Utilization of Natural Gas Capacity in Response to U.S. Clean Power Plan

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Overview

The core of the U.S. Environmental Protection Agency's Clean Power Plan (CPP) is a set of state-level targets for carbon dioxide emissions per megawatt-hour of electricity generation. A key assumption underlying the targets is that states will be able to raise the utilization rate (capacity factor) of natural gas combined cycle (NCGG) plants to 70%. However, that is far from current practice: in 2014, the average capacity factor for those plants was only 40%. While on average NGCC plants are running at below baseload levels, there have been substantial increases in NGCC utilization in the last ten years for some plants in particular parts of the country. This paper examines the factors that have driven NGCC utilization since the natural gas capacity buildout in the early 2000s. It builds on previous work examining the role of natural gas price decreases on natural gas generation, but expands the analysis to consider environmental policies and other factors. This study also focuses specifically on NGCC capacity factors, the natural gas fired technology targeted by the CPP. The results are used to run a counterfactual analysis to evaluate the relative contribution of environmental policies versus the decrease in natural gas prices on NGCC utilization.

Methods

This study uses EIA and EPA data from 2003-2014 on U.S. power plants. The first section uses a random effects model to evaluate the role of environmental policies for both conventional and greenhouse gas pollutants on monthly NGCC capacity factors. It includes controls for seasonality, energy demand, and fuel supply, as well as plant and area characteristics. Using the results from this model, I run a counterfactual decomposition analysis to measure the impact of the policies and low natural gas prices on NGCC utilization and carbon dioxide emissions.

Results

The random effects model shows three main factors are associated with increases in capacity factors: (1) criteria pollutant policies such as ozone nonattainment and interstate air pollution transport policies, (2) regional and state greenhouse gas programs, and (3) low natural gas prices. In addition to these factors, plant and area characteristics such as the size and the age of the generators, fuel mix in the region, and meteorological conditions play a role in NGCC utilization responses. The counterfactual analysis using the model's results show the combined impact of the policies had approximately three times the effect of the natural gas price decreases since 2007 on NGCC generation. The policy impact is equivalent to a $17.55 carbon tax applied over the period 2003-2014. This increase in NGCC generation due to the environmental policies averted approximately 3.5% of all U.S. electric sector carbon dioxide emissions in 2014 by replacing coal generation.

Conclusions

The findings show that several policy mechanisms mentioned in the CPP, such as regional greenhouse gas programs, have contributed to increases in NGCC utilization thus far. There is also a substantial co-benefit from criteria pollutant policies in incentivizing increased NGCC utilization, which in turn reduce carbon dioxide emissions. Despite these policy efforts, few plants have run at high capacity factors despite low natural gas prices and environmental policies that favor gas over coal. The fuel mix of the area, age, and size of the generators can alter these relationships. Finally, the results raise an important cautionary note for the CPP: capacity factors increase most in years with anonymously warm winters and hot summers. The base year used by the EPA in setting state targets, 2012, was unusual in exactly that respect: it had an exceptionally warm winter followed by an anomalously hot summer. The CPP may thus overstate the rate at which capacity factors are likely to increase without the help of additional incentives.