Texas' Energy Base Drives Climate Concerns as Renewables Expand

By Emma Marshall and Jesse Thompson

ABSTRACT: The energy industry's large presence in Texas—production and refining—is a key contributor to carbon emissions. At the same time, the state is a renewable energy leader, especially with its large share of wind-based electricity generation. Both trends place the state in the center of the debate about climate change and reducing greenhouse gases.

Texas emits more carbon dioxide (CO_2) gas—a leading contributor to climate change—than any other state in the U.S., though much of the discharge is indicative of the state's larger economy and population.[1] It also reflects the prominence of the region's energy industry.

The Permian Basin produced 32 percent of the nation's crude oil in 2018, and significant portions of the nation's refining and petrochemical capacity are concentrated along the Gulf Coast.

Texas also has the nation's second-largest population (28 million residents) and economy ($1.7 trillion in economic output) after California. CO_2 emissions in terms of population and output—the carbon intensity of the state—put the state in the middle of the pack. Viewed that way, Texas emitted 23 metric tons of CO_2 per capita, ranking 12th nationally, and 0.4 metric tons per $1,000 of gross domestic product (GDP), ranking 18th nationally *(Chart 1)*.[2]

Emissions of CO_2 are important because CO_2 is a primary greenhouse gas, which prevents heat from radiating into space. According to government reports, the burning of fossil fuels contributed substantially to a 40 percent net increase in the CO_2 content of the Earth's atmosphere between 1750 and 2011.[3]

To the extent that climate change results in global warming and more frequent extreme weather events, it will have repercussions for the U.S. and Texas economies.

Emissions and the States

The top CO_2-emitting states by GDP are Wyoming, West Virginia and North Dakota, due to their relatively high use of coal for energy, low population densities and long, cold winters.

By comparison, New York has the lowest emissions per capita and per dollar of GDP, due to high population density, a relatively service-sector-focused economy and heavier reliance on natural gas and carbon-free nuclear power. New York City, accounting for much of the state population, has large numbers of multifamily housing units, including high-rise buildings, which distribute heat relatively efficiently. Moreover, extensive public-transit commuting contributes to a lower-emissions environment.[4]

Accumulated greenhouse gas is changing the Earth's climate, contributing to rising average temperatures and increases in extreme weather events, according to the most recent National Climate Assessment (NCA), a scientific report published by the federal government. Studies suggest that the Federal Reserve Bank of Dallas' region of Texas, northern Louisiana and southern New Mexico, already known for temperamental weather, faces the probability of stronger storms and increased episodes of hail and tornadic activity.[5]

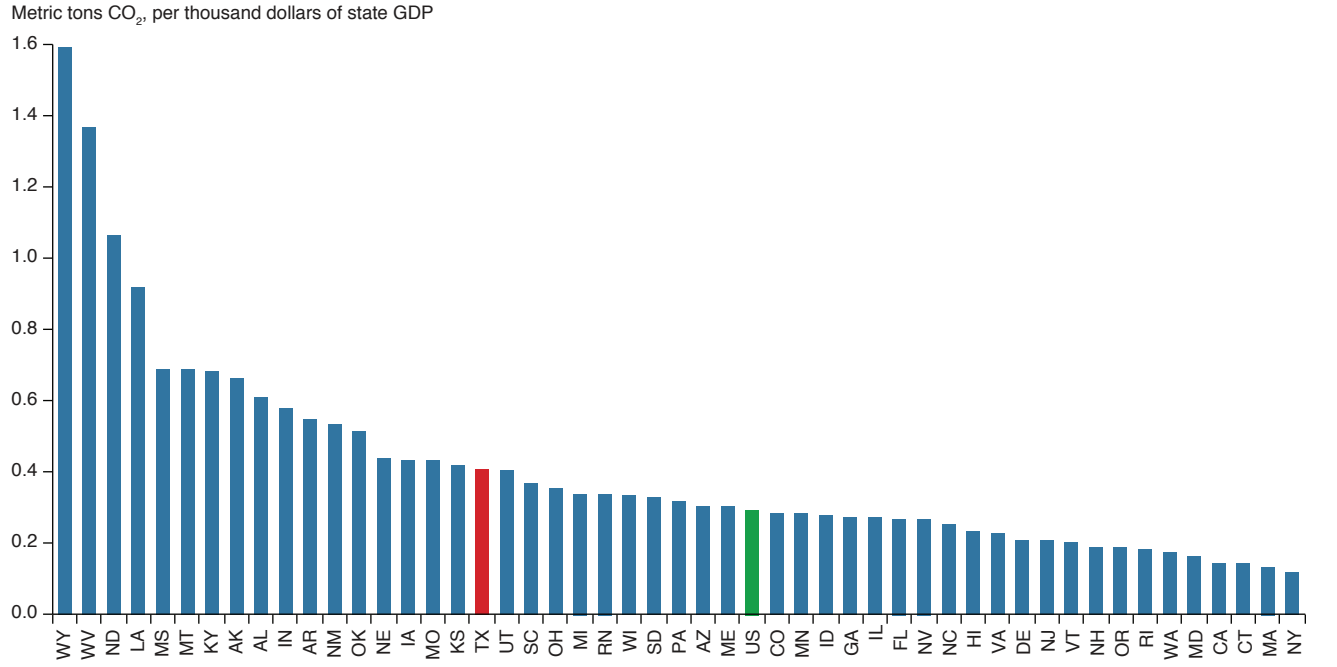
Climate change will require greater investment for emergency preparedness and more resilient infrastructure. It may also lead to government policies directed at reducing global warming, changes that would likely target carbon emissions and the activities that produce them.

Most Overall Emissions

Texas' CO_2 emissions have been increasing. The state's outsized volume of emissions arises in part from the state's disproportionate share of energy-intensive manufacturing as well as its growing auto-dependent population. Nationwide, motor vehicles are

CHART 1

Texas Has Less Carbon Emissions per Thousand Dollars of GDP than 17 States



NOTE: 2016 state gross domestic product (GDP) in chained 2012 dollars.
SOURCES: Bureau of Economic Analysis; Energy Information Administration; authors' calculations.

a leading CO_2 contributor in major population centers.

Texas is an important supplier to domestic and global markets of a range of products from motor fuels to petrochemicals.

Texas emitted almost twice as much CO_2—653 million metric tons (MMT) in 2016—as the next-highest state, California at 361 MMT *(Chart 2)*. Texas' emissions have increased by 13 MMT since 2001 despite dipping in 2009, when the Great Recession depressed industrial production. By comparison, California reduced its discharge by more than 20 MMT during the period.

Petrochemical, Refinery Output

Texas was about 8.4 percent of the nation's economy in 2016, but it produced 13 percent of the nation's carbon emissions. The Energy Information Administration (EIA) breaks down its emission estimates, based on fuel consumption, into groups. Nearly all of Texas' CO_2 pollution came from three of them: transportation, electric power and industrial *(Chart 3)*.

The EIA-estimated carbon emissions don't include the flaring of natural gas, common in the Permian Basin energy production sites in West Texas.[6] Reported flaring in Texas was responsible for nearly 4.8 MMT of CO_2 in 2016, representing a statewide emissions increase of 0.7 percent in 2016.[7]

Nationally, the industrial sector accounted for 18 percent of emissions in 2016. That compares with 30 percent in Texas, the equivalent of 198 MMT of CO_2. The fuels responsible for most of the industrial sector's CO_2 were natural gas (102 MMT) and "other" petroleum (95 MMT).[8]

Texas' high industrial share largely results from the production of energy-intensive goods such as motor fuels and petrochemicals, which yields substantial CO_2 waste. The state is home to 30 percent of U.S. refining capacity and 70 percent of the nation's basic petrochemical capacity.[9] These industries rely on crude oil, natural gas liquids (NGLs) and natural gas as material inputs for manufacturing as well as for power in the production of these goods. Indeed, mining, bulk chemical production and refining combined account for about 58 percent of total U.S. industrial energy consumption.

Texas produced nearly half of U.S. crude oil and NGLs and nearly a quarter of the nation's output of natural gas in 2016.[10] Rising production from prominent shale regions, such as the Permian Basin, substantially damped energy costs. This incentivized increased utilization and investment at refineries and induced the petrochemical industry to engage in a decade-long build-out of capacity focused on exports, contributing to Texas' carbon footprint.

Role of Transportation

Transportation was the largest contributor to Texas CO_2 emissions—totaling 225 MMT—for a second consecutive year in 2016. The number of passenger vehicles—cars, pickups, minivans and SUVs weighing less than 6,000 pounds—amounted to approximately 0.9 vehicles per person that year. The ratio has remained roughly

constant as the number of registered vehicles has kept pace with population growth, yielding a 17 percent increase in daily light-duty vehicle miles traveled in Texas from 2001 to 2016.[11]

However, rising fuel economy has helped hold down emissions growth. For example, the fuel economy of an entry-level Toyota Camry and a Ford F-150—the most common vehicles in Texas—rose nearly 23 percent and 30 percent, respectively, from 2001 to 2016. Increasingly stringent federal fuel-efficiency mandates have played a role.

Electricity Generation Evolves

Electric power generation is another top carbon-emitting sector in Texas, contributing 208 MMT of CO_2 in 2016, 124 MMT of which came from coal. Coal emissions peaked in 2011 during a blistering heat wave and a long-term drought that lasted from May 2010 to July 2015.[12]

Since then, coal-fired plants have been retired, and coal has played a diminishing role in electric power as new capital investment favored relatively low-cost natural gas and renewables *(Chart 4)*.[13] Natural gas, though a fossil fuel and contributor to carbon emissions, is far cleaner than coal and has helped lessen power generation's environmental impact.

Texas has taken a leading role in the use of wind power, which has benefited from declining installation costs. Plentiful wind and policies, such as a state target for renewable energy and federal regulation of greenhouse gases, has helped make Texas the nation's top generator of electricity from renewable fuels, excluding hydroelectric, since 2010.[14]

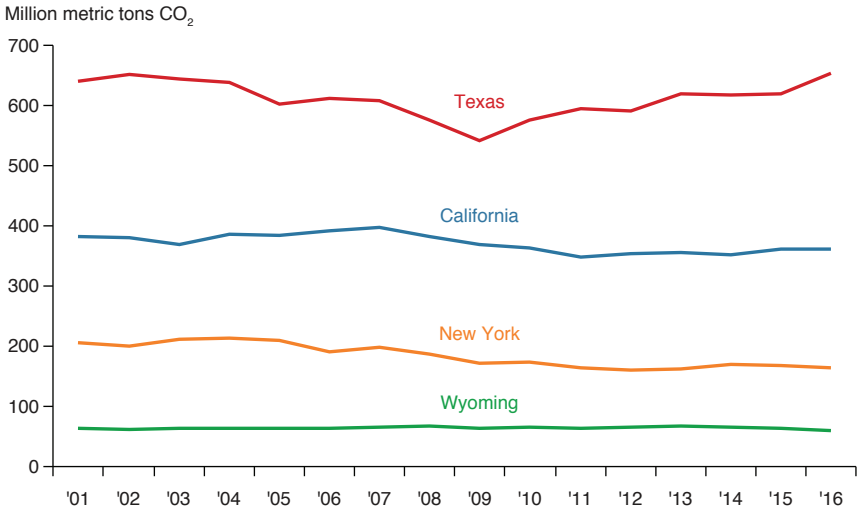
Texas, with its lower-carbon mix of electric generation capacity, produced more electricity per pound of carbon emitted than any other state and the most electricity overall in 2016. Texas emitted 1.5 metric tons of CO_2 per megawatt hour of electricity generated, compared with California's 1.8 metric tons. Renewables' share of Texas electricity has since risen. Wind-generated power increased 32 percent from 2016 to 2018, amounting to 75.8 million megawatt hours, or 16 percent of the total—equivalent to avoiding 59 MMT of CO_2 had that power been coal generated.

Federal, State Policy

Carbon emissions regulation is a fairly recent phenomenon. The Clean Air Act, approved in 1970 and amended in 1977 and 1990, was the first concerted national effort to curtail air pollution but targeted only particulates, mercury and sulfur compounds. It was not until 2007 that the Environmental Protection Agency included CO_2 and other greenhouse gases among pollutants to be regulated under the act.

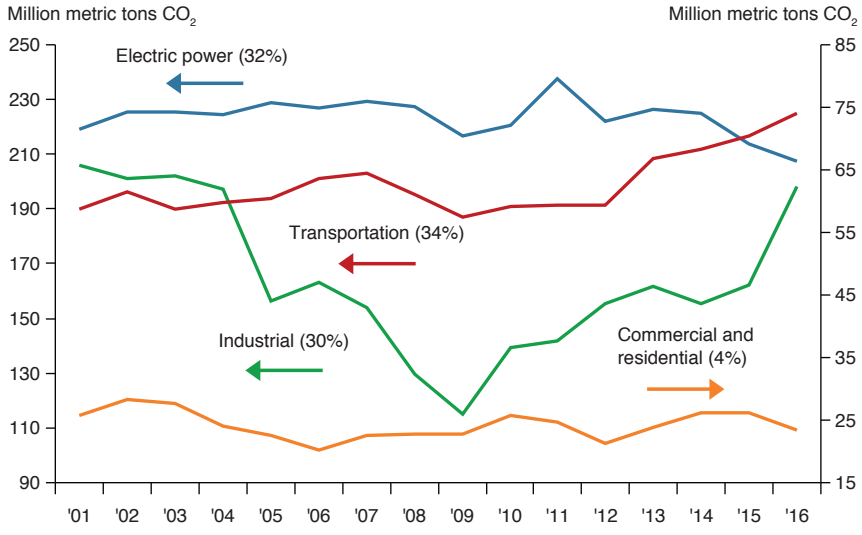
Emissions-reducing regulations in the U.S. have taken several forms. Some

CHART 2 Large-Population States Lead in Carbon Dioxide Emissions



SOURCE: Energy Information Administration.

CHART 3 Texas Industrial Carbon Emissions Growing Quickly



NOTE: Percentages represent share of total Texas carbon emissions in 2016.
SOURCE: Energy Information Administration.

stipulate limits to emissions that may require adopting compliant technologies, such as scrubbers in smokestacks to remove sulfur compounds, or curbing nitrogen oxides from some diesel engines. A national efficiency mandate, such as the Corporate Average Fuel Economy standard, sets targets for mileage and fuel consumption for new vehicles. These kinds of standards can also contribute to lower greenhouse gas emissions.

Several Texas Commission on Environmental Quality programs also support emissions reductions. The voluntary Texas Emissions Reduction Plan seeks to aid organizations that want to shrink their carbon footprint or get funding for related research and development. These programs subsidize purchases that improve fuel efficiency or enable a switch to less carbon-intensive fuels—such as converting diesel-powered equipment to natural gas.

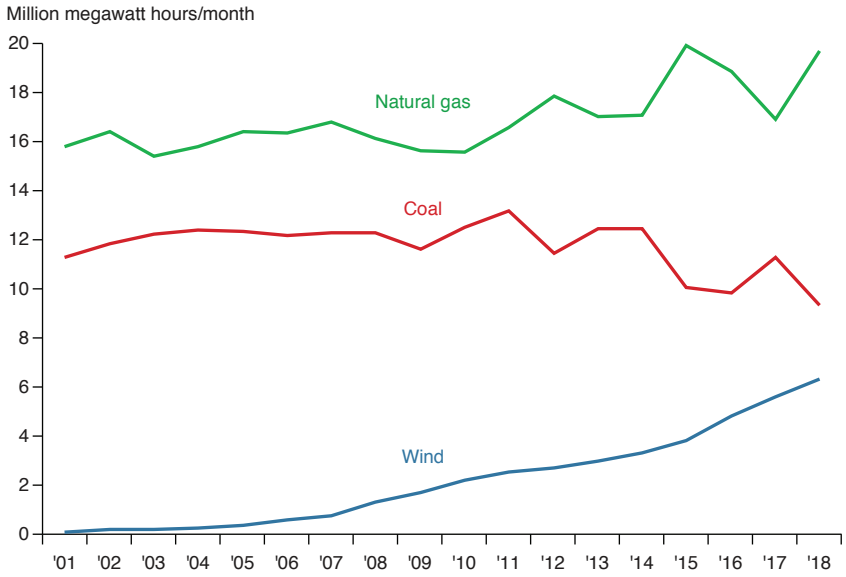
Many economists who have studied environmental policy favor setting prices on emissions rather than simply regulating them.[15] Taxing carbon or implementing cap-and-trade systems allowing emitting entities to pay for the ability to pollute are economic approaches that incentivize behavioral changes.

The European Union has a cap-and-trade framework, which limits the total carbon emissions allowed and allocates pollution rights across firms. Firms can then trade their right-to-pollute tons of CO_2 at a price determined in the marketplace. Texas uses a cap-and-trade approach on some emissions, such as sulfur dioxide, a pungent chemical that when emitted into the atmosphere contributes to acid rain and the formation of particulate-matter pollution that can exacerbate conditions such as asthma or heart disease.

Taxing carbon is another approach involving government intervention. Such a levy could involve extracting a specific "cost" for every ton of carbon emitted from burning fossil fuels. A U.S. carbon tax of $50 per ton in 2020, for example, would reduce carbon emissions by 11 to 25 percent in the first full year of implementation, one comparison of academic modeling exercises found.[16]

Most of the reductions would come through fuel switching from coal to natural gas in electric power generation and continue over the longer term. However, the lower emissions would come at a cost to energy producers and consumers, who would share the burden through higher prices on commodities such as coal, natural gas and gasoline. Simultaneously, demand would weaken for the energy that Texas produces—including crude oil and natural gas—as well as for refined goods and petrochemicals.

CHART 4 Wind, Natural Gas Rise as Sources of Texas Electricity Generation



SOURCE: Energy Information Administration.

Diversification Holds Promise

The concentration of the energy industry in Texas, both in production and processing, contributes to making carbon emissions bigger in Texas. However, the main driver is simply the size of the state's economy, accounting for the state's No. 18 ranking based on emissions per dollar of economic activity.

Policymakers, acting on climate change concerns, will likely implement policies that will slowly lead to decreased reliance on carbon-based energy over time. Texas can be better prepared for the future by continuing to diversify its sources of energy and overall economic activity.

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Dallas Fed President Rob Kaplan assesses climate change and its impacts on the Eleventh District in *Dallas Fed Economics*, **www.dallasfed.org/research/economics/2019/0627b.**

Notes

[1] Emissions data are based on estimates of the amount of CO_2 released in the consumption of different energy sources. Energy consumption comprises approximately 80 percent of total greenhouse emissions by weight on a carbon-equivalent basis. Other greenhouse gas emissions, such as methane or refrigerants, can be exponentially more potent, complicating state-to-state comparisons. See "Documentation for Estimates of State Energy-Related Carbon Dioxide Emissions," U.S. Energy Information Administration, October 2018, www.eia.gov/environment/emissions/state/pdf/statemethod.pdf.

[2] Federal Reserve Bank of Dallas calculation, chained 2012 dollars, based on U.S. Bureau of Economic Analysis and Energy Information Administration data.

[3] See U.S. Global Change Research Program, *Fourth National Climate Assessment*, vol. II, 2018, p. 39, https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf. Also see the Intergovernmental Panel on Climate Change, Climate Change 2014 Synthesis Report Summary for Policymakers, p. 4, www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf.

[4] See "Energy-Related Carbon Dioxide Emissions by State, 2005–2016," U.S. Energy Information Administration, February 2019, www.eia.gov/environment/emissions/state/analysis/.

[5] See note 3, U.S. Global Change Research Program, p. 990.

[6] Natural gas flaring is permitted as part of oil and gas operations for limited periods, primarily following well completions. See Texas Administrative Code Part 1, Chapter 3, Rule 3.32.

[7] Natural gas flaring emits approximately 120.7 pounds of CO_2 per thousand cubic feet of gas flared. State agencies provide flaring data to the U.S. Energy Information Administration. Texas vented and flared more than 87 billion cubic feet of natural gas in 2016. Satellite data analyzing flaring activity suggests that this reporting underestimates total flaring by as much as 50 percent. See "Flaring in Two Texas Shale Areas: Comparison of Bottom-Up with Top-Down Volume Estimates for 2012 to 2015," by Katherine Ann Willyard and Gunnar W. Schade, *Science of the Total Environment*, vol. 691, pp. 243–51, November 2019. Also see "Permian Natural Gas Flaring and Venting Reaching All-Time High," Rystad Energy, press release, June 4, 2019. www.rystadenergy.com/newsevents/news/press-releases/Permian-natural-gas-flaring-and-venting-reaching-all-time-high/.

[8] Other petroleum includes asphalt, coke, petroleum coke and miscellaneous hydrocarbon fuels.

[9] See "Booming Shale Production Drives Texas Petrochemical Surge," by Jesse Thompson, Federal Reserve Bank of Dallas *Southwest Economy*. Fourth Quarter, 2012; and "Shale Revolution Feeds Petrochemical Profits as Production Adapts," by Jesse Thompson, *Southwest Economy*, Fourth Quarter, 2013.

[10] Emissions from the oil and gas sector focus on the consumption of fuels such as diesel to operate drilling rigs or to fuel the thousands of truckloads of supplies needed for well production. Emissions from natural gas flaring are not included in the calculation. This likely contributes to an underestimation of total CO_2 emissions in Texas for the period. See note 7.

[11] Vehicle Titles and Registration Data, Texas Department of Motor Vehicles, June 2019.

[12] See "Drought in Texas," National Integrated Drought Information System, National Oceanic and Atmospheric Administration and Texas Water Development Board, and "The Drought Is Over in Texas," *Texas Tribune*, July 20, 2015.

[13] See "Pollution: More Natural Gas, Less Coal Pace CO_2 Emissions Drop," by Amy Jordan, Federal Reserve Bank of Dallas *Southwest Economy*, Fourth Quarter, 2012.

[14] See "Average U.S. Construction Costs for Solar and Wind Continued to Fall in 2016," U.S. Energy Information Administration, *Today in Energy*, Aug. 8, 2018; and "Wind Generators' Cost Declines Reflect Technology Improvements and Siting Decisions," U.S. Energy Information Administration, *Today in Energy*, July 12, 2018. See "Abundant Sunshine Not Enough to Power Texas Residential Solar Energy," by Benjamin Meier and Jesse Thompson, Federal Reserve Bank of Dallas *Southwest Economy*, First Quarter, 2019.

[15] See "Climate Change and the Federal Reserve," by Glenn Rudebusch, Federal Reserve Bank of San Francisco *Economic Letter*, March 25, 2019, and "Global Perspectives: Greg Mankiw on Economic Advice, Climate Change and Trade," by Mark Wynne, Federal Reserve Bank of Dallas *Dallas Fed Economics*, March 28, 2019.

[16] See "Policy Insights from the EMF 32 Study on U.S. Carbon Tax Scenarios," by Alexander R. Barron et al., *Climate Change Economics*, vol. 9, no. 1, February 2018, pp. 1–47.