HEDGING INSTRUMENTS IN ELECTRICITY MARKETS FOR NEW TECHNOLOGIES – A LONG-TERM PERSPECTIVE

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Overview

This paper investigates the need for hedging products for the power sector for new technologies and the impact on investments in these technologies. The methods are adopted from de Maere d'Aertrycke et al. [1] and applied to storage and demand response. According to existing literature (de Maere d'Aertrycke et al. [2]) there is a need for long-term contracts for conventional power generation technologies. However, financial markets do not offer long-term hedging possibilities for capacities due to the fact that contracts become illiquid for a maturity beyond four years (Genoese et al. [3]). New extensions of the recent risk trading in capacity equilibrium models of de Maere d'Aertrycke et al. in [1] are developed for addressing these topics. The suitability of hedging products for flexibility providers such as storage and demand response and the impact on investment are examined in an equilibrium framework using optimization as well as MCP formulations (Mixed Complementarity Problems).

Methods

The methods are adopted from de Maere d'Aertrycke et al. [1], who developed a framework for analyzing the liquidity and suitability of hedging products under endogenous investment decisions in several technologies (each represented by one agent). We apply and extend this methodology to the hedging needs of new technologies such as storage and demand response. Next to investment in base and peak load plants, this paper also considers investment in storage (and demand response) technologies. The modelled market is the competitive electricity spot-market and long-term contract markets[1].

The four different methodological approaches, which are considered in the paper are (1) a stochastic capacity expansion problem of a risk-neutral agent in a complete market – the idealized benchmark case formulated as an optimization problem, (2) a Nash-Game simplified to an optimization problem in a complete and risky market with hedging, (3) an equilibrium problem in an incomplete market with no hedging and (4) an equilibrium problem with financial options like traditional base load contracts.

All four models described in this paper are implemented in the Julia programming language and use the JuMP package as an algebraic modelling language in combination with several packages serving as links to the examined solvers. Julia is a high-level, high-performance dynamic programming language for numerical computing. Libraries in Julia can be written entirely in the Julia language itself and Julia is fully open source.

Results

Preliminary results show the importance of suitable hedging products for investment decisions of different market actors. Absent future markets lead to insufficient investment overall (as already shown by de Maere d'Aertrycke et al. in [2]) and thus scarcity of capacity. Limited futures markets (in terms of hedging product types) are here also shown to lead to insufficient investment incentives for new technologies who cannot adequately hedge their production profiles with traditional product types (i.e. hedging a flexibility option with a base load contract).

Conclusions

The contributions of this paper to the existing literature are an extension of the novel methodologies introduced by de Maere d'Aertrycke et al. [1] to investigate the liquidity of futures markets and their impact on investment decisions. This paper extends the analysis to new actor types such as demand response and storage. We find that there is a need to introduce new matching hedging products in future markets in order to avoid technological bias against new market actors such as storage and demand response.

[1] Market power as also considered by de Maere d'Aertrycke et al. [1] in alternative formulations lie outside the scope of this paper.

References

[1] Gauthier de Maere d'Aertrycke, Andreas Ehrenmann, Daniel Ralph and Yves Smeers. "Risk trading in capacity equilibrium models". In: Cambridge Working Paper in Economics 1757 (2017). url: https://www.eprg.group.cam.ac.uk/wp-content/uploads/2018/01/1720-Text.pdf.

[2] Gauthier de Maere d'Aertrycke, Andreas Ehrenmann, and Yves Smeers. "Investment with incomplete markets for risk: The need for long-term contracts". In: Energy Policy105 (2017),pp. 571–583.issn: 0301-4215.doi:https://doi.org/10.1016/j.enpol.2017.01.029.url:http://www.sciencedirect.com/science/article/pii/S0301421517300411.

[3] Fabio Genoese, Eleanor Drabik, and Christian Egenhofer. "The EU Power Sector Needs Long-Term Price Signals". In: CEPS Special Report No.135 (2016). url: https://www.ceps.eu/system/files/SR135%20LongTermPriceSignals_0.pdf.