The Economics of Renewables Expansion: Price and Profit Impacts in France

Sai BRAVO, I-Tésé, French Alternative Energies and Atomic Energy Commission (CEA), Université Paris Saclay, +33169085268, sai.bravomelgarejo@cea.fr

Overview

The integration of intermittent renewable energy sources—with near-zero marginal costs—into electricity markets has generally led to a decrease in wholesale electricity prices, a phenomenon known as the merit-order effect (Sensfuß, Ragwitz, and Genoese, 2008; De Lagarde and Lantz, 2018). However, Bushnell and Novan (2021) showed that this effect is not necessarily consistent throughout the day, with prices increasing during certain hours. These structural changes raise important questions about the operations and profitability of other generation sources.

This paper examines the long-term effects of renewable capacity expansions on electricity prices and the production of other generation sources in France, using data from 2015 to 2024. Specifically, it investigates how the growth of solar and wind energy has influenced hourly wholesale electricity prices, as well as the production and profitability of other generation sources. France is a particularly interesting case study because, unlike in other markets where renewables have displaced production from traditional high-emission sources, the French market has traditionally been dominated by a low-carbon source: nuclear power.

Methods

The analysis focuses on the long-run effects of intermittent renewable energy sources which unlike short-term term effects, attributed to weather variability (Ekoue, Woerman and Clastres, 2024), are driven by capacity expansions. To examine this relationship, I estimate a Newey-West regression model, which accounts for heteroskedasticity and autocorrelation in the residuals, providing robust estimates of the hourly impact of solar and wind energy on wholesale electricity prices as well as other generation sources. The model incorporates renewable energy potential indicators for solar, wind, and hydro, which reflect the maximum possible electricity generation based on installed capacities and weather conditions, which are independent of market curtailment. For nuclear and hydro, operational constraints, such as plant maintenance schedules, are included to better account for actual availability and capacity limits. Additionally, following the framework of Bushnell and Novan (2021), I investigate how solar and wind capacity expansions displace production from other generation sources and influence their profitability.

Results

This study seeks to show that the impact of solar and wind energy growth in France, on wholesale electricity prices varies throughout the day. Previous research has shown that solar capacity expansions tend to reduce mid-day electricity prices while increasing prices during shoulder hours in markets like California (Bushnell and Novan, 2021). Xiao and Mu (2024) found that, instead, wind energy capacity expansion has consistently lowered prices throughout the day in the United Kingdom. Unlike these markets, which are dominated by a particular intermittent renewable source, France has a more balanced mix of installed wind and solar capacity. Furthermore, while solar and wind energy expansion in other regions has primarily displaced production from high-emission sources such as coal and gas—leading to a significant reduction of carbon emissions—the French electricity market may experience a different dynamic given the large presence of nuclear energy.

Conclusion

The conclusions of this study will highlight how the French electricity market is adapting to solar and wind energy growth, including potential shifts in the production of other generation sources and their profitability, highlighting the interplay between market dynamics, renewables expansion, and the role of existing low-carbon technologies.

References

Bushnell, James. and Novan, Kevin. 2021. Setting with the Sun: The Impacts of Renewable Energy on Conventional Generation, Journal of the Association of Environmental and Resource Economists, University of Chicago Press, vol. 8(4), pages 759-796.

Ekoue, Maurice K. and Woerman, Matt and Clastres, Cédric. 2024. Intermittency and Uncertainty in Wind and Solar Energy: Impacts on the French Electricity Market. Available at SSRN: https://ssrn.com/abstract=4906729 or http://dx.doi.org/10.2139/ssrn.4906729

De Lagarde, Cyril Martin. and Lantz, Frédéric. 2018. How renewable production depresses electricity prices: Evidence from the German market, *Energy Policy*, vol 117, pages 263-277.

Sensfuß, Frank, Ragwitz, Mario and Genoese, Massimo. 2008. The merit-order effect: A detailed analysis of the price effect of renewable electricity generation on spot market prices in Germany, *Energy Policy*, **36**, issue 8, pages 3076-3084.

Xiao, H. and Mu, X., 2024. The Intraday Impacts of Wind Energy on Wholesale Electricity Prices and Carbon Emissions in Great Britain.