The Environmental Impacts of Fuel Switching Electricity Generators

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We examine the environmental and policy impacts of switching from oil-fired to natural gas-fired generation in New York City (NYC). The fracking revolution has led to huge decreases in the price of natural gas. While natural gas fired electricity generation used to be expensive and reserved for satisfying peak demand, cheap natural gas has changed the dynamics of the electricity market. As use of natural gas as a fuel has increased, the pollution emissions associated with electricity generation have decreased. In this paper we estimate the environmental benefits of the switch to natural gas and evaluate the impact of switching fuels on energy policy.

In addition to being a large and important electricity market, for reliability reasons New York City requires at least 80% of the electricity consumed in the city to be generated in the city. Environmental regulations ensure that there are no coal-fired power plants in the city, so generators are limited to choosing between oil and natural gas. This makes New York an ideal test bed to study the impact of fuel switching. We know that most demand in New York is met by generation in New York, and that changes in fuels will have an impact on emissions in the city.

To estimate the environmental impact of fuel switching we develop a new techinque that uses hourly data on pollution emissions reported by the Environmental Protection Agency to infer what fuel the plant is using. We use this technique to create an hourly panel of the fuel use at each of NYC's 18 power plants. We then employ a semi-parametric regression approach to identify the fuel price spread that induces the switch from oil to gas. We also estimate how pollution emissions vary with the relative prices of oil and natural gas.

The reliability requirement ensures that the level of generation at power plants in the city does not change with fuel prices. This suggests that we have to isolate the marginal power plants that are likely to respond to fuel price changes in our sample. The results show that when the price of oil exceeds the price of natural gas by more than about $4 per mmBTU, there is a large increase in gas-fired generation. The impact is particularly pronounced at low levels of demand. Not surprisingly, pollution emissions decrease significantly as a function of the switch to natural gas. Around two-thirds of these emission reductions come from reduced emission intensity within plants, while the remaining third comes from less intense dispatch of oil-fired generators.

Fuel switching at electric power plants can have a significant impact on existing and proposed energy policies. Because fuel switching reduces emissions by different amounts throughout the day, any policy that shifts generation (bulk storage) or demand (peak shaving) will be affected by fuel swiching.

To illustrate the policy impact, we simulate the introduction of a real time pricing (RTP)

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program in NYC. We employ existing estimates from the literature and New York City electricity prices to predict how RTP will change demand for each hour of each day in our study period. We take those demand changes and multiply them by the pollution intensity at different levels of oil and natural gas prices.

The results suggest that RTP reduces demand by less in the current cheap natural gas environment because peak electricity prices do not rise as high. The environmental benefits of RTP also decrease as the generation that is offset during the peak hours is relatively cleaner. In total our estimates suggest that the environmental benefits of RTP decreased by nearly 30% due to fuel switching from oil to natural gas. While we focus on RTP, these results can be used to evaluate any energy policy that has a heterogeneous impact across time or the demand profile. The environmental impacts of existing energy policies need to be re-evaluated to take into account the impact of changing fuel prices and future environmental impact and cost-benefit analyses need to take into account a range of possible fuel prices to ensure that policies are justified no matter what happens to fuel price.