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CCGT unit commitment model with first-principle formulation of cycling costs due to fatigue damage

S. Wogrin, D. Galbally, A. Ramos

Abstract— Combined cycle gas turbine power plants (CCGTs) play a key role in modern electric power systems due to their operational flexibility and the firmness they provide to the networks where they operate. Due in part to this flexibility and firmness, the function of CCGTs has experienced a significant evolution with the advent of intermittent renewable energy sources such as wind: CCGTs are increasingly required to rapidly vary load levels in order to counterbalance the fluctuations of renewable energy sources and satisfy overall system demand. The purpose of this paper is to develop a methodology that can be used for assessing the optimal operational strategy of a CCGT when subjected to cycling requirements. This is achieved by introducing a unit commitment formulation that takes into account useful life expenditure costs due to fatigue damage accumulation associated to cycling. The case studies presented in this paper show that neglecting fatigue cycling costs when making operational decisions generates suboptimal cost and profit outcomes for CCGT operators. Furthermore, it is shown that profitability of CCGTs is compromised in systems with very significant penetration of intermittent renewable energy sources, due to the increase in cycling costs derived from continuous load-following operation.

Index Terms— CCGT; Combined cycle plants; Cycling costs; Fatigue damage; Unit commitment model; Wind penetration

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