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Dynamic Long-Term Modelling of Generation Capacity Investment and Capacity Margins: a GB Market Case Study

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Abstract

Many governments who preside over liberalised energy markets are developing policies aimed at promoting investment in renewable generation whilst maintaining the level of security of supply customers have come to expect. Of particular interest is the mix and amount of generation investment over time in response to policies promoting high penetrations of variable output renewable power such as wind.

Modelling the dynamics of merchant generation investment in market environments can inform the debate. Such models need improved methods to calculate expected output, costs and revenue of thermal generation subject to varying load and random independent thermal outages in a power system with high penetrations of wind.

This paper presents a dynamic simulation model of the aggregated Great Britain (GB) generation investment market. The short-term energy market is simulated using probabilistic production costing based on the Mix of Normals distribution technique with a residual load calculation (load net of wind output). Price mark-ups due to market power are accounted for. These models are embedded in a dynamic model in which generation companies use a Value at Risk (VaR) criterion for investment decisions. An `energy-only' market setting is used to estimate the economic profitability of investments and forecast the evolution of

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security of supply. Simulated results for the GB market case study show a pattern of increased relative security of supply risk during the 2020s. In addition, fixed cost recovery for many new investments can only occur during years in which more frequent supply shortages push energy prices higher. A sensitivity analyses on a number of key model assumptions provides insight into factors affecting the simulated timing and level of generation investment. This is achieved by considering the relative change in simulated levels of security of supply risk metric such as de-rated capacity margins and expected energy unserved.

The model can be used as a decision support tool in policy design, in particular how to address the increased `energy-only' market revenue risk facing thermal generation, particularly peaking units, that rely on a small number of high price periods to recover fixed costs and make adequate returns on investment.

Keywords Power generation economics, Mix of Normals distribution, Thermal power generation, Wind power generation.

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