

# Reduction in US carbon emissions attributed to cheaper natural gas

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This map shows the changes in carbon dioxide emissions from the power sector in the nine census regions of the contiguous United States, 2008-2009.

Researchers at the Harvard School of Engineering and Applied Sciences have attributed the decrease to the lower price of natural gas. Credit: Image courtesy of Xi Lu

In 2009, when the United States fell into economic recession, greenhouse gas emissions also fell, by 6.59 percent relative to 2008.

In the power sector, however, the recession was not the main cause.

Researchers at the Harvard School of Engineering and Applied Sciences (SEAS) have shown that the primary explanation for the reduction in CO<sub>2</sub> emissions from power generation that year was that a decrease in the price of natural gas reduced the industry's reliance on coal.

According to their econometric model, emissions could be cut further by the introduction of a carbon tax, with negligible impact on the price of electricity for consumers.

A regional analysis, assessing the long-term implications for [energy investment](#) and policy, appears in the journal [Environmental Science and Technology](#).

In the United States, the power sector is responsible for 40 percent of all [carbon emissions](#). In 2009, CO<sub>2</sub> emissions from power generation dropped by 8.76 percent. The researchers attribute that change to the new abundance of cheap natural gas.

"Generating 1 kilowatt-hour of electricity from coal releases twice as much CO<sub>2</sub> to the atmosphere as generating the same amount from natural gas, so a slight shift in the relative prices of coal and natural gas can result in a sharp drop in carbon emissions," explains Michael B. McElroy, Gilbert Butler Professor of Environmental Studies at SEAS, who led the study.

"That's what we saw in 2009," he says, "and we may well see it again."

Patterns of electricity generation, use, and pricing vary widely across the United States. In parts of the Midwest, for instance, almost half of the available power plants (by capacity) were built to process coal. [Electricity production](#) can only switch over to natural gas to the extent that gas-fired plants are available to meet the demand. By contrast, the Pacific states and New England barely rely on coal, so price differences there might make less of an impact.

To account for the many variables, McElroy and his colleagues at SEAS developed a model that considers nine regions separately.

Their model identifies the relationship between the cost of [electricity generation](#) from coal and gas and the fraction of electricity generated from coal.

"When the natural gas prices are high, as they were 4 years ago, if the gas prices come down a little bit, it doesn't make any difference," explains lead author Xi Lu, a postdoctoral associate at SEAS. "But there's a critical price level where the gas systems become more cost-effective than the oldest coal-fired systems.

"If the gas price continues to drop, you'll continue to go down this curve so that you'll knock out not just the really ancient coal-fired power plants, but maybe some of the more recent coal-fired plants."

The model also predicts that a government-imposed carbon tax on emissions from [power generation](#) would drive a move away from coal.

"With a relatively modest [carbon tax](#)—about \$5 per ton of CO<sub>2</sub>—you could save 31 million tons of CO<sub>2</sub> in the [United States](#), and that would change the price of electricity by a barely noticeable amount," says McElroy.

The initial model was developed by Jackson Salovaara '11, an applied mathematics concentrator at SEAS. His work was recognized as the "best senior thesis" in the Harvard Environmental Economics Program, earning him the Stone Prize in May 2011.

Since then, the model has been "souped up," incorporating more sophisticated regional data analysis, and producing not just the findings on 2009 but also predictions for more recent years.

"While the data from 2011 are not yet available, based on the gas prices, we're making a confident prediction that there should be a continued

shift from coal to [natural gas](#) in 2011 as compared to 2008," says McElroy.

"That's good news for the atmosphere."

Provided by Harvard University

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