D1.2 Methodology to represent discrete decision variables in probabilistic optimisation models

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1. *Methodology to represent discrete decision variables in probabilistic optimisation models*

This document provides a brief summary of the methodological research conducted, which was developed in order to tractably present discrete decision variables in stochastic power system optimization problems, e.g., used to determine topological remedial actions.

1.1. Summary

The increase in renewable energy resources necessitates flexible and reliable power systems. This work addresses this need by proposing a Polynomial Chaos Expansion (PCE) based chance-constrained stochastic optimal transmission switching framework for hybrid AC/DC grids under non-Gaussian uncertainty. The framework includes discrete switching decision variables in the PCE domain which assumes the continuity of the uncertainty space. The integration of discrete variables into the PCE framework presents two difficulties: ensuring the continuity of the uncertainty space and maintaining the tractability of the framework. The former is overcome by framing the discrete variables within the context of decision-making under uncertainty, categorizing them as here-and-now decisions. To address this, non-anticipativity constraints are introduced to the PCE framework, aiding in preserving the continuity of the uncertainty space. The latter is handled by relaxing the binary variables. While the relaxation of binary variables is a well-established method in literature, this paper uniquely explores its implications on the PCE framework. In the paper, two case studies are conducted. First, the proposed method is compared against the SOPF and MINLP SOTS models in a 5-bus AC/DC test system. Second, the proposed method's susceptibility to binary relaxation is assessed in a 67-bus AC/DC test system.

The figures below shows that the taken relaxation approach (SOTS) can produce as accurate results as the classical integer formulation (SOTS MINLP) of the problem (fig. 7) whereas the computation time is at least one order of magnitude smaller (fig. 8).

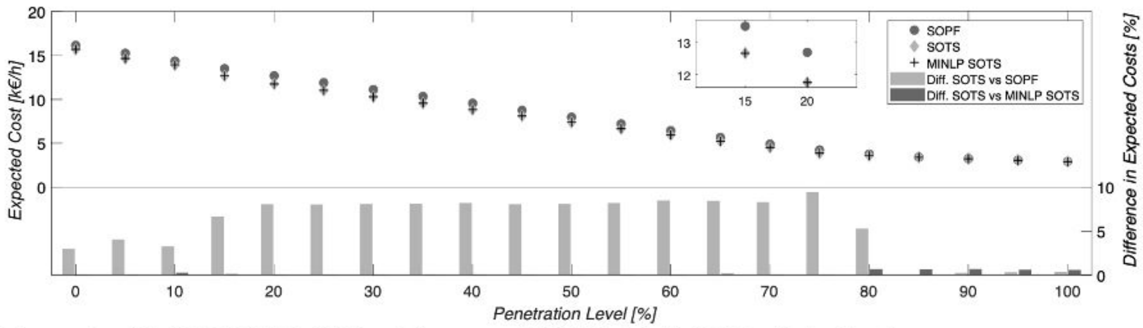

Fig. 7. Simulation results of the SOPF, MINLP SOTS, and the proposed SOTS for hybrid AC/DC grids in Case 1

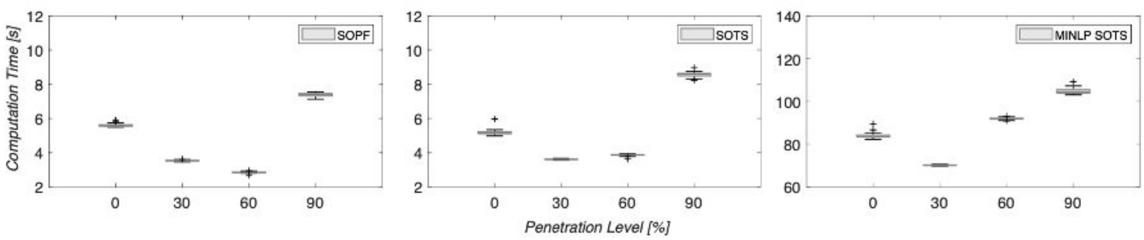

Fig. 8. Computational times in the SOPF, MINLP SOTS, and the proposed SOTS for hybrid AC/DC grids in Case 1