# *ELECTRICITY MARKETS, RENEWABLES COMPETITION AND FORWARD CONTRACTING*

Robert A. Ritz, Cambridge University (EPRG), +44 (0)1223 766638, rar36@cam.ac.uk

## Overview

Renewables such as solar and wind already account for up to 30% of power generation capacity in the UK, Germany and parts of the US (Borenstein 2012; Pollitt & Anaya 2015) – and global decarbonization objectives will require further large-scale investment. Due to their near-zero marginal costs, renewables come with a well-known "merit-order effect" by which they displace conventional electricity generators (e.g., Green & Leautier 2015, Liski & Vehvilainen 2015).

This paper examines theoretically how renewables competition affects forward contracting by conventional generators in a wholesale electricity market. It finds that higher renewables penetration reduces their incentive to sell forward electricity, and thus undermines the much-discussed role of forward contracting in mitigating market power. Due to this forward-contracting effect, more renewables can *raise* wholesale electricity prices in states of the world where their capacity utilization is low due to intermittency. The analysis suggests that the knock-on effect of renewables on competition via forward contracting may deserve more attention from policymakers and analysts.

## Methods

Microeconomics & game theory

The literature on wholesale electricity markets places significant emphasis on how forward contracting can mitigate market power (e.g., Wolak 2000; Ausubel & Cramton 2010). This line of argument gained prominence especially following California's electricity crisis in the early 2000s. Such forward commitments can take the form of forward contracting (Allaz & Vila 1993) or retail market sales which are contracted before spot-market competition takes place (Bushnell, Mansur & Saravia 2008). In practice, power generators indeed sell forward a significant fraction of production (Anderson, Hua & Winchester 2007).

The model presented is a generalized version of the workhorse model due to Allaz & Vila (1993), which identifies the *strategic* incentive of firms to engage in forward contracting and is widely used in the study of wholesale electricity markets. This paper extends their model to (i) incorporate renewables production as well as its intermittent nature across different states of the world, and (ii) allow for several conventional generation technologies with different cost structures.

## Results

The first key finding is that more renewables competition reduces the equilibrium degree of forward contracting by conventional generators. In the model, more renewables displace "incumbent" electricity production along the lines of the merit-order effect. However, this makes the market less attractive to conventional generators, which reduces their incentive to make forward commitments to it. Renewables thus *directly* raise the intensity of competition in the wholesale market (by way of additional capacity) but *indirectly* reduce the intensity of rivalry amongst conventional generators (by reducing forward contracting).

The second key finding is that electricity prices can sometimes *rise* due to higher renewables competition. The merit-order effect – which pushes price down – is always present but is weaker in states of the world where the load factor of renewables is low. By contrast, the above forward-contracting effect – which pushes price up – is equally strong across all states of the world. So the price rises for states in which the intermittency of renewables is pronounced. For example, in a market with six incumbent players the electricity price rises in states of the world where renewables' capacity utilization is below 80% of its average.

## Conclusions

The paper concludes with a discussion of how the main insights from the analysis are likely robust to (i) demand uncertainty, (ii) shutdown and market exit of conventional plant, (iii) increasing marginal costs of production, and (iv) (moderate) risk aversion of conventional producers. These results should lend themselves naturally to empirical and experimental testing. Future research could also pursue a welfare analysis that incorporates the cost side of renewables investment as well as the social value of the carbon emissions reductions achieved.

## References


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