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A computationally efficient formulation to accurately represent start-up costs in the medium-term unit commitment problem

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Abstract-

Nowadays, the changing paradigm in power systems highlights the necessity of improving detail in energy models. The deployment of non-dispatchable renewable energy resources that regulators traditionally promoted, like the European Union case and some areas of the United States, is being accelerated due to the enhanced competitiveness of clean technologies. However, the delay in the widespread use of non-conventional energy-storage techniques, like batteries, is causing an increase in the variability of the thermal-generated demand for electricity. Moreover, many coal-fired plants are being dismantled as a result of their end-of-life, new climate change policies, and high prices in the emissions allowances trading markets. Meanwhile, nuclear energy remains a backup generator but does not offer the possibility of boosting its operational flexibility. Thereby, combined cycles gas turbines are positioned as a key vector towards a clean energy transition, increasing their start-up and shut-down frequency for operating a lower number of hours than historically have done. Their fast ramping capabilities position them as the best alternative to cover demand peaks in the near term. Consequently, there is a growing interest in representing these thermal units properly. This paper exposes a great-detailed analysis of the start-up cost modeling to accomplish future market trends. Likewise, a new mathematical formulation of the unit commitment problem is also presented. Finally, the formulation is compared to one of the most renowned methodologies. Its successful performance is described in several case studies, where authentic power-demand curves and technical details of a gas-fired generation portfolio are handled in medium-term horizons.

Index Terms- unit commitment, start-up costs, medium-term, piecewise linearization, stairwise aggregation method, electricity markets, power systems, efficient formulation, optimization.

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