Investment, Emissions, and Reliability in Electricity Markets*

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Abstract

How should we design electricity markets to promote investment in clean energy while maintaining a reliable electricity grid with a low likelihood of blackouts? These two topics are related because zero-emission renewable energy sources, such as wind and solar, are intermittent. Their supply is less reliable than traditional, greenhouse gas-emitting generators like coal and natural gas, so an increasing share of renewables can potentially lead to increased blackouts if the addition of intermittent renewables causes these generators to retire. Quantifying the full impact of electricity market policies therefore requires an understanding of how investment responds in equilibrium. To that end, I build a structural equilibrium model of investment and dis-investment in generators of different energy sources. Oligopolistic firms make dynamic decisions to build or retire generators based on the profits they receive from wholesale electricity markets, which respond to the composition of generators in the market. I estimate this model using data from the Western Australia Wholesale Electricity Market and use the estimated model to simulate investment and production under counterfactual policies. Carbon taxes reduce emissions but, for certain values, can cause an increase in the likelihood of blackouts by causing retirement of coal and some natural gas generators. Subsidizing capacity prevents this from occurring, but at the expense of a high level of emissions. Using both policies together, however, keeps high-emitting but reliable generators in the market but prevents them from being used unless necessary, substantially lowering emissions while keeping the likelihood of blackouts low. I also explore alternative environmental policies, which are less effective at reducing emissions but have a lower cost on consumer surplus.

Keywords: electricity, renewable energy, market structure, investment, capacity payments, greenhouse gas emissions

JEL Classification: L11, L13, L94, Q41, Q52

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