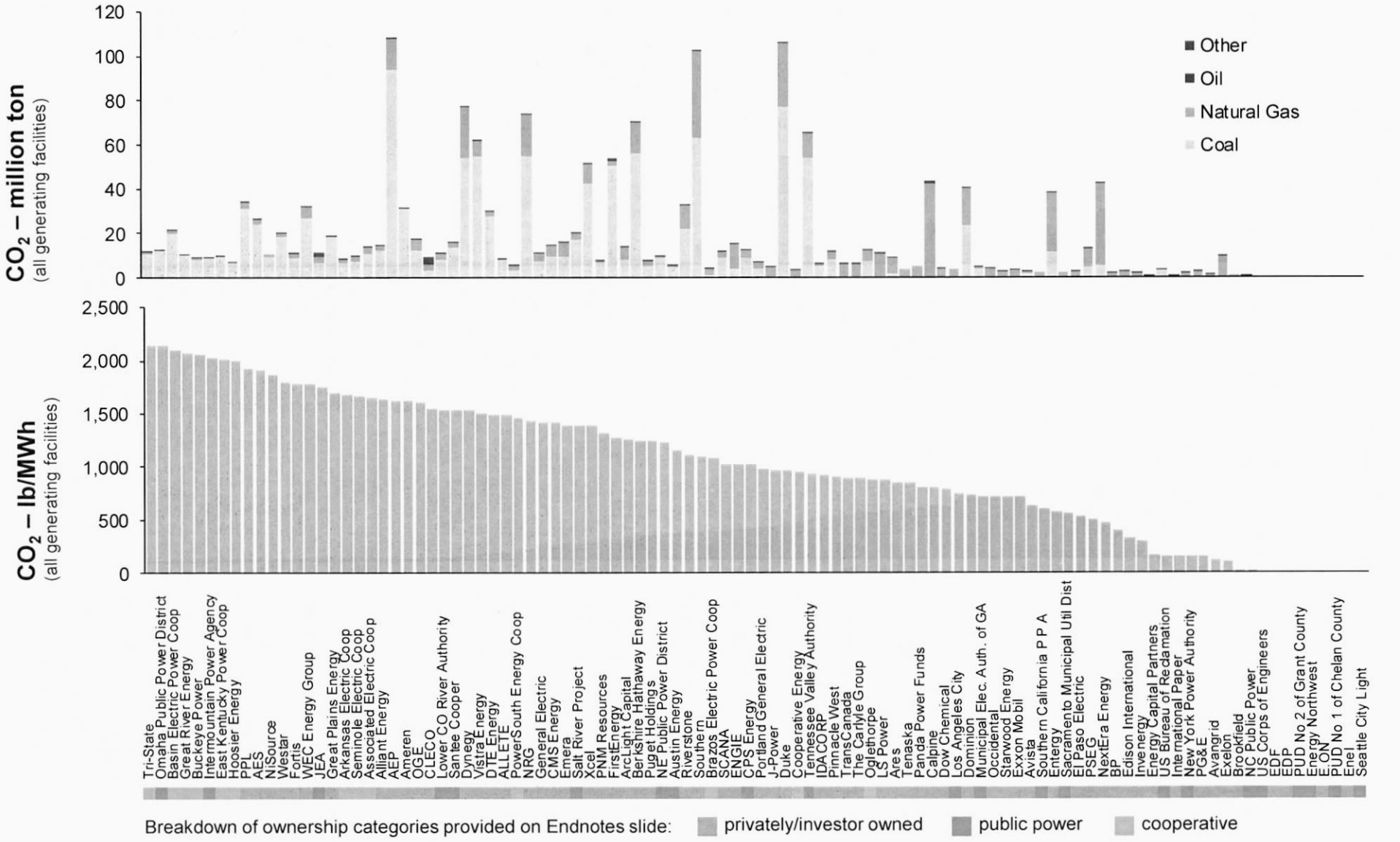
# NOx: Total Emissions and Emission Rates



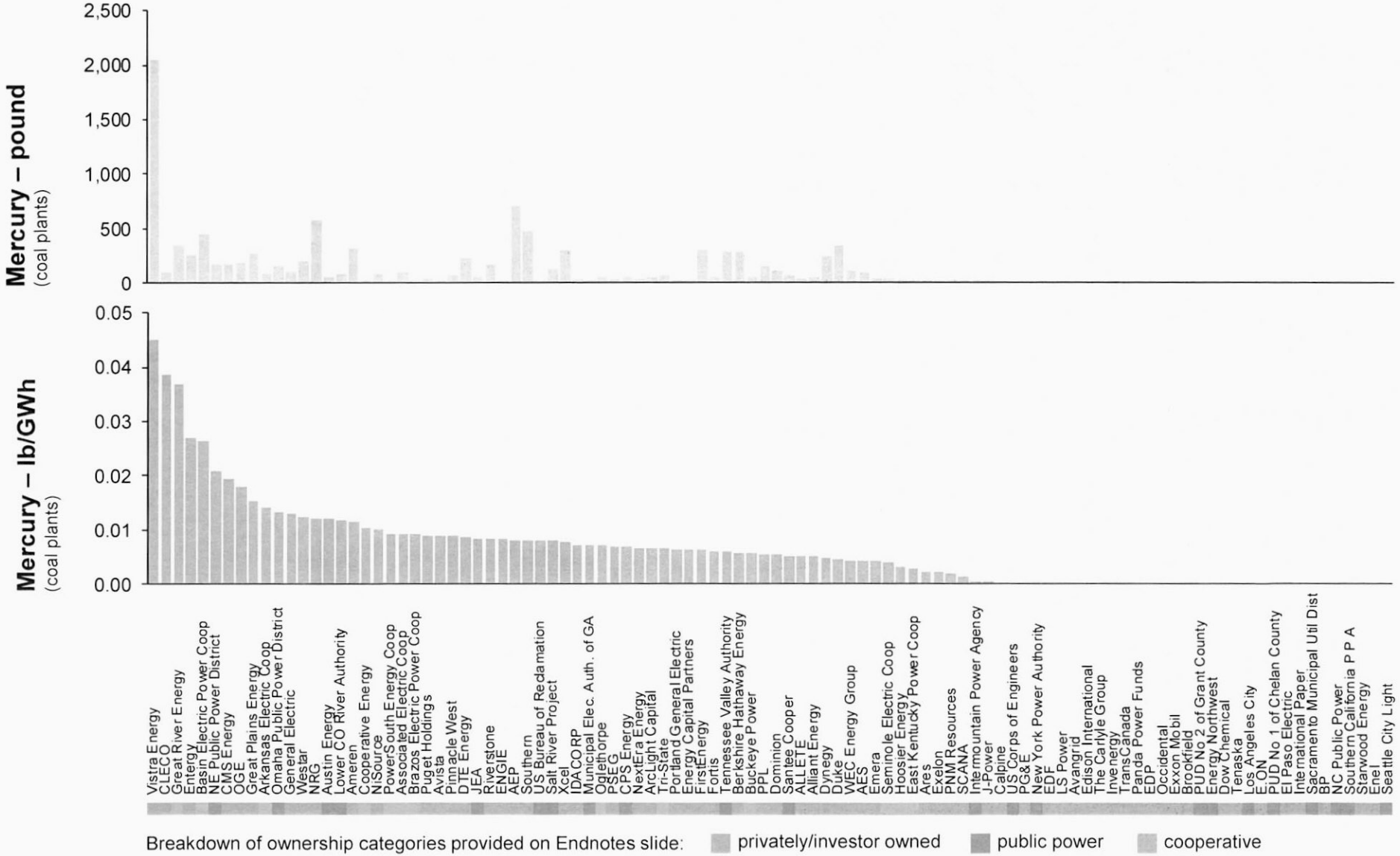
# $SO_2$: Total Emissions and Emission Rates



# $CO_2$: Total Emissions and Emission Rates



# Mercury: Total Emissions and Emission Rates

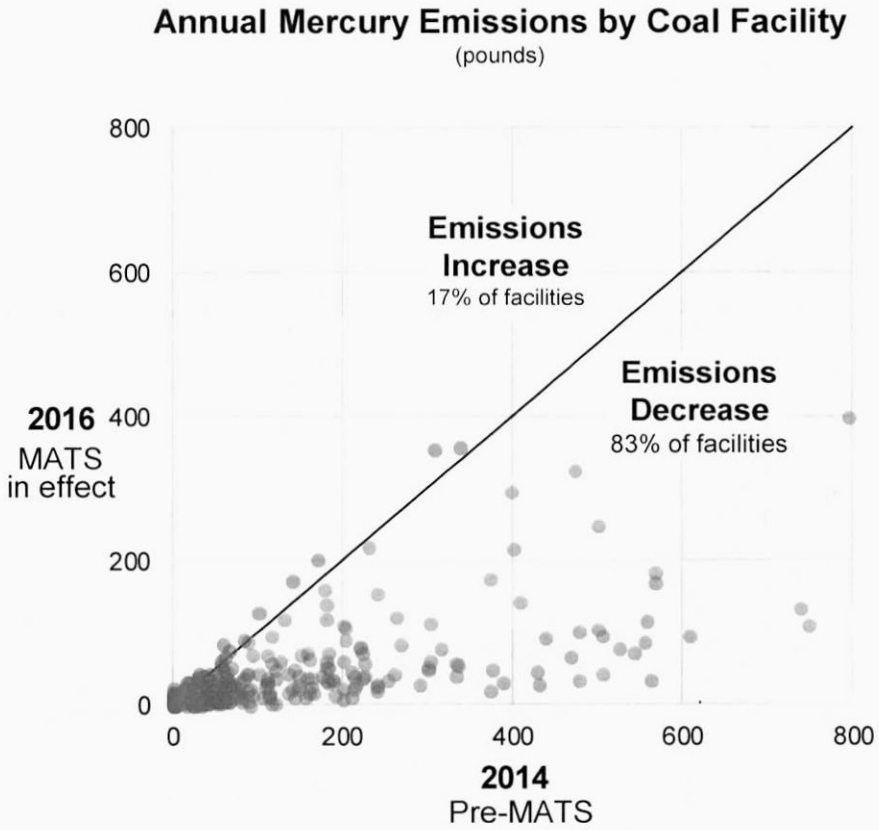


# Mercury and Air Toxics Standards Impacts

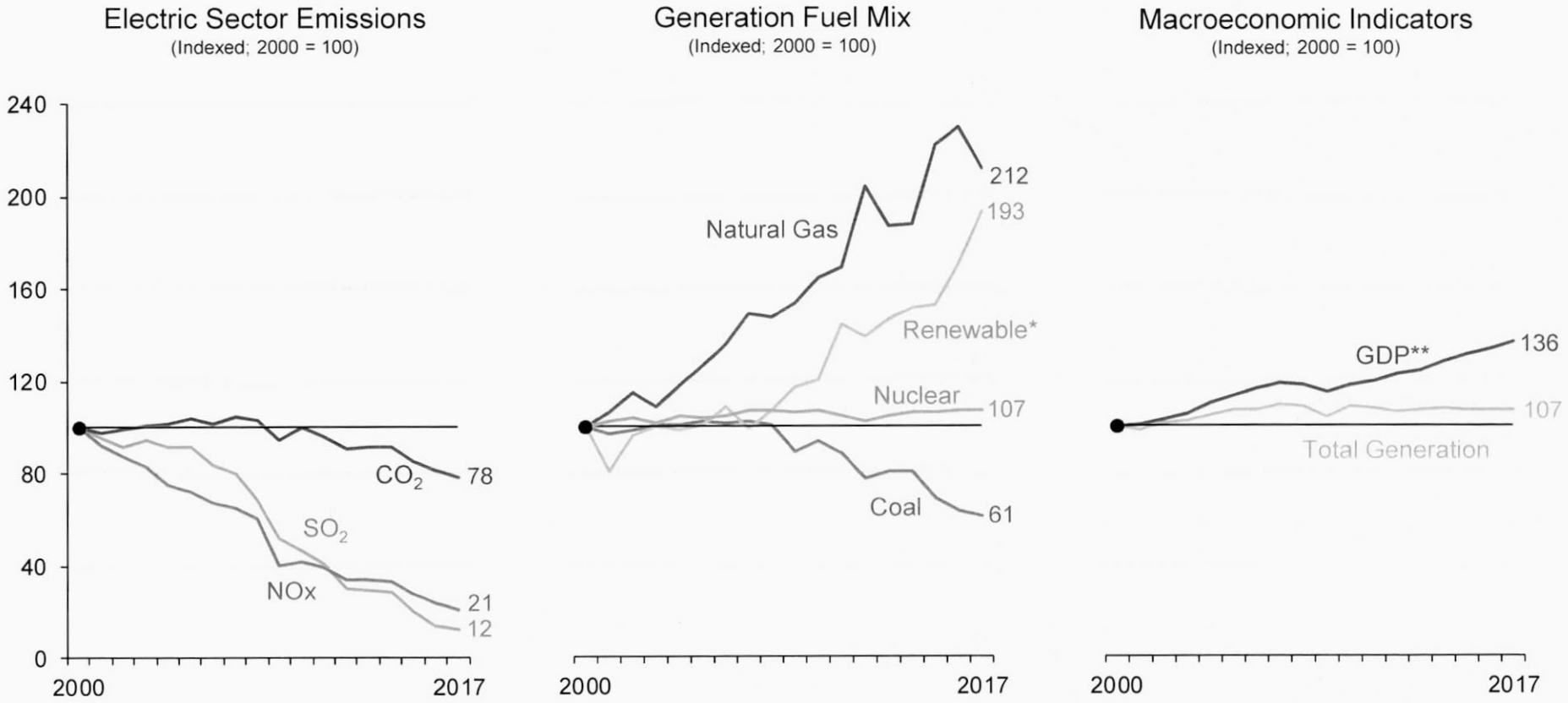
- In 2012, EPA finalized the Mercury and Air Toxics Standards (MATS), regulating emissions of mercury and other hazardous air pollutants from coal- and oil-fired electric generating units. The standards went into effect on April 16, 2015, although many coal units obtained a one-year extension to the initial compliance date. Reported emissions have declined 69 percent between 2014 and 2016.

- Coal mercury emissions from the top 100 power producers in 2016 range from less than 1 pound to 2,040 pounds, and coal mercury emission rates range from 0.0002 pound per gigawatt hour (a gigawatt hour is 1,000 megawatt hours) to 0.045 pound per gigawatt hour.

- Compared to 2014 levels mercury emissions declined at 83 percent of coal facilities that were in operation as of December 31, 2016 (see adjacent chart). Across these facilities, emissions decreased by an average of 63 percent.



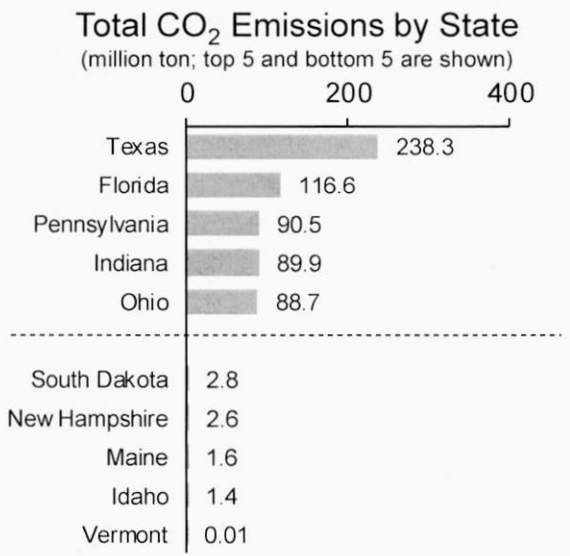
# Annual Trends

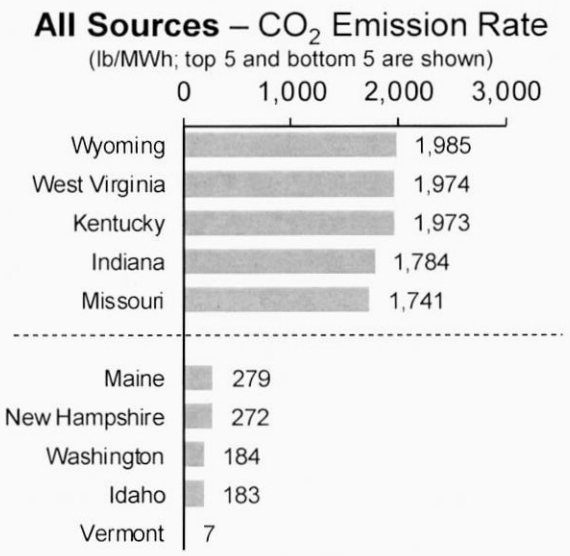


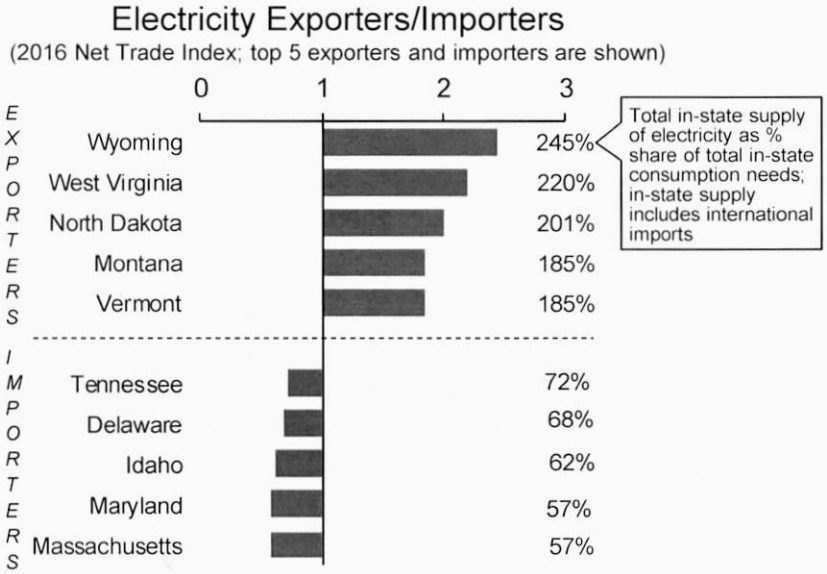

*Includes hydroelectric, wind, solar, biomass, geothermal, and other renewable sources.
**GDP in chained 2009 dollars.

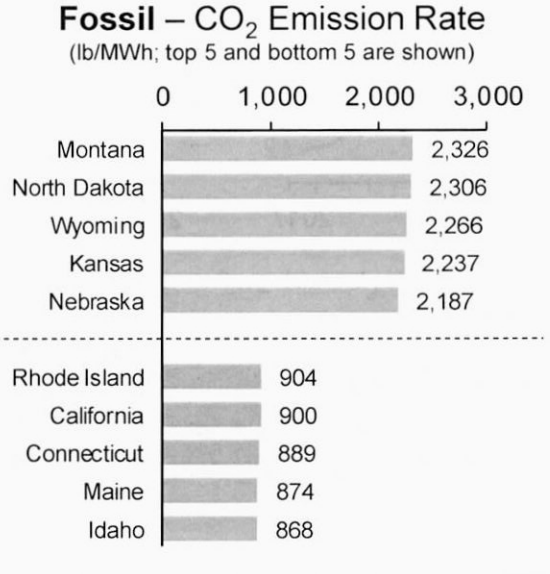
The electric power sector has made significant progress in terms of reducing its NOx and $SO_2$ emissions. From 2000 through 2017, NOx and $SO_2$ emissions decreased 79 and 88 percent, respectively. From 2005 to 2017, $CO_2$ emissions decreased 24 percent while GDP grew 20 percent. Over the same period, generation from renewables grew 92 percent.

# State-by-State $CO_2$ Emissions

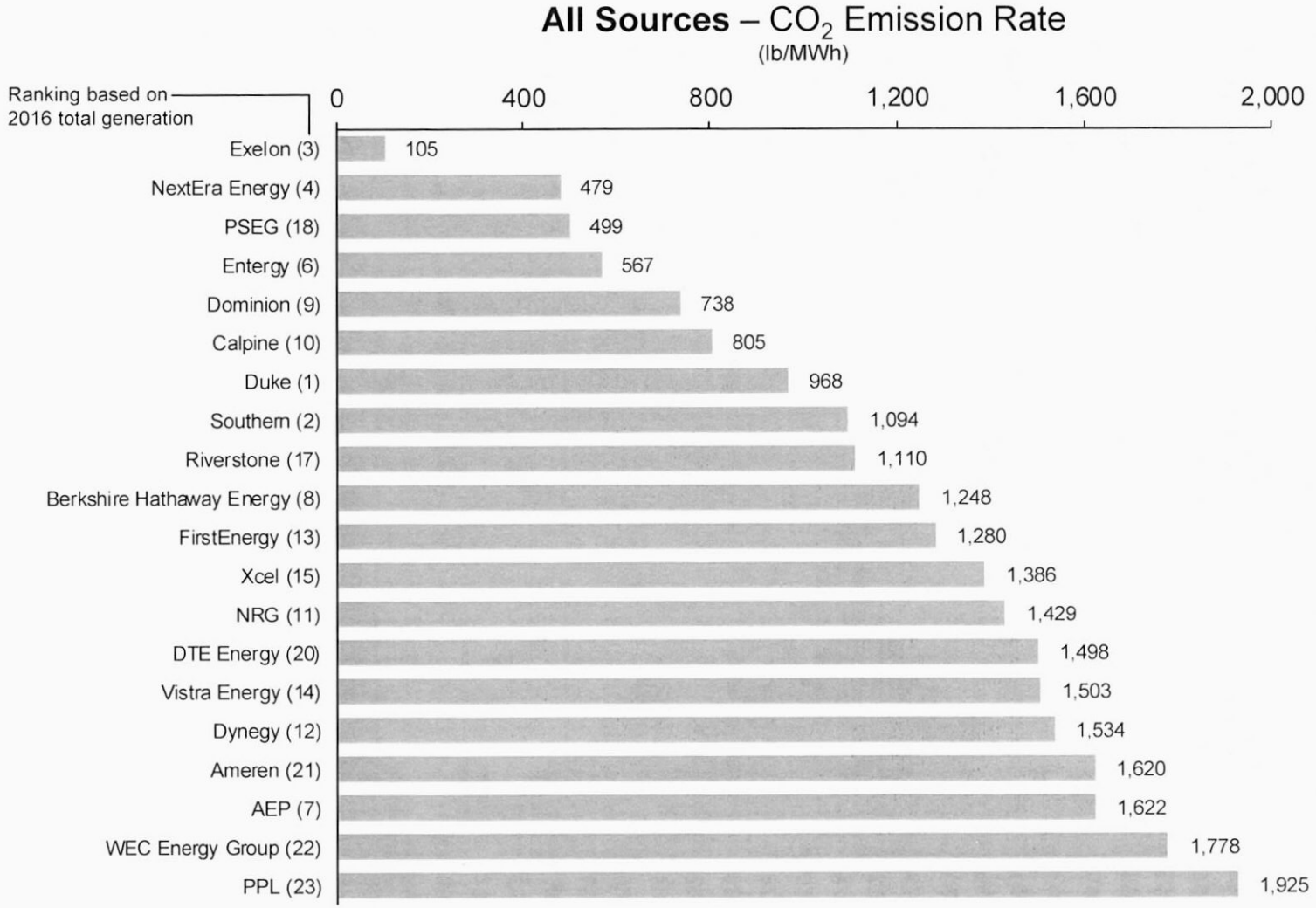


# Rankings by $CO_2$ Emission Rate
## (Top 20 Privately/Investor Owned Power Producers)

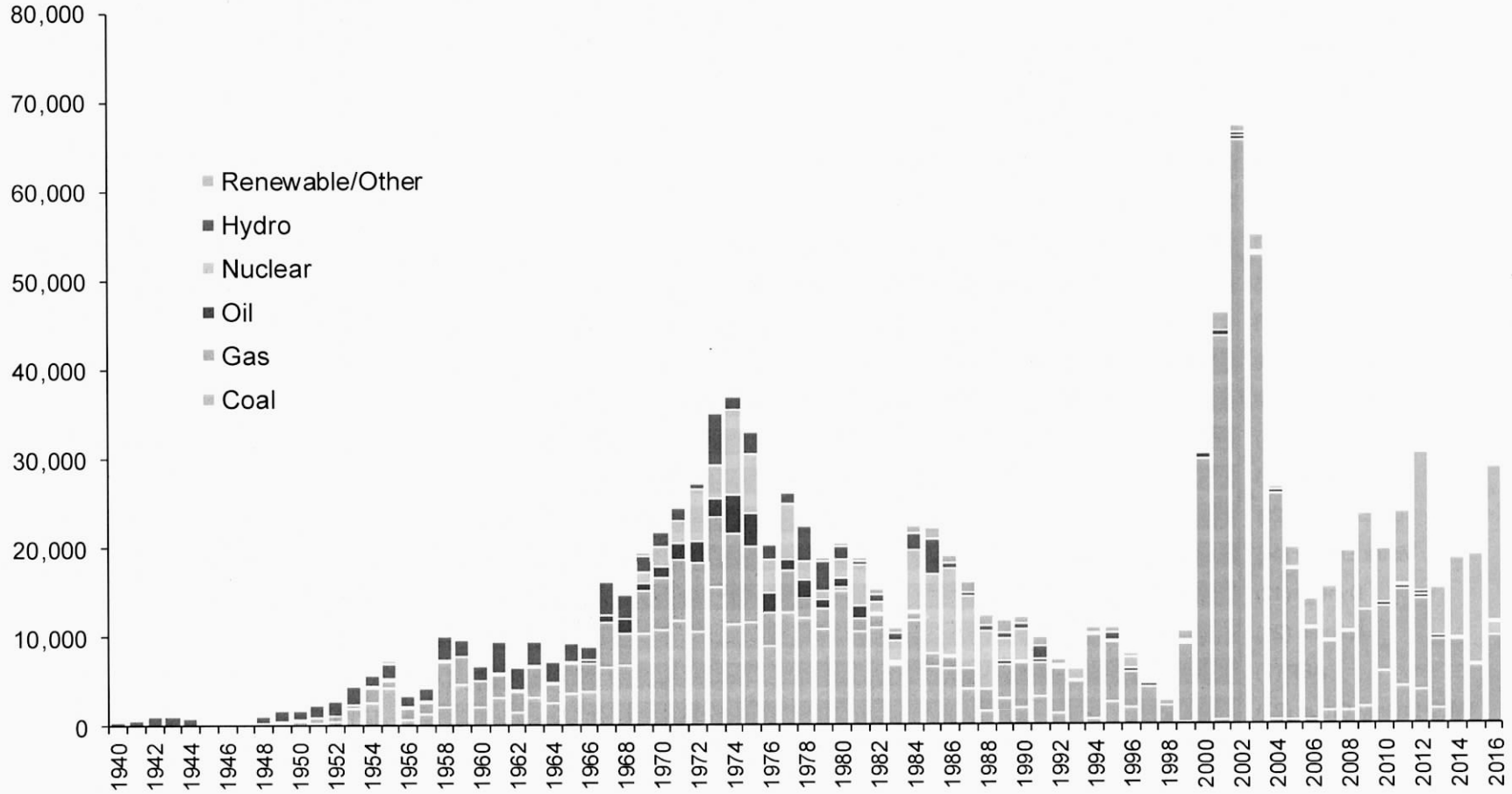



**Note:** "Privately/investor owned" power producers include investor owned, privately held, and foreign owned corporations. This chart does not show public power producers (federal power authorities, state power authorities, municipalities, power districts), or cooperatives.

# Existing Capacity

**U.S. Electric Generating Capacity by In Service Year: 1940 – 2016**

(Nameplate Capacity; MW)

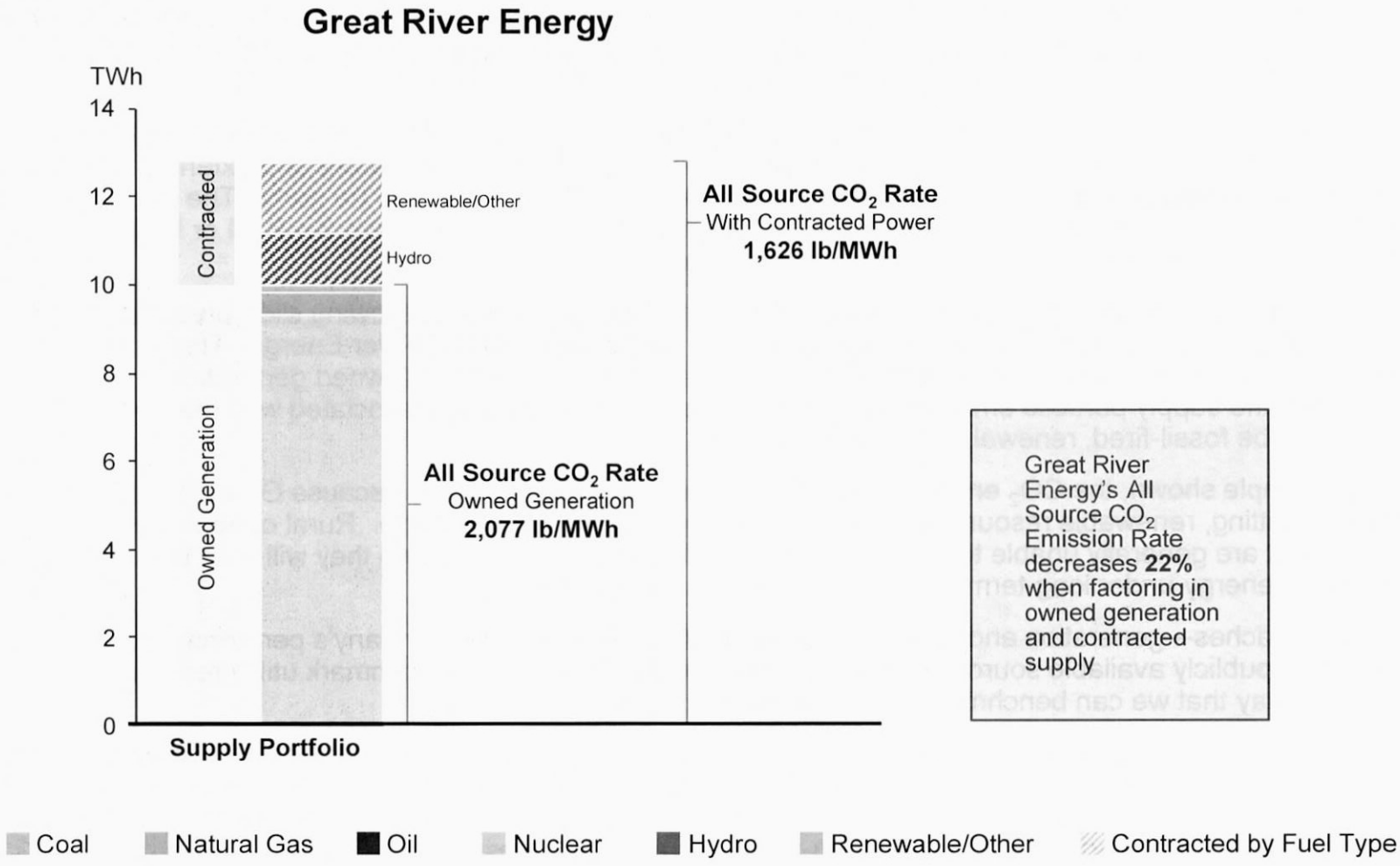



Source: U.S. Energy Information Administration. EIA-860 Annual Electric Generator Report. November 9, 2017.

# 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, 2016.
- 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




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

# Average Capacity Factors

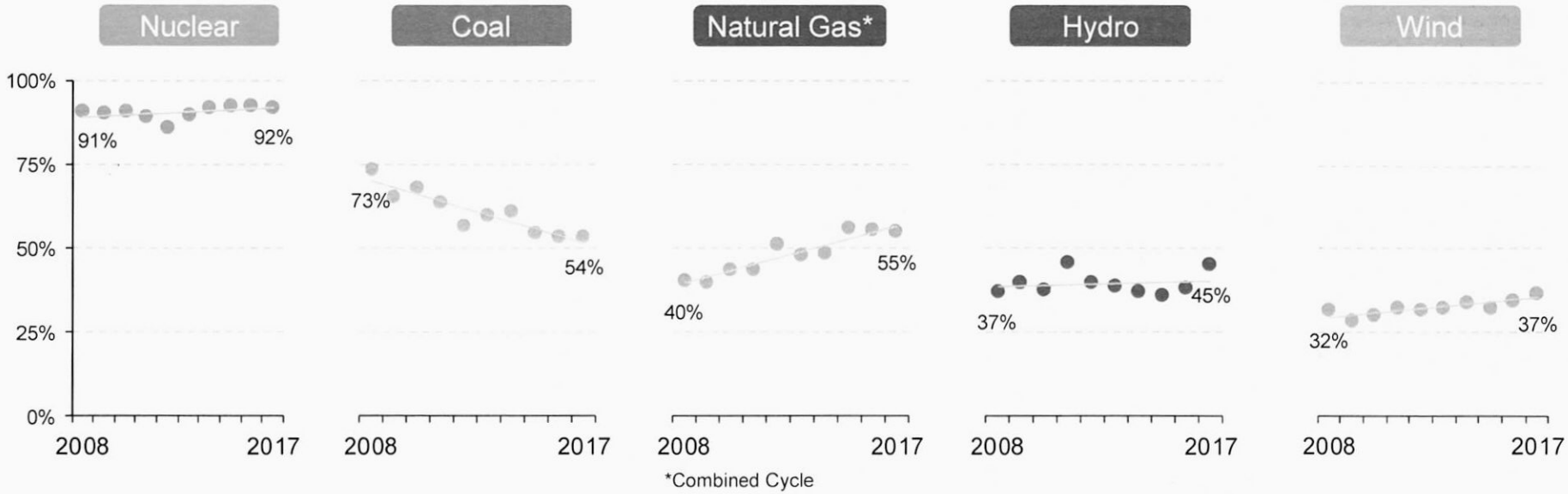
## Annual Capacity Factors for Select Fuels and Technologies

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 55 percent in 2017, while over the same time period, natural gas combined-cycle capacity factors rose from 40 to 55 percent.

Nuclear plants have high utilization rates, consistently running at above 90 percent average capacity factor.

Hydropower and wind capacity factors are lower, but have also remained relatively constant over the past decade.



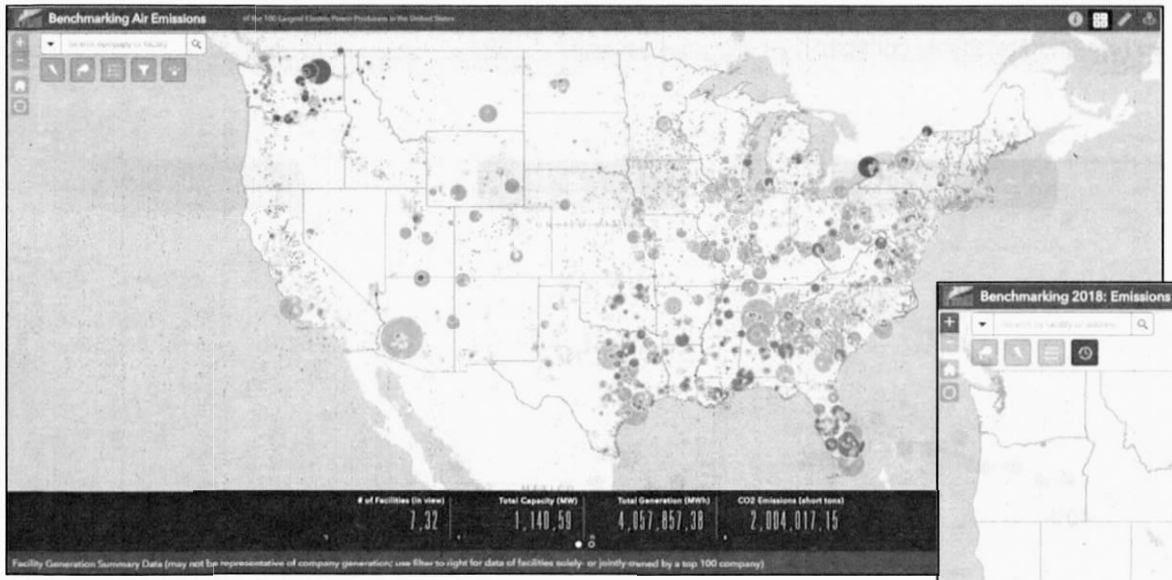

Source: U.S. Energy Information Administration. Electric Power Monthly, Tables 6.7A and 6.7B. January 2018.

# Benchmarking Maps

To supplement the 2018 Benchmarking Report, MJB&A has developed two interactive maps to further visualize the emissions and electricity generation from power producers in the United States. The primary map ("Main") provides facility-level emissions and generation data and offers interactive features to filter facilities by geography, fuel type, company ownership, and other metrics. An additional map ("Trends") was developed with historical Benchmarking data (2012-2016 data) to show how facility-level emissions and generation are changing through time.

These maps and accompanying user guide are available at www.mjbradley.com.

**Main Map**




**Trends Map**

# Appendix: 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 2016 mercury emissions used in this report are based on TRI reports submitted by facility managers.

EIA FORMS 923 POWER PLANT DATABASES (2016): 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 (2016): 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 (2018): 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.

# Appendix: Methodology

**Plant Ownership**

This report aims to reflect power plant ownership as of December 31, 2016. Plant ownership data used in this report are primarily based on the EIA-860 database from the year 2016. 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 2016. 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, 2016.

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.

# Appendix: 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 2016 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.

# Appendix: Carbon Content Coefficients by Fuel Type

## From Annex 2 of EPA GHG Inventory 2018

| Fuel Type | Carbon Content Coefficients (Tg Carbon/Qbtu) |
|---|---|
| **Coal** | |
| Anthracite Coal | 28.28 |
| Bituminous Coal | 25.44 |
| Sub-bituminous Coal | 26.50 |
| Lignite Coal | 26.65 |
| 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) | 20.17 |
| 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 | 14.46 |
| Blast Furnace Gas | 18.55 |
| Other Gas | 18.55 |
| Gaseous Propane | 14.46 |

# Appendix: Quality Assurance

This report examines the air pollutant emissions of the 100 largest electricity generating companies in the United States based on 2016 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 2016 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.

2. 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.

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

   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

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

   The sources used in the Annual Trends figure have already made national-level 2017 data available, allowing the trends section to extend through 2017. Detailed 2017 data used for the company-specific analysis of the top 100 electricity producers was not yet available at the time of report publication.

Qsearch

# Coal and Air Pollution

Air pollution from coal-fired power plants is linked with asthma, cancer, heart and lung ailments, neurological problems, acid rain, global warming, and other severe environmental and public health impacts.

Contents



Coal has long been a reliable source of American energy, but it comes with tremendous costs because it is *incredibly* dirty. The same chemistry that enables coal to produce energy—the breaking down of carbon molecules—also produces a number of profoundly harmful environmental impacts and pollutants that harm public health. Air pollution and global warming are two of the most serious.

## Coal and air pollution

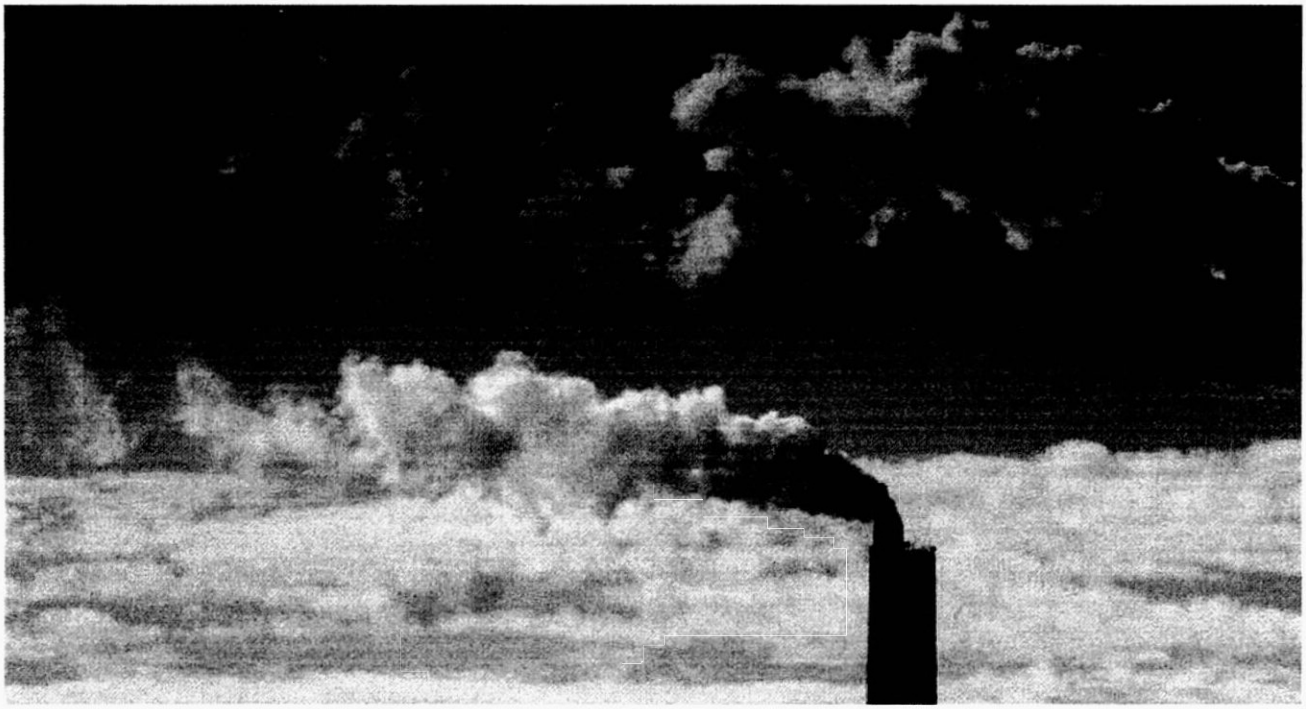


Photo: Shutterstock

The smoke from coal power plants is exceedingly dangerous to human health.

When coal burns, the chemical bonds holding its carbon atoms in place are broken, releasing energy. However, other chemical reactions *also* occur, many of which carry toxic airborne pollutants

and heavy metals into the environment.

This air pollution includes:

**Mercury**: Coal plants are responsible for 42 percent of US mercury emissions, a toxic heavy metal that can damage the nervous, digestive, and immune systems, and is a serious threat to the child development. Just 1/70th of a teaspoon of mercury deposited on a 25-acre lake can make the fish unsafe to eat. According to the Environmental Protection Agency's (EPA) National Emissions Inventory, US coal power plants emitted 45,676 pounds of mercury in 2014 (the latest year data is available).

**Sulfur dioxide (SO2)**: Produced when the sulfur in coal reacts with oxygen, $SO_2$ combines with other molecules in the atmosphere to form small, acidic particulates that can penetrate human lungs. It's linked with asthma, bronchitis, smog, and acid rain, which damages crops and other ecosystems, and acidifies lakes and streams. US coal power plants emitted more than 3.1 million tons of $SO_2$ in 2014.

**Nitrogen oxides** (NOx): Nitrous oxides are visible as smog and irritate lung tissue, exacerbate asthma, and make people more susceptible to chronic respiratory diseases like pneumonia and influenza. In 2014, US coal power plants emitted more than 1.5 million tons.

**Particulate matter**: Better known as "soot," this is the ashy grey substance in coal smoke, and is linked with chronic bronchitis, aggravated asthma, cardiovascular effects like heart attacks, and premature death. US coal power plants emitted 197,286 tons of small airborne particles (measured as 10 micrometers or less in diameter) in 2014..

Other harmful pollutants emitted in 2014 by the US coal power fleet include:

- 41.2 tons of **lead**, 9,332 pounds of **cadmium,** and other **toxic heavy metals**.
- 576,185 tons of **carbon monoxide**, which causes headaches and places additional stress on people with heart disease.
- 22,124 tons of **volatile organic compounds** (VOC), which form ozone.
- 77,108 pounds of **arsenic**. For scale, arsenic causes cancer in one out of 100 people who drink water containing 50 parts per *billion*.

Most of these emissions can be reduced through pollution controls—sometimes by a significant amount—though many plants don't have adequate controls installed.

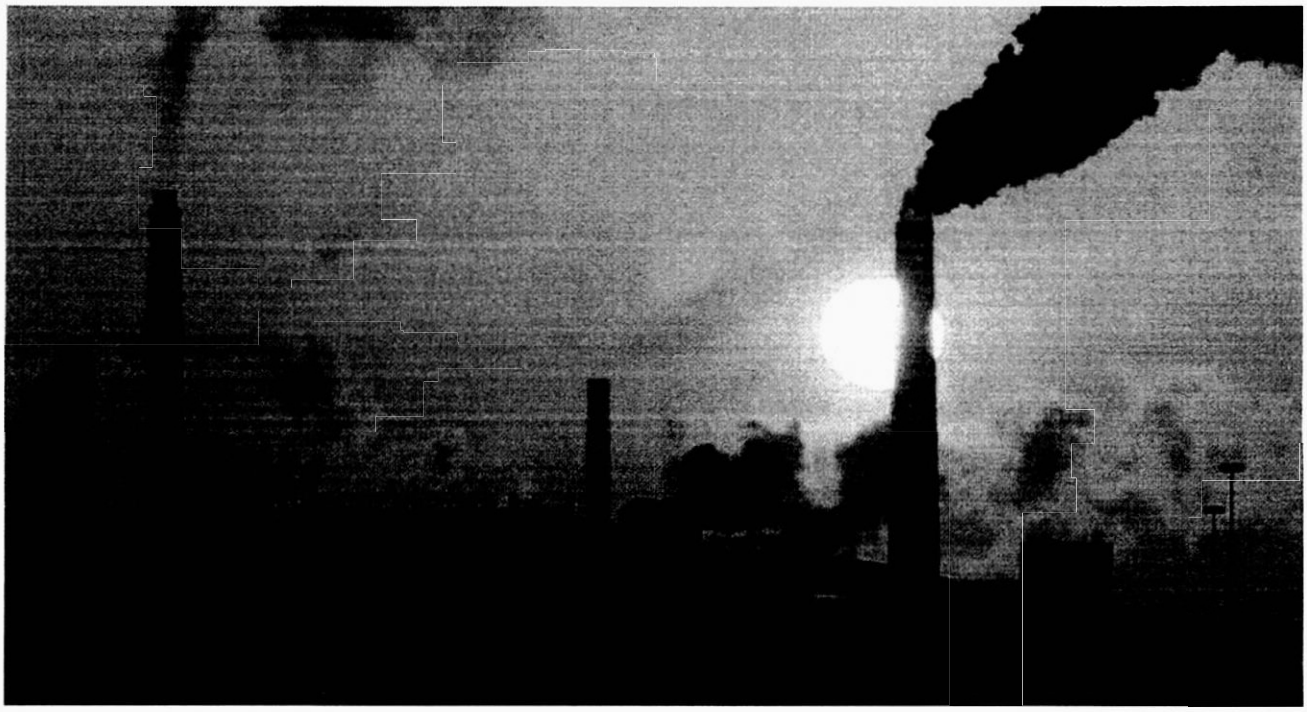
Under the Clean Air Act, the Clean Water Act and other environmental laws, the US Environmental Protection Agency (EPA) has the responsibility and authority to set and enforce emissions limits for pollutants deemed harmful to human health and the environment.

However, the head of the EPA under President Trump—Scott Pruitt—built his career suing the EPA to withdraw pollution protections. Actions he has taken since his tenure began, including regulatory rollbacks and delays, and cuts to the EPA's staffing and budget, put many protective standards in jeopardy.

## Coal and global warming

Photo: Thinkstock/Digital Vision

Climate change could cause irrevocable harm.



Of coal's many environmental impacts, none are as harmful, long term, and irreversible as global warming. Global warming is driven by emissions of heat-trapping gases, primarily from human activities, that rise into the atmosphere and act like a blanket, warming the earth's surface.

Consequences include rising temperatures and accelerating sea level rise as well as growing risks of drought, heat waves, heavy rainfall intensified storms, and species loss. Left unchecked climate change could lead to profound human and ecological disruption.

**Carbon dioxide** ($CO_2$) emissions from combusting fossil fuels are the main driver of global warming. $CO_2$ is also the main byproduct of coal combustion: nearly 4 grams of CO2 are produced for every gram of carbon burnt (depending on its type, coal can contain as much as 60 to 80 percent carbon).

**Methane** (CH4) often occurs in the same areas that coal is formed, and is released during mining activities. Methane is 34 times stronger than carbon dioxide at trapping heat over a 100-year period and 86 times stronger over 20 years; roughly 10 percent of all US methane emissions come from coal mining.

Carbon capture and storage technologies (or CCS) are emerging technologies that could allow coal plants to capture some of the CO2 they would otherwise release; the CO2 could then be transported and stored in a geological repository without harming the earth's climate. A few projects worldwide are currently operating, but the technology remains expensive, especially compared with cleaner forms of generation, and it is still unproven at the scale needed to materially contribute to addressing climate change. The deployment of CCS would also not reduce other harmful pollutants produced across the fuel cycle of coal.

To date the federal government has invested on the order of $5 billion dollars in CCS research, including $4.8 billion under the Obama administration and millions of dollars during the Bush administration.

The Union of Concerned Scientists supports continued federal incentives for research for a limited

number of full-scale integrated CCS demonstration projects, alongside private sector efforts. CCS technology could potentially play an important role in transitioning to a clean energy future, if significant cost, technical, legal and environmental challenges can be overcome.

UCS has spent decades advocating for clean energy technologies. You can read more about cleaner, reliable alternatives to coal—like wind and solar—here >

**Learn more:**

- All About Coal
- How Coal Works
- The Hidden Costs of Fossil Fuels
- Coal and Water Pollution

Last revised date: December 19, 2017



**Union of Concerned Scientists**
**Science for a Healthy Planet and Safer World**

**Science for a healthy planet and safer world**

U.S. Energy Information Administration

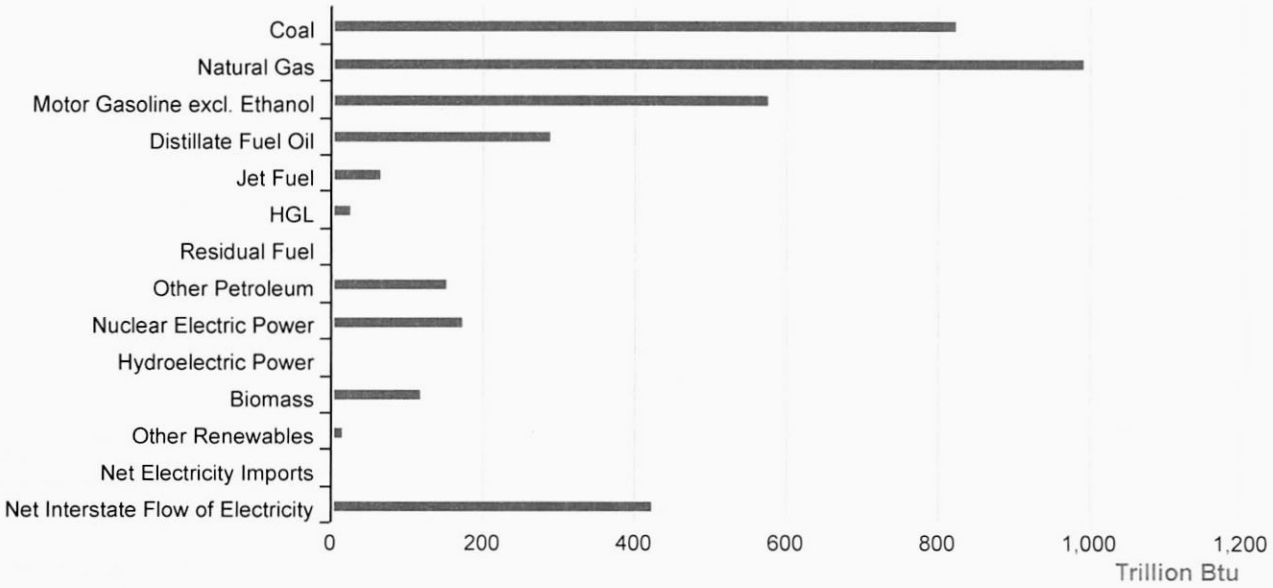
# Ohio State Energy Profile

## Ohio Quick Facts

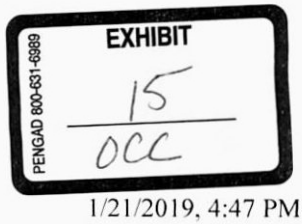
- The Utica Shale accounts for almost all of the rapid increase in natural gas production in Ohio, which was more than 21 times greater in 2017 than in 2012.
- Ohio is the eighth-largest ethanol-producing state in the nation, supplying almost 550 million gallons of ethanol per year.
- As of January 2017, Ohio had the sixth-largest crude oil-refining capacity in the nation.
- In 2017, coal fueled 58% of Ohio's net electricity generation, natural gas fueled 24%, and nuclear energy accounted for another 15%.
- In 2017, wind provided 53% of Ohio's electricity generation from renewable resources.

Last Updated: May 17, 2018

### Ohio Energy Consumption Estimates, 2016




Source: Energy Information Administration, State Energy Data System



# Data

**Last Update:** January 17, 2019 | **Next Update:** February 21, 2019

## Energy Indicators

| Demography | Ohio | Share of U.S. | Period |
|---|---|---|---|
| Population | 11.7 million | 3.6% | 2017 |
| Civilian Labor Force | 5.8 million | 3.5% | Nov-18 |
| **Economy** | **Ohio** | **U.S. Rank** | **Period** |
| Gross Domestic Product | $ 649.1 billion | 7 | 2017 |
| Gross Domestic Product for the Manufacturing Sector | $ 107,949 million | 3 | 2017 |
| Per Capita Personal Income | $ 45,615 | 30 | 2017 |
| Vehicle Miles Traveled | 118,608 million miles | 6 | 2016 |
| Land in Farms | 13.0 million acres | 23 | 2012 |
| **Climate** | **Ohio** | **U.S. Rank** | **Period** |
| Average Temperature | 53.3 degrees Fahrenheit | 25 | 2017 |
| Precipitation | 45.5 inches | 20 | 2017 |

## Prices

| Petroleum | Ohio | U.S. Average | Period | find more |
|---|---|---|---|---|
| Domestic Crude Oil First Purchase | $ 65.85 /barrel | $ 65.20 /barrel | Oct-18 | |
| **Natural Gas** | **Ohio** | **U.S. Average** | **Period** | find more |
| City Gate | NA | $ 4.08 /thousand cu ft | Oct-18 | find more |
| Residential | $ 12.62 /thousand cu ft | $ 12.26 /thousand cu ft | Oct-18 | find more |
| **Coal** | **Ohio** | **U.S. Average** | **Period** | find more |
| Average Sales Price | $ 42.28 /short ton | $ 33.72 /short ton | 2017 | |
| Delivered to Electric Power Sector | W | $ 2.04 /million Btu | Oct-18 | |
| **Electricity** | **Ohio** | **U.S. Average** | **Period** | find more |
| Residential | 12.48 cents/kWh | 12.87 cents/kWh | Oct-18 | find more |

## Prices

| | | | | |
|---|---|---|---|---|
| Commercial | 10.12 cents/kWh | 10.74 cents/kWh | Oct-18 | find more |
| Industrial | 6.73 cents/kWh | 6.91 cents/kWh | Oct-18 | find more |

## Reserves

| Reserves | Ohio | Share of U.S. | Period | find more |
|---|---|---|---|---|
| Crude Oil (as of Dec. 31) | 47 million barrels | 0.1% | 2017 | find more |
| Expected Future Production of Dry Natural Gas (as of Dec. 31) | 26,123 billion cu ft | 6.0% | 2017 | find more |
| Expected Future Production of Natural Gas Plant Liquids | -- | -- | 2017 | find more |
| Recoverable Coal at Producing Mines | 91 million short tons | 0.6% | 2017 | find more |
| **Rotary Rigs & Wells** | **Ohio** | **Share of U.S.** | **Period** | find more |
| Rotary Rigs in Operation | 13 rigs | 2.5% | 2016 | |
| Natural Gas Producing Wells | 28,640 wells | 5.9% | 2017 | find more |
| **Capacity** | **Ohio** | **Share of U.S.** | **Period** | |
| Crude Oil Refinery Capacity (as of Jan. 1) | 583,000 barrels/calendar day | 3.1% | 2017 | |
| Electric Power Industry Net Summer Capacity | 29,098 MW | 2.7% | Oct-18 | |

## Supply & Distribution

| Production | Ohio | Share of U.S. | Period | find more |
|---|---|---|---|---|
| Total Energy | 2,411 trillion Btu | 2.9% | 2016 | find more |
| Crude Oil | 2,497 thousand barrels | 0.7% | Oct-18 | find more |
| Natural Gas - Marketed | 1,772,932 million cu ft | 6.1% | 2017 | find more |
| Coal | 9,489 thousand short tons | 1.2% | 2017 | find more |
| **Total Utility-Scale Net Electricity Generation** | **Ohio** | **Share of U.S.** | **Period** | find more |

## Supply & Distribution

| | | | | |
|---|---|---|---|---|
| Total Net Electricity Generation | 10,797 thousand MWh | 3.3% | Oct-18 | |
| **Utility-Scale Net Electricity Generation (share of total)** | **Ohio** | **U.S. Average** | **Period** | |
| Petroleum-Fired | 0.1 % | 0.3 % | Oct-18 | find more |
| Natural Gas-Fired | 35.1 % | 38.1 % | Oct-18 | find more |
| Coal-Fired | 46.6 % | 26.9 % | Oct-18 | find more |
| Nuclear | 14.9 % | 18.3 % | Oct-18 | find more |
| Renewables | 2.7 % | 15.8 % | Oct-18 | |
| **Stocks** | **Ohio** | **Share of U.S.** | **Period** | find more |
| Motor Gasoline (Excludes Pipelines) | 718 thousand barrels | 4.3% | Oct-18 | |
| Distillate Fuel Oil (Excludes Pipelines) | 1,759 thousand barrels | 1.9% | Oct-18 | find more |
| Natural Gas in Underground Storage | 495,464 million cu ft | 6.5% | Oct-18 | find more |
| Petroleum Stocks at Electric Power Producers | 327 thousand barrels | 1.3% | Oct-18 | find more |
| Coal Stocks at Electric Power Producers | 2,838 thousand tons | 2.7% | Oct-18 | find more |
| **Fueling Stations** | **Ohio** | **Share of U.S.** | **Period** | |
| Motor Gasoline | 3,804 stations | 3.4% | 2016 | |
| Liquefied Petroleum Gases | 81 stations | 2.5% | 2017 | |
| Electricity | 277 stations | 1.8% | 2017 | |
| Ethanol | 147 stations | 5.1% | 2017 | |
| Compressed Natural Gas and Other Alternative Fuels | 51 stations | 4.0% | 2017 | |

## Consumption & Expenditures

| **Summary** | **Ohio** | **U.S. Rank** | **Period** | |
|---|---|---|---|---|
| Total Consumption | 3,685 trillion Btu | 7 | 2016 | find more |
| Total Consumption per Capita | 317 million Btu | 22 | 2016 | find more |

## Consumption & Expenditures

| | | | | |
|---|---|---|---|---|
| Total Expenditures | $ 37,835 million | 6 | 2016 | find more |
| Total Expenditures per Capita | $ 3,255 | 30 | 2016 | find more |
| **by End-Use Sector** | **Ohio** | **Share of U.S.** | **Period** | |
| Consumption | | | | |
| » Residential | 867 trillion Btu | 4.3% | 2016 | find more |
| » Commercial | 700 trillion Btu | 3.9% | 2016 | find more |
| » Industrial | 1,192 trillion Btu | 3.8% | 2016 | find more |
| » Transportation | 926 trillion Btu | 3.3% | 2016 | find more |
| Expenditures | | | | |
| » Residential | $ 9,412 million | 4.0% | 2016 | find more |
| » Commercial | $ 6,098 million | 3.4% | 2016 | find more |
| » Industrial | $ 6,743 million | 4.0% | 2016 | find more |
| » Transportation | $ 15,583 million | 3.5% | 2016 | find more |
| **by Source** | **Ohio** | **Share of U.S.** | **Period** | |
| Consumption | | | | |
| » Petroleum | 217.1 million barrels | 3.0% | 2016 | find more |
| » Natural Gas | 931.0 billion cu ft | 3.4% | 2016 | find more |
| » Coal | 33.1 million short tons | 4.5% | 2016 | find more |
| Expenditures | | | | |
| » Petroleum | $ 18,266 million | 3.3% | 2016 | find more |
| » Natural Gas | $ 4,929 million | 3.8% | 2016 | find more |
| » Coal | $ 1,870 million | 5.9% | 2016 | find more |
| **Consumption for Electricity Generation** | **Ohio** | **Share of U.S.** | **Period** | find more |
| Petroleum | 23 thousand barrels | 1.3% | Oct-18 | find more |
| Natural Gas | 27,086 million cu ft | 3.0% | Oct-18 | find more |
| Coal | 2,095 thousand short tons | 4.3% | Oct-18 | find more |
| **Energy Source Used for Home Heating (share of households)** | **Ohio** | **U.S. Average** | **Period** | |
| Natural Gas | 65.5 % | 48.0 % | 2017 | |
| Fuel Oil | 2.1 % | 4.7 % | 2017 | |

## Consumption & Expenditures

| | | | |
|---|---|---|---|
| Electricity | 24.1 % | 39.0 % | 2017 |
| Propane | 5.2 % | 4.7 % | 2017 |
| Other/None | 3.2 % | 3.6 % | 2017 |

## Environment

| **Renewable Energy Capacity** | **Ohio** | **Share of U.S.** | **Period** | find more |
|---|---|---|---|---|
| Total Renewable Energy Electricity Net Summer Capacity | 1,044 MW | 0.5% | Oct-18 | |
| Ethanol Plant Operating Capacity | 548 million gal/year | 3.5% | 2018 | |
| **Renewable Energy Production** | **Ohio** | **Share of U.S.** | **Period** | find more |
| Utility-Scale Hydroelectric Net Electricity Generation | 47 thousand MWh | 0.3% | Oct-18 | |
| Utility-Scale Solar, Wind, and Geothermal Net Electricity Generation | 190 thousand MWh | 0.7% | Oct-18 | |
| Utility-Scale Biomass Net Electricity Generation | 58 thousand MWh | 1.1% | Oct-18 | |
| Distributed (Small-Scale) Solar Photovoltaic Generation | 12 thousand MWh | 0.5% | Oct-18 | |
| Ethanol Production | 12,923 Thousand Barrels | 3.5% | 2016 | |
| **Renewable Energy Consumption** | **Ohio** | **U.S. Rank** | **Period** | find more |
| Renewable Energy Consumption as a Share of State Total | 3.9 % | 48 | 2016 | |
| Ethanol Consumption | 11,536 thousand barrels | 6 | 2016 | |
| **Total Emissions** | **Ohio** | **Share of U.S.** | **Period** | find more |
| Carbon Dioxide | 207.4 million metric tons | 4.0% | 2016 | |
| **Electric Power Industry Emissions** | **Ohio** | **Share of U.S.** | **Period** | find more |
| Carbon Dioxide | 79,917 thousand metric tons | 4.3% | 2017 | |

| Environment | | | |
|---|---|---|---|
| Sulfur Dioxide | 109 thousand metric tons | 6.6% | 2017 |
| Nitrogen Oxide | 65 thousand metric tons | 4.2% | 2017 |

# Analysis

Last Updated: May 17, 2018

## Overview

Ohio, named after the river that forms its southern boundary, is a Great Lakes state bordered on the north by Lake Erie, the twelfth-largest lake in the world.[1,2] The eastern half of Ohio is occupied by the hills and valleys of the Appalachian Plateau, part of the larger Appalachian Basin.[3] Ohio's coal resources and most of the state's many natural gas and crude oil fields are located there. Several more oil fields lie further to the west in a narrow belt that crosses northwestern Ohio.[4,5] Western Ohio's rolling plains have some of the most fertile farmland in the nation and mark the beginning of the nation's Corn Belt, which extends westward across the Midwest.[6] Corn and soybeans are the state's leading crops, and corn is used as the feedstock at most of Ohio's ethanol plants.[7,8] Prevailing winds that blow across Ohio from the southwest deliver wind resources to the state, and Lake Erie provides an important offshore wind energy resource as well.[9,10]

With its large population, heavily industrial economy, and large seasonal temperature variations, Ohio is among the top 10 states in total energy consumption.[11,12,13] Energy consumption is greatest in Ohio's industrial sector.[14] The state's primary economic activities are in the financial and manufacturing sectors. A significant amount of Ohio's manufacturing is related to the production of chemicals; motor vehicles and transportation equipment; food, beverage, and tobacco products; fabricated metals; machinery; and minerals extraction, including oil, natural gas, and coal.[15] With the fourth-largest interstate highway system in the nation, Ohio's transportation sector consumes the second-largest amount of energy in the state.[16] Despite Ohio's strong industrial base, extensive highway system, and below freezing winter temperatures, total per capita energy consumption in the state is near the national median.[17]

## Natural gas

In 2017, natural gas production in Ohio was more than 21 times greater than in 2012, rising from less than 0.3% of the nation's total to nearly 5.4% during that period. Almost all of the state's natural gas production comes from shale gas wells, and the substantial increase in Ohio's natural gas reserves and production reflects the higher production from those wells.[18,19,20] Most of that natural gas production is from the Utica Shale.[21,22] Ohio's marketed natural gas production surpassed state demand for the first time in 2015, but as production has increased consumption has not, and the state now has a surplus supply.[23,24]

*In 2015, natural gas production in Ohio surpassed state demand for the first time.*

Several interstate natural gas pipelines cross Ohio.[25] The 2009 extension of the Rockies Express Pipeline (REX) to Clarington, Ohio, near the border with West Virginia, led to the formation of new natural gas trading points in the state. In August 2015, the eastern section of the REX became bidirectional, allowing delivery of natural gas from the Appalachian Basin to the Midwest, as well as delivery of Rocky Mountain natural gas to the East.[26,27] Ohio receives natural gas deliveries from other states, but, because of the increased Ohio natural gas production, more natural gas leaves the state than arrives there. Most of the natural gas that leaves Ohio is sent on to Kentucky, Indiana, and Michigan.[28] Some of the state's natural gas is placed in storage. Ohio has 24 natural gas storage fields with a combined total storage capacity of almost 576 billion cubic feet, about 6% of the nation's total.[29,30] To meet peak demand in winter, Ohio withdraws natural gas from storage.[31]

Ohio is one of the 10 largest states by population and is among the top 10 natural gas-consuming states.[32,33] The residential sector, where two-thirds of the households use natural gas for home heating, and the industrial sector are the state's largest natural gas consumers, followed by the electric power sector.[34,35] Natural gas use for electric power generation in Ohio has increased markedly in the past decade and was more than eight times greater in 2017 than in 2008.[36,37]

## Coal

*Ohio is the 8th-largest bituminous coal-producing state in the nation.*

Bituminous coal is one of Ohio's primary fossil fuel resources. The state has almost 1.4% of the nation's recoverable coal reserves at producing mines.[38] Ohio is the 13th-largest coal-producing state in the nation, and it is the 8th-largest producer of bituminous coal. All of the coal produced in Ohio is bituminous coal. More than half of the state's mining operations are surface mines, but most of Ohio's coal comes from the state's underground mines.[39,40] Two-fifths of the coal mined in Ohio is shipped out to other states by barge, truck, and rail. A small amount of Ohio coal is exported to other countries.[41,42] Coal from Ohio and other states is shipped from the state's ports along Lake Erie and on the Ohio River.[43] The Cleveland Customs District is a leading Great Lakes center for coal export.[44] Coal is transferred from rail to vessels at several points on Lake Erie, including ports at Toledo and Loraine, and shipped from there throughout the Great Lakes region and overseas.[45] Coal is also shipped on the Ohio River from Cincinnati, one of the nation's largest inland coal ports.[46]

Ohio is among the top five coal-consuming states in the nation along with Texas, Indiana, Pennsylvania, and Illinois.[47] Almost three times as much coal is consumed in Ohio as is produced there.[48,49] To meet the state's needs, coal is brought in from several surrounding states by barge, rail, and truck. Coal arrives primarily from West Virginia, Pennsylvania, Illinois, Indiana, and Kentucky. Lesser amounts come from several other states, including from as far away as Wyoming.[50] Almost 90% of the coal consumed in Ohio is used for electric power generation.[51]

## Petroleum

Ohio's crude oil reserves and production are modest, but, among the states in the Appalachian basin, Ohio is first in production and second only to Alabama in reserves.[52,53] The state's crude oil production has increased in recent years, reaching a high of almost 27 million barrels in 2015, and proved reserves reached a peak of 78 million barrels in 2014, the highest level in nearly 30 years.[54,55] A surge in drilling in the Utica/Point Pleasant and Marcellus shale formations using advanced technologies accounted for the increase.[56,57] Despite the increases, Ohio's crude oil production remains below 1% of the nation's total.[58]

*Ohio is among the top 10 oil-refining states in the nation.*

Ohio is consistently among the top 10 oil-refining states in the nation.[59] The state's four refineries have a combined processing capacity of about 583,000 barrels of crude oil per calendar day.[60] Collectively, they can process a wide variety of crude oils from light, sweet crudes to heavy, sour ones. The crude oils come from Canada, the Midcontinent region, North Dakota, the Appalachian Basin, and the U.S. Gulf Coast. Among the finished products from Ohio's refineries are transportation fuels, including motor gasoline, aviation fuels, and diesel fuels. Petroleum products are shipped from the state's refineries by pipeline, truck, and rail.[61,62,63] Petroleum products also move in and out of port facilities on Lake Erie.[64]

Total petroleum demand in Ohio far exceeds the state's production, and the state is among the top 10 petroleum-consuming states in the nation.[65,66] Most of the petroleum consumed in Ohio is used as transportation fuels, either as motor gasoline or diesel fuel.[67] Conventional motor gasoline can be sold throughout the state.[68] However, Ohio has substantial ethanol production capacity, and the additive is blended into most of the state's motor gasoline.[69] The

industrial sector is the state's second-largest consumer of petroleum. Neither the residential sector, where fewer than 1 in 13 Ohio households heat with petroleum products, nor the electric power sector use much petroleum.[70,71]

## Electricity

The primary fuel for electricity generation in Ohio is coal. Eight of Ohio's 10 largest power plants by capacity are coal-fired, although only 6 are among the 10 largest by generation.[72] In recent years, coal's share of generation and the number of coal-fired power plants in the state has decreased.[73] In 2015, 15% of the state's coal-fired generating capacity was retired. However, in 2017, coal still fueled almost three-fifths of the state's net generation.[74,75] Even though natural gas-fired generation has increased greatly since 2008, it accounted for less than one-fourth of the state's net generation in 2017.[76,77] Ohio's two nuclear power plants, located along Lake Erie, supply about one-seventh of the state's net generation.[78,79] Renewable energy resources, gases derived from fossil fuels, petroleum coke, and petroleum are used to produce almost all of the remainder of Ohio's net generation.[80]

Ohio is among the top 10 electric power generators in the nation and among the top 5 states in retail electricity sales. The residential sector, where almost one in four households heat with electricity, accounts for the largest share of retail electricity sales in Ohio.[81,82] Because in-state generation does not meet consumer demand, Ohio is a net recipient of electricity from outside of the state.[83] Ohio is part of the PJM Interconnection, which coordinates the movement of electricity through all or part of 12 states between the Mississippi River and the Atlantic Ocean.[84] In August 2003, a transmission failure in northeastern Ohio led to the largest blackout to date in North America, affecting more than 50 million people in the northeastern United States and Canada for up to two days.[85] It took only nine seconds for the grid to collapse.[86] A U.S.-Canadian joint task force investigated the causes of the blackout and a number of task force recommendations were incorporated into federal laws that established standards for electricity reliability nationwide.[87]

## Renewable energy

Renewable energy resources, including hydroelectric power, supply about 2.5% of Ohio's net electricity generation. Wind provides the largest share.[88,89] The 304-megawatt Blue Creek Wind Farm, with 152 2-megawatt turbines, became the state's largest wind farm when it was completed in 2012.[90,91] By 2017, Ohio had 37 wind projects online, at least a dozen of which had generating capacities of greater than 1 megawatt.[92,93] Most of the state's larger wind farms are in western Ohio, the area with the greatest wind potential.[94,95] At the end of 2017, Ohio had 617 megawatts of installed wind capacity online and more than 275 megawatts of capacity under construction.[96,97] Offshore wind-powered generation in Lake Erie is planned with a demonstration project called Icebreaker in development in Lake Erie northwest of Cleveland.[98]

*Ohio is exploring offshore wind power development in Lake Erie.*

Biomass from wood and wood waste, municipal solid waste, landfill gas, and biodigesters contributes to Ohio's net electricity generation. There are 19 utility-scale power plants fueled by landfill gas or other biomass in Ohio.[99] Together those plants fuel only a small portion of the state's net electricity generation, but they account for about three-tenths of Ohio's nonhydroelectric renewable sourced power generation.[100] Two wood pellet manufacturing facilities that produce a combined total of about 105,000 short tons of pellets per year are also located in Ohio. Wood pellets are used for power generation and for heating.[101] In 2017, solar photovoltaic (PV) generation contributed about one-tenth of Ohio's nonhydroelectric renewable generation. More than half of that was distributed (small-scale, customer-sited) generation.[102] However, Ohio has 16 utility-scale (more than 1 megawatt of generating capacity) solar PV power facilities. The two largest solar installations in the state are the 10-megawatt Wyandot Solar Farm and the 8-megawatt Napoleon Solar Project, both located in the northwestern part of the state.[103]

Ohio is the eighth-largest ethanol-producing state in the nation.[104] All but one of the state's eight operational ethanol

plants use corn as a feedstock. The remaining plant uses waste industrial alcohol.[105] Ohio's ethanol plants produce almost 550 million gallons of ethanol per year, and state fuel ethanol consumption is about 480 million gallons per year.[106] Ohio also has one operational biodiesel plant that processes soy oil into biofuels. That plant has a capacity of about 60 million gallons per year.[107]

Ohio has both an alternative energy portfolio standard (AEPS) and an energy efficiency portfolio standard (EEPS). The AEPS requires the state's investor-owned utilities and retail electricity providers—except municipal utilities and electric cooperatives—to obtain 12.5% of their retail electricity sales of power generated from alternative energy resources by the end of 2026. The AEPS includes a separate solar energy requirement.[108] Ohio's EEPS requires that utilities put in place energy efficiency and peak demand reduction programs that achieve a 7.75% reduction in peak demand by 2020 and cumulative energy savings of 22% by 2027.[109]

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# Other Resources

## Energy-Related Regions and Organizations

- Coal Region: Appalachian
- Petroleum Administration for Defense District (PADD): 2
- North American Electric Reliability Corporation (NERC) Regional Entity: Reliability First Corporation (RFC)
- Regional Transmission Organization (RTO)/Independent System Operator (ISO): Midcontinent Transmission System Operator (MISO), PJM Interconnection (PJM)

## Other Websites

- Ohio Development Services Agency, Business, Advanced Energy and Efficiency Programs
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- Ohio Department of Natural Resources Division of Oil and Gas Resources
- Ohio Development Services Agency, State Energy Program (SEP)
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- National Association of Regulatory Utility Commissioners (NARUC)
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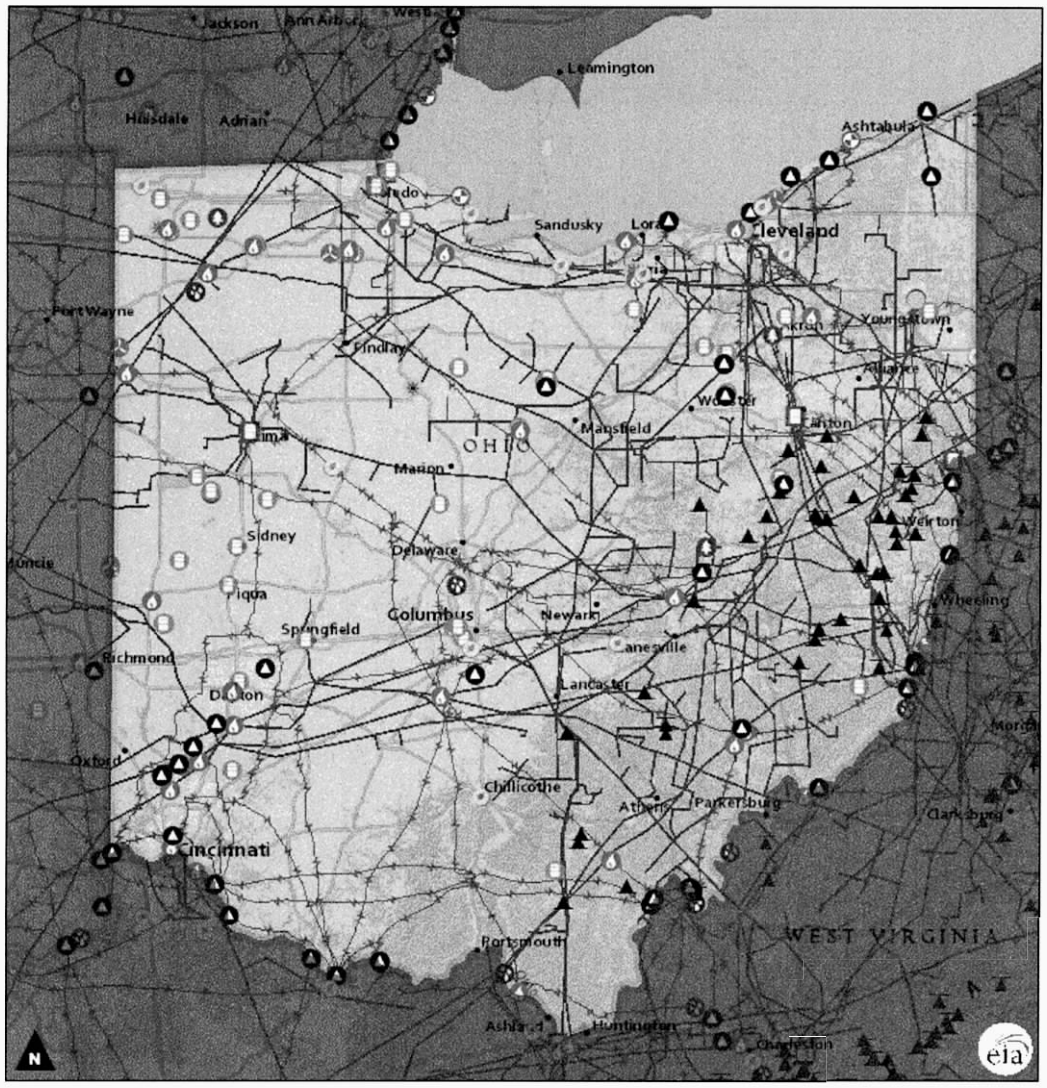
- U.S. Geological Survey, Maps
- Lawrence Livermore National Laboratory, Energy Flow Diagrams
- U.S. Department of Energy, State and Local Energy Data (SLED)
- EIA Natural Gas Storage Dashboard

Email suggestions for additional Ohio website resources to: states@eia.gov.




States:Electricity Transmission Lines - Ventyx, Velocity Suite;Grey Base:National

0 15 30 60 Miles

| | | |
|---|---|---|
| Mask | Hydroelectric Power Plant | Pumped Storage Power Plant |
| Surface Coal Mine | Natural Gas Power Plant | Solar Power Plant |
| Underground Coal Mine | Nuclear Power Plant | Wind Power Plant |
| Biomass Power Plant | Other Power Plant | Wood Power Plant |
| Coal Power Plant | Other Fossil Gases Power Plant | Petroleum Refinery |
| Geothermal Power Plant | Petroleum Power Plant | Strategic Petroleum Reserve |

http://www.eia.gov/state/

## Table 7. Electric power industry emissions estimates, 1990 through 2014

### Ohio

| Emission type | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 |
|---|---|---|---|---|---|---|---|---|
| Sulfur dioxide (short tons) | | | | | | | | |
| Coal | 328,298 | 314,945 | 360,893 | 649,158 | 643,705 | 664,660 | 760,207 | 1,022,707 |
| Natural gas | 52 | 49 | 56 | 29 | 18 | 10 | 7 | 10 |
| Other | 2,186 | 2,325 | 2,536 | 2,487 | 2,583 | 2,588 | 2,586 | 2,217 |
| Petroleum | 24,572 | 29,554 | 27,603 | 27,070 | 26,374 | 20,682 | 36,206 | 31,018 |
| Total | 355,108 | 346,873 | 391,088 | 678,744 | 672,679 | 687,940 | 799,006 | 1,055,950 |
| Nitrogen oxide (short tons) | | | | | | | | |
| Coal | 87,637 | 84,220 | 82,619 | 122,806 | 124,365 | 114,015 | 237,743 | 242,740 |
| Natural gas | 2,472 | 2,617 | 2,738 | 1,687 | 1,183 | 980 | 939 | 1,758 |
| Other | 12,413 | 12,241 | 11,573 | 5,555 | 5,643 | 3,547 | 1,409 | 1,377 |
| Petroleum | 3,166 | 3,448 | 3,370 | 3,877 | 3,770 | 2,944 | 4,717 | 4,387 |
| Total | 105,688 | 102,526 | 100,300 | 133,925 | 134,960 | 121,487 | 244,808 | 250,263 |
| Carbon dioxide (thousand metric tons) | | | | | | | | |
| Coal | 86,571 | 90,898 | 83,439 | 104,732 | 116,465 | 110,910 | 125,468 | 127,713 |
| Natural gas | 9,873 | 9,129 | 9,685 | 5,330 | 3,298 | 2,164 | 1,380 | 2,132 |
| Other | 20 | 27 | 34 | 26 | 33 | 31 | 28 | 23 |
| Petroleum | 2,187 | 2,411 | 2,365 | 2,231 | 2,168 | 1,961 | 2,184 | 2,103 |
| Total | 98,650 | 102,466 | 95,523 | 112,320 | 121,964 | 115,066 | 129,061 | 131,970 |
| Total emission rate (lbs/MWh) | | | | | | | | |
| Sulfur dioxide | 5.3 | 5.1 | 6.0 | 10.0 | 9.4 | 10.1 | 10.4 | 13.6 |
| Nitrogen oxide | 1.6 | 1.5 | 1.5 | 2.0 | 1.9 | 1.8 | 3.2 | 3.2 |
| Carbon dioxide | 1,614 | 1,642 | 1,620 | 1,822 | 1,869 | 1,860 | 1,851 | 1,871 |

Source: Calculations made by the Electric Power Systems and Reliability Team; Office of Electricity, Renewables, and Uranium Statistics; U.S. Energy Information Administration.

| 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,037,604 | 1,157,246 | 1,150,521 | 1,250,636 | 1,193,241 | 1,191,814 | 1,258,662 | 1,318,060 | 1,426,879 | 1,462,973 | 1,485,827 | 1,209,189 | 2,085,965 |
| 7 | 7 | 6 | 3 | 6 | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| 2,076 | 2,276 | 2,254 | 2,102 | 2,016 | 2,007 | 10,655 | 10,939 | 9,960 | 10,677 | 10,567 | 7,496 | 10,913 |
| 29,486 | 5,216 | 4,203 | 4,631 | 12,556 | 10,676 | 985 | 18,266 | 19,669 | 18,307 | 21,562 | 16,106 | 3,474 |
| 1,069,175 | 1,164,746 | 1,156,982 | 1,257,372 | 1,207,822 | 1,204,497 | 1,270,310 | 1,347,272 | 1,456,510 | 1,491,963 | 1,517,964 | 1,232,797 | 2,100,354 |
| | | | | | | | | | | | | |
| 242,886 | 258,212 | 271,970 | 359,361 | 375,194 | 340,242 | 381,665 | 432,258 | 522,507 | 544,946 | 580,934 | 535,963 | 532,713 |
| 1,469 | 1,270 | 1,746 | 1,540 | 1,387 | 979 | 2,273 | 2,358 | 2,313 | 2,304 | 2,328 | 1,112 | 892 |
| 1,307 | 1,585 | 1,661 | 1,926 | 2,478 | 2,310 | 5,203 | 4,666 | 4,650 | 4,543 | 3,958 | 2,973 | 2,581 |
| 1,602 | 1,607 | 1,443 | 2,458 | 3,985 | 4,270 | 1,461 | 3,979 | 3,095 | 2,883 | 3,199 | 2,837 | 1,359 |
| 247,267 | 262,672 | 276,820 | 365,291 | 383,048 | 347,804 | 390,600 | 443,258 | 532,562 | 554,671 | 590,418 | 542,884 | 537,546 |
| | | | | | | | | | | | | |
| 126,983 | 130,411 | 122,112 | 127,448 | 122,750 | 118,098 | 124,480 | 118,375 | 123,412 | 119,657 | 122,506 | 114,890 | 113,097 |
| 1,358 | 1,611 | 1,187 | 1,230 | 1,371 | 1,169 | 1,203 | 1,293 | 912 | 755 | 770 | 698 | 335 |
| 8 | 9 | 14 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 7 | 7 |
| 2,220 | 1,386 | 1,431 | 414 | 311 | 428 | 417 | 1,073 | 982 | 976 | 1,053 | 795 | 921 |
| 130,568 | 133,417 | 124,744 | 129,092 | 124,432 | 119,695 | 126,100 | 120,740 | 125,309 | 121,388 | 124,330 | 116,390 | 114,359 |
| | | | | | | | | | | | | |
| 13.8 | 14.8 | 15.6 | 17.1 | 16.4 | 16.9 | 17.0 | 18.9 | 19.7 | 20.9 | 21.0 | 17.7 | 31.9 |
| 3.2 | 3.3 | 3.7 | 5.0 | 5.2 | 4.9 | 5.2 | 6.2 | 7.2 | 7.8 | 8.2 | 7.8 | 8.2 |
| 1,848 | 1,870 | 1,850 | 1,937 | 1,861 | 1,851 | 1,861 | 1,866 | 1,863 | 1,870 | 1,894 | 1,838 | 1,909 |

| 1993 | 1992 | 1991 | 1990 |
|---|---|---|---|
| | | | |
| 2,172,699 | 2,204,132 | 2,247,165 | 2,213,291 |
| 0 | 1 | 1 | 0 |
| 1,909 | 2,554 | 3,200 | 2,229 |
| 3,977 | 3,837 | 4,942 | 4,263 |
| 2,178,585 | 2,210,524 | 2,255,308 | 2,219,783 |
| | | | |
| 561,792 | 557,684 | 554,860 | 550,693 |
| 1,027 | 928 | 988 | 757 |
| 1,565 | 1,928 | 2,140 | 1,804 |
| 1,527 | 1,497 | 1,653 | 1,401 |
| 565,912 | 562,037 | 559,641 | 554,656 |
| | | | |
| 117,485 | 113,902 | 111,863 | 109,566 |
| 402 | 364 | 389 | 291 |
| 7 | 9 | 0 | 9 |
| 873 | 848 | 902 | 741 |
| 118,767 | 115,123 | 113,155 | 110,607 |
| | | | |
| 32.2 | 32.1 | 33.7 | 34.7 |
| 8.4 | 8.2 | 8.4 | 8.7 |
| 1,932 | 1,840 | 1,857 | 1,901 |

Climate Changed

# Businesses Are Buying More Renewable Power Than Ever Before

By Brian Eckhouse
April 30, 2018, 4:00 PM EDT
*Updated on May 1, 2018, 12:01 AM EDT*

- Buyers already signed deals for 3.3 gigawatts this year
- On pace to break record of 4.8 gigawatts set in 2017


The Way Humans Get Electricity Is About to Change Forever

Companies are buying renewable power at a record pace.

AT&T Inc. and Walmart Inc. are among 36 businesses, government agencies and universities that have agreed to buy 3.3 gigawatts of wind and solar power so far this year. That's on track to shatter the previous high of 4.8 gigawatts of disclosed deals last year, according to a report Monday by Bloomberg New Energy Finance.

One of the key reasons is that smaller companies are more comfortable doing these deals now.

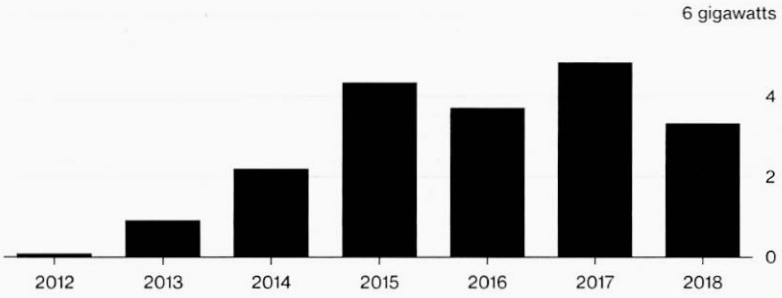
Replay

"There's a blueprint now," said Kyle Harrison, a New York-based analyst at Bloomberg New Energy Finance. "So it's a lot easier for other companies to do it." In addition to the 4.8 gigawatts in announced deals last year, BNEF also estimates 600 megawatts of undisclosed contracts were signed in Asia.

The gains are also due to local renewables program and growing demand in international markets like Mexico and Australia.

## Buying Binge

Corporations are acquiring more clean power than ever before




Source: Bloomberg New Energy Finance
Note: 2018 total through April 30. All totals are for disclosed deals.

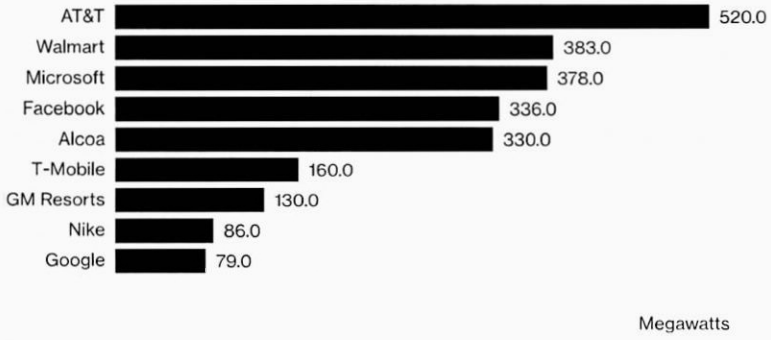
There are several reasons clean power is attractive. Renewable energy is often the cheapest source of electricity. Long-term contracts to buy clean power from wind and solar farms can also act as hedges against uncertain wholesale prices.

Google and other big technology companies have driven the trend, but the pool of clean-power buyers is deepening.

Smaller companies have benefited from growing standardization in the ways companies agree to buy clean energy. Sometimes these companies are recruited to buy wind and solar power from the same power plant as larger buyers that function "like anchor tenants," Harrison said.

## Green Giants

Telecoms and technology companies among biggest 2018 buyers of clean power




Source: Bloomberg New Energy Finance

Other findings from the BNEF report:

- Of the 3.3 gigawatts of clean-power deals signed this year, 76 percent involve U.S. power projects
- The 15 clean-power deals signed globally in April will add almost 1.1 gigawatts of new wind and solar power
- Industrias Penoles SAB signed the largest agreement in April, a 245-megawatt wind-power contract that's also the biggest such deal in Mexico since a landmark energy-market reform
- Mumbai Metro signed India's second-biggest corporate power-purchase agreement

### In this article

T
**AT&T INC**
28.31 USD ▼ -0.23 -0.81%

WMT
**WALMART INC**
92.24 USD ▼ -0.91 -0.97%

GOOGL
**ALPHABET INC-A**
1,032.87 USD ▼ -12.09 -1.16%