

PowSyBl RAO: an open-source toolbox to improve Power Grid European Coordination

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1 Context

Cross-borders exchanges have taken a major role in European strategy to achieve climate goals. The European Commission set a target of 15% interconnections in 2030, meaning that each country should have the physical capability to export at least 15% of their production. To achieve this goal, the European Union Agency for the Cooperation of Energy Regulators (ACER) urges European Transmission System Operators (TSO) to improve their coordination methodology in order to operate their networks closer to the margins, in line with a strong security of supply doctrine, and thus increase the cross-border capacities. This approach is made possible at the cost of more complex short term planning which leads to new decision problems.

2 Remedial Action Optimisation

Remedial Action Optimisation (RAO) plays a major role in the operation of the European electricity system. Indeed, RAO calculation is performed:

1. upstream of market clearing to compute feasible exchange domain between market zones: this step is called Coordinated Capacity Calculation (CCC).
2. downstream of market clearing to solve remaining contingency situations: this step is called Regional Operational Security Coordination (ROSC).

These two steps, which allow to ensure the security of supply in Europe, involves running simulations (load flow calculation) to detect violations on the network and then determining the preventive or curative actions to be implemented to resolve contingencies at the lowest possible cost.

This second stage is called Remedial Actions Optimisation (RAO) and consists in solving a Security Constrained Optimal Power Flow (SC OPF) problem with several complexity axis (Non-additive Remedial Actions, Integer / Combinatorial modelling, intertemporal constraints, recourses).

3 The PowSyBl RAO toolbox

The French TSO (Rte) released an open-source toolbox PowSyBl RAO [1], to which Artelys contributes, to perform Coordinated Capacity Calculation (CCC) and ensure the security of supply. PowSyBl RAO is composed of three nested algorithms:

1. Single-stage RAO: preventive remedial action optimization only
2. 2-stages RAO: preventive and curative remedial action optimization
3. Dichotomy: trial-and-error to find the optimal exchanges

These algorithms address the optimisation problem decomposed into 3 sub-problems (one per perimeter):

- firstly, the single-stage RAO makes it possible to determine a common preventive remedial action for all possible contingencies,
- then, each contingencies are solved separately to determine a corresponding curative remedial action,
- if residual constraints persist, they are added back into the preventive remedial action optimization and the two previous stages are re-launched,
- finally a dichotomy is performed to calculate the Total Transfer Capacity.

The core of this methodology is the single-stage RAO which combines a tree search heuristic to determine the topological remedial actions, a Security Constrained DC OPF to compute additive remedial actions and AC load flow simulation to validate the feasibility of solutions.

4 Conclusions & Perspectives

PowSyBI RAO is operationally used for the exchanges between Italy and its northern neighbors as well as between France, Spain and Portugal. And Artelys, as a consultancy expert in power systems optimization, leads several other implementation projects of this toolbox in Europe which provides us with a map of operational needs involving the resolution of SC OPF. These needs justify Artelys' research and development efforts on OPF problems for more than 10 years [2], which will be the subject of another talk during the RoadeF 2024 conference [3].

References

- [1] Fully Autonomous Remedial Actions Optimisation: *An open-source modular toolbox for power system coordination process*, <https://farao-community.github.io/>.
- [2] Ruiz Manuel, Maeght Jean, Marié Alexandre, Panciatici Patrick and Renaud Arnaud A progressive method to solve large-scale AC optimal power flow with discrete variables and control of the feasibility. In *2014 Power Systems Computation Conference*, (pp. 1-7). IEEE.
- [3] Nicolas Lair, Paul Champion, Richard Waltz and Vincent Renault. An Overview of Complementary Approaches for Grid Optimization. *ROADEF 2024*.