



A Unit Commitment and Economic Dispatch Model of the GB Electricity Market – Formulation and Application to Hydro Pumped Storage

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Abstract We present a well calibrated unit commitment and economic dispatch model of the GB electricity market and applied it to the economic analysis of the four existing hydro pumped storage (PS) stations in GB. We found that with more wind on the system PS arbitrage revenue increases: with every percentage point (p.p) increase in wind capacity the total PS arbitrage profit increases by 0.21 p.p.. However, under a range of wind capacity, the PS' modelled revenue from price arbitrage is not enough to cover their ongoing fixed costs. Analysing the 2015-18 GB balancing and ancillary services data suggests that PS stations were not active in managing transmission constraints and in fact about 60% of constraint payments went to gas-fired units. However, the PS stations are active in provision of ancillary services such as fast reserve, response and other reserve services with a combined market share of at least 30% in 2018. Stacking up the modelled revenue from price arbitrage with the 2018 balancing and ancillary services revenues against the ongoing fixed costs suggests that the four existing PS stations are profitable. Most of the revenue comes from balancing and ancillary services markets – about 75% – whereas only 25% comes from price arbitrage. However, the revenues will not be enough to cover capex and opex of a new 600 MW PS station. The gap in financing will have to come from balancing and ancillary services market opportunities and less so from purely price arbitrage. Finally, we found that the marginal contribution of most of the existing PS stations to gas and coal plant profitability is negative, while from the system point of view, PS stations do contribute to minimizing the total operating cost.

Keywords economic modelling; unit commitment; economic dispatch; electricity market modelling; hydro pumped energy storage; wind energy; solar energy; electrical energy storage investment

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