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Analyzing the computational performance of balance constraints in the medium-term unit commitment problem: tightness, compactness, and arduousness

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Abstract-

Since its beginning, the computational performance of numerical optimization techniques has depended on utilizing efficient mathematical formulations to deal with large-size problems successfully. This fact is manifested in the unit commitment literature. Several approaches have been proposed to handle the complexity of accurately modeling real power systems. However, most of these methodologies focus on strengthening the technical features’ representations by reducing the number of constraints and variables of the associated optimization problem or approximating its relaxed feasible region to the integer one to improve resolution processes. Hence, the state-of-art of these effective procedures is periodically studied under operational research and commercial solvers developments. Nevertheless, the formulation comparisons frequently obviate analyzing the impact of the balance equations on the computational burden of the unit commitment problem. This constraint links every single technical restriction along the time span and sometimes provides an ample optimization space, sometimes a narrow one, directly affecting resolution proceedings. It can impose an electricity generation equal to demand, allow production excesses, include non-served energy, or establish profit-based relationships. This paper presents a computational analysis of the most popular balance equations, detailing solver performances and determining these methodologies’ tightness, compactness, and arduousness. Therefore, 1010 case studies were run utilizing different input profiles and optimality-convergence criteria.

Index Terms- Arduousness; Balance equation; Computational efficiency; Demand-constraint analysis; Medium-term representation; Optimization; Power systems; Thermal generation; Unit commitment

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