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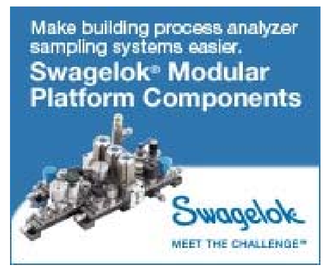

Short Run Effects of a Price on Carbon Dioxide Emissions

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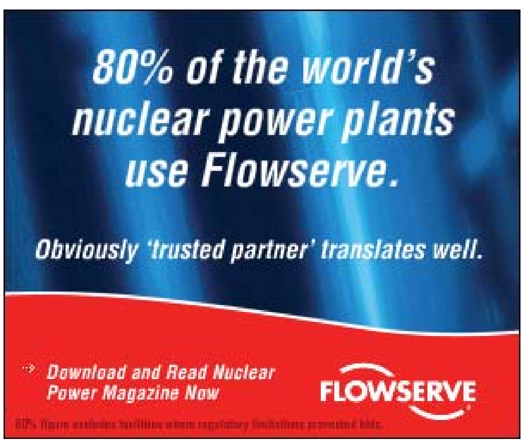

The Study

The price of delivered electricity will rise if generators have to pay for carbon dioxide emissions through an implicit or explicit mechanism.

There are two main effects that a substantial price on CO_2 emissions would have in the short run (before the generation fleet changes significantly). First, consumers would react to increased price by buying less, described by their price elasticity of demand. Second, a price on CO_2 emissions would change the order in which existing generators are economically dispatched, depending on their carbon dioxide emissions and marginal fuel prices.

Both the price increase and dispatch changes depend on the mix of generation technologies and fuels in the region available for dispatch, although the consumer response to higher prices is the dominant effect. This study estimates that the instantaneous imposition of a price of $35 per metric ton on CO_2 emissions would lead to a 10 percent reduction in CO_2 emissions in PJM and MISO at a price elasticity of -0.1. Reductions in ERCOT would be about one-third as large. Thus, a price on CO_2 emissions that has been shown in earlier work to stimulate investment in new generation technology also provides significant CO_2 reductions before new technology is deployed at large scale.

Recent judicial, political and industrial actions suggest that there may soon be either an explicit or implicit price on CO_2 emissions in the United States. Because 72 percent of the electricity generated in the U.S. comes from fossil fuels (50 percent from coal) a price on carbon emissions will increase the cost of generating electricity. Previous studies have examined the effects of the price of emitted CO_2 on firm-level decisions about what type of generation to build, and on whether to retrofit or replace an existing plant. These studies have generally found that costs of between $35 and $50 per metric ton of CO_2 will be required to induce private firms to invest in low-carbon technologies such as coal with carbon capture and sequestration.

Here we consider the short run effects of imposing such prices on the CO_2 emissions of the existing fleet of generation plants. That is, we consider the effects on electricity price and demand before any new or replacement capacity can be built. The replacement time for U.S. generation plants has been very long (the median size-weighted age of the in-service coal generation units is 35 years; 75 percent of the capacity is at least 27 years old, and 25 percent is at least 42 years old). While replacement rates would likely increase with carbon controls, clearly short run marginal carbon emission reductions are an important policy metric.

With a carbon price, electric generation units powered by fossil fuels will have increased marginal costs. In the short run (before changes in the mix of available generation could be brought online), demand for electricity could be met at the lowest cost by redispatching existing generation assets according to their marginal costs, including the costs of their carbon emissions, taking into account transmission constraints.

The resulting change in electricity price due to a price on carbon depends on the portfolio of generation facilities available for dispatch and on the demand for electricity. Regions with significant amounts of low-carbon generation, such as nuclear, hydroelectricity, or natural gas, would see smaller increases in generation costs, while areas that are predominantly supplied by coal generation facilities would see larger increases in short run electricity prices.

We examine the effects of a carbon price on electricity demand in three U.S. Independent System Operator (ISO) or Regional Transmission Organization (RTO) regions. We simulate the imposition of a carbon price in the Midwest ISO, ERCOT (Texas), and PJM, and calculate the resulting change in carbon dioxide emissions in each area. We quantify the effect of a carbon price on load by first redispatching existing generators in these control areas under a range of carbon prices to determine the electricity price increase due to a carbon price, and then by analyzing a range of consumers' price elasticity of demand in response to the increase in electricity price.

A price for carbon emissions can change the demand for each fuel, since it can affect the order of dispatch of the generators. We find that a carbon dioxide price of $50 per ton or less has a small effect on the dispatch order between coal and natural gas generators (heat rate, rather than fuel, has the largest dispatch order effect). Some low-carbon plants (for example, biomass) are dispatched before fossil plants at high carbon prices, but they do not account for much capacity. The main short run effect of the price increase is to lower the demand for electricity. In the long run, consumers may respond to higher electricity prices by adjusting their stock of goods that are powered by electricity (for example, they may purchase more energy-efficient appliances); in the short run they can only curtail use.

We emphasize that our analysis is confined to the short run, where the capital stock held by consumers is assumed not to change as a result of electricity price increases. Our analysis is a partial equilibrium analysis in that we hold the prices for various generation fuels constant, however we examine the effects of fuel prices on our results.

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