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Optimal design of the electrical layout of an offshore wind farm applying decomposition strategies

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Abstract-

Electrical layout design is a key element in offshore wind farm planning, with a critical impact on both plant cost and reliability. OffshoreWindfarm Layout optimizer (OWL) has been developed to efficiently find optimal electrical layouts in affordable computation times. The tool includes the possibility of HVDC connection and incorporates an approximation of losses, as well as stochasticity in wind inputs and component failures. OWL has been applied to several case studies including Barrow Offshore Wind Farm. OWL produces a significant cost reduction over the actually implemented design, with total realizable savings of EUR 800 k. The optimal layout includes redundant elements and deviates from a symmetrical pattern, therefore showing that a full optimization of the layout, rather than the selection of a pre-defined configuration, is necessary in order to fully capture efficiencies. The model relies on MIP and exploits the structure of the problem via decomposition strategies. Two different approaches have been developed, both resulting in substantial time savings. Benders’ decomposition has been further improved by the addition of partially relaxed cuts and the application of scenario aggregation techniques. In addition, the Progressive Contingency Incorporation algorithm proposed by the authors is applied. Computation time savings reach two orders of magnitude.

Index Terms- Circuit optimization, integer programming, power system planning, power system reliability, stochastic systems, wind power generation.

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