

A column generation approach to multiscale capacity planning for power-intensive process networks

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Due to the high volatility in electricity prices, power-intensive industrial plants often have to frequently shift load in order to remain cost-competitive. Capacity planning is required for assessing the value of additional operational flexibility and planning for expected changes in product demand. Here, the main challenge lies in the simultaneous consideration of long-term capacity planning and short-term operational decisions. In this work, we extend the multiscale model proposed by Mitra et al. (Comput Chem Eng 65:89-101, 2014a) to a formulation that applies a general process network representation and incorporates inventory handling across seasons. We propose a column generation approach to solve large instances of the resulting mixed-integer linear program (MILP). The algorithm decomposes the original problem into multiple MILP subproblems, while the restricted master problem is an integer program. Computational experiments demonstrate the effectiveness of the column generation algorithm, which clearly outperforms the full-space model, especially with increasing number of years in the planning horizon. Also, the results show that the master problem tends to yield integer solutions within the required optimality gap due to its strong linear programming relaxation, such that no further branching is required. Moreover, the proposed approach is applied to perform capacity planning for a real-world industrial air separation plant.