Cost-Optimal ATCs in Zonal Electricity Markets

In contrast to existing frameworks for Available Transfer Capacity (ATC) determination, we propose to define ATCs in an integrated and data-driven manner, optimizing for expected operational costs of the whole system to derive cost-optimal ATCs. These ATCs are purely financial parameters, separate from the physical ATCs based on security indices only typically used in zonal electricity markets today. Determining cost-optimal ATCs requires viewing ATCs as an endogenous market construct, and leads naturally to the definition of a market entity whose responsibility is to optimize ATCs. The optimization problem which this entity solves is a stochastic bilevel problem, which we decompose to yield a computationally tractable formulation. We show that cost-optimal ATCs depend non-trivially on the underlying network structure, and the problem of finding a set of cost-optimal ATCs is in general non-convex. On a European scale test system, cost-optimal ATCs achieve expected total costs midway between those for non-integrated ATCs and a fully stochastic nodal setup. This benefit comes from qualitatively different ATCs compared to typical definitions, with ATCs which exceed the physical cross-border capacity by a factor of 2 or more, and ATCs which are zero between well-connected areas. Our results indicate that the perceived efficiency gap between zonal and nodal markets may be exaggerated if non-optimal ATCs are used.